

Chapter 7**1 Groundwater Resources and
2 Groundwater Quality****3 7.1 Introduction**

4 This chapter describes groundwater resources and groundwater quality in the
5 Study Area, and potential changes that could occur as a result of implementing the
6 alternatives evaluated in this Environmental Impact Statement (EIS).
7 Implementation of the alternatives could affect groundwater resources through
8 potential changes in operation of the Central Valley Project (CVP) and State
9 Water Project (SWP) and ecosystem restoration.

**10 7.2 Regulatory Environment and Compliance
11 Requirements**

12 Potential actions that could be implemented under the alternatives evaluated in
13 this EIS could affect groundwater resources in the areas along the rivers impacted
14 by changes in the operations of CVP or SWP reservoirs and in the vicinity of and
15 lands served by CVP and SWP water supplies. Groundwater basins that may be
16 affected by implementation of the alternatives are in the Trinity River Region,
17 Central Valley Region, San Francisco Bay Area Region, Central Coast Region,
18 and Southern California Region.

19 Actions located on public agency lands or implemented, funded, or approved by
20 Federal and state agencies would need to be compliant with appropriate Federal
21 and state agency policies and regulations, as summarized in Chapter 4, Approach
22 to Environmental Analyses.

23 Several of the state policies and regulations described in Chapter 4 have resulted
24 in specific institutional and operational conditions in California groundwater
25 basins, including the basin adjudication process, California Statewide
26 Groundwater Elevation Monitoring Program (CASGEM), California Sustainable
27 Groundwater Management Act (SGMA), and local groundwater management
28 ordinances, as summarized below.

29 7.2.1 Groundwater Basin Adjudication

30 Basin adjudications are determined through court decisions or pre-court mediation
31 on litigation that determine the groundwater rights of all the groundwater users
32 overlying the basins. The court identifies the extractors or well owners and the
33 amount of groundwater those well owners are allowed to extract, and appoints a
34 Watermaster whose role is to ensure that the basin is managed in accordance with
35 the court's decree. The Watermaster must report periodically to the court. There
36 are currently 23 adjudicated groundwater basins in California, most of which are

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- 1 located in Southern California. Table 7.1 lists the adjudicated groundwater basins
 2 located in the Study Area.

3 **Table 7.1 Adjudicated Groundwater Basins in the Study Area**

Basin Name	Date of Final Court Decision	County
Antelope Valley Groundwater Basin	Under way	Kern and Los Angeles
Beaumont – Upper Santa Ana Groundwater Basin	2004	Riverside
Brite Groundwater Basin	1970	Kern
Central Subbasin of the Coastal Plain of Los Angeles Basin	1965	Los Angeles
Chino Subbasin of the Upper Santa Ana Valley Basin	1978	Riverside and San Bernardino
Cucamonga Subbasin of the Upper Santa Ana Valley Basin	1978	San Bernardino
Cummings Valley Groundwater Basin	1972	Kern
Goleta Groundwater Basin	1989	Santa Barbara
San Jacinto Groundwater Basin	2013	Riverside
Los Osos Valley Groundwater Basin	Under way	San Luis Obispo
Mojave Basin Area (Lower Mojave River Valley, Middle Mojave River Valley, Upper Mojave River Valley, El Mirage Valley, and Lucerne Valley groundwater basins)	1996	San Bernardino
San Gabriel Valley Groundwater Basin – excluding Raymond Groundwater Basin	1973	Los Angeles
San Gabriel Valley Groundwater Basin – Puente Narrows	1985	Los Angeles
Raymond Groundwater Basin	1944	Los Angeles
Rialto-Colton Subbasin of the Upper Santa Ana Valley Basin	1961	San Bernardino
Santa Margarita River Watershed – Santa Margarita Valley, Temecula Valley, and Cahuilla Valley groundwater basins	1966*	Riverside and San Diego
Santa Maria Valley Groundwater Basin	2008	San Luis Obispo and Santa Barbara
Santa Paula Subbasin of the Santa Clara River Valley Groundwater Basin	1996	Ventura
Six Basins Area in upper Santa Ana Valley	1998	Los Angeles and San Bernardino
Tehachapi Valley West Basin and Tehachapi Valley East Basin	1973	Kern

Basin Name	Date of Final Court Decision	County
Upper Los Angeles River Area– San Fernando Valley Groundwater Basin	1979	Los Angeles
Warren Valley Groundwater Basin	1977	San Bernardino
West Coast Subbasin of the Coastal Plain of Los Angeles Basin	1961	Los Angeles
Western San Bernardino – Upper Santa Ana Groundwater Basin	1969	San Bernardino

1 Sources: DWR 2003a, 2014a; LOCSD 2013

2 Note:

3 * Santa Margarita Watershed Adjudication addresses both groundwater and surface
 4 water if water contributes to Santa Margarita River and its tributaries flows (SMRW 2014).
 5 The agreements include interlocutory judgements for Murrieta-Temecula Groundwater
 6 Basin that describes non-Indian water rights subject to court jurisdiction, land and water
 7 rights not subject to court jurisdiction, reserved water rights for the Pechanga
 8 Reservation, appropriative storage and diversion rights in conjunction with use of
 9 groundwater by the Vail Company.

10 **7.2.2 California Statewide Groundwater Elevation** 11 **Monitoring Program**

12 Senate Bill X7-6, enacted in November 2009, mandates a statewide groundwater
 13 elevation monitoring program to track seasonal and long-term trends in
 14 groundwater elevations in California’s groundwater basins defined in
 15 Bulletin 118. This amendment to Division 6 of the Water Code, specifically
 16 Part 2.11 Groundwater Monitoring, requires the collaboration between local
 17 monitoring entities and California Department of Water Resources (DWR) to
 18 collect groundwater elevation data. The law requires local agencies to monitor
 19 and report the groundwater elevation in the basins. To achieve this goal, DWR
 20 developed the CASGEM Program to establish a permanent, locally-managed
 21 program of regular and systematic monitoring in all of the state’s alluvial
 22 groundwater basins.

23 DWR is required to establish a priority schedule for monitoring groundwater
 24 basins, and to report to the Legislature on the findings from these investigations
 25 (Water Code section 10920 et. seq). The 2012 CASGEM Status Report to the
 26 Legislature describes that more than 400 monitoring entities have been identified
 27 and water level data are being submitted to DWR (DWR 2012). The
 28 prioritization of basins is to identify, evaluate, and determine the need for
 29 additional groundwater level monitoring. The prioritization approach includes the
 30 following eight criteria.

- 31 • Overlying population in the groundwater basin
- 32 • Projected growth of the overlying population
- 33 • Number of public water supply wells

- 1 • Total number of water supply wells
 - 2 • Irrigated acreage overlying the groundwater basin
 - 3 • Reliance on groundwater as the primary source of water by the overlying
 - 4 land uses
 - 5 • Impacts on groundwater, including overdraft, subsidence, saline intrusion, and
 - 6 other water quality degradation
 - 7 • Any other information relevant to the groundwater conditions
- 8 Groundwater basins designations in the study area are described for each basin in
- 9 the following subsection of this chapter (DWR 2014e).

10 **7.2.3 Sustainable Groundwater Management Act**

11 In September 2014, the SGMA was enacted. The SGMA establishes a new

12 structure for locally managing California’s groundwater in addition to existing

13 groundwater management provisions established by Assembly Bill (AB)

14 3030 (1992), Senate Bill (SB) 1938 (2002), and AB 359 (2011), as well as

15 SBX7-6 (2009).

16 The SGMA includes the following key elements:

- 17 • Provides for the establishment of a Groundwater Sustainability Agency (GSA)
- 18 by one or more local agencies overlying a designated groundwater basin or
- 19 subbasin identified in DWR Bulletin 118-03
- 20 • Requires all DWR Bulletin 118 groundwater basins found to be of “high” or
- 21 “medium” priorities to prepare Groundwater Sustainability Plans (GSPs)
- 22 • Provides for the proposed revisions, by local agencies, to the boundaries of a
- 23 DWR Bulletin 118 basin, including the establishment of new subbasins
- 24 • Provides authority for DWR to adopt regulations to evaluate GSPs, and
- 25 review the GSPs for compliance every 5 years
- 26 • Requires DWR to establish best management practices and technical measures
- 27 for GSAs to develop and implement GSPs
- 28 • Provides regulatory authority to the State Water Resources Control Board
- 29 (SWRCB) for developing and implementing interim groundwater
- 30 management plans under certain circumstances (such as lack of compliance
- 31 with development of GSPs by GSAs)

32 The SGMA defines sustainable groundwater management as “the management

33 and use of groundwater in a manner that can be maintained during the planning

34 and implementation horizon without causing undesirable results.” Undesirable

35 results are defined as any of the following effects.

- 36 • Chronic lowering of groundwater levels (not including overdraft during a
- 37 drought if a basin is otherwise managed)
- 38 • Significant and unreasonable reduction of groundwater storage

- 1 • Significant and unreasonable seawater intrusion
- 2 • Significant and unreasonable degraded water quality, including the migration
- 3 of contaminant plumes that impair water supplies
- 4 • Significant and unreasonable land subsidence that substantially interferes with
- 5 surface land uses
- 6 • Depletions of interconnected surface water that have significant and
- 7 unreasonable adverse impacts on beneficial uses of the surface water

8 Based on basin priority definitions defined by DWR's CASGEM program in June
 9 2014 and confirmed in January 2015, the SGMA requires the formation of GSPs
 10 by 2020 or 2022. GSPs for medium and high priority basins identified subject to
 11 critical conditions of overdraft are required by 2022. All other high and medium
 12 priority basins must complete a GSP by 2020. Updates to CASGEM-defined
 13 June 2014 designated priorities are possible and can affect GSP deadline
 14 requirements. Sustainable groundwater operations must be achieved within
 15 20 years following completion of the GSPs.

16 **7.2.4 Regional and Local Groundwater Ordinances**

17 Many counties within the Study Area considered in this EIS have adopted or are
 18 considering groundwater ordinances. The ordinances primarily address well
 19 installation, groundwater extraction, and export of the groundwater to areas
 20 outside the basin of origin. Local county groundwater ordinances vary by
 21 authority, agency, or region but typically involve permitting for well installation,
 22 and provisions to limit or prevent groundwater overdraft, to regulate transfers, and
 23 to protect groundwater quality.

24 Table 7.2 provides a list of substantial county groundwater ordinances within the
 25 Study Area that could affect groundwater supply availability.

26 **Table 7.2 County Groundwater Ordinances in the Study Area with a Summary of**
 27 **Regulations**

County	Ordinance Number and Title	Description
Trinity	County Code Title 15: Buildings and Construction, Chapter 15.20: Water wells.	Well standards.
Trinity and Humboldt	Hoopa Valley Tribal Council Title 37: Pollution Discharge Prohibition Ordinance	Regulates surface water and groundwater operations.
Humboldt	County Code Title VI: Water and Sewage, Division 3: Wells.	Well standards.
	Hoopa Valley Tribe: Not identified at this time.	Not applicable.
Del Norte	County Code Title 7: Health and Welfare Chapter 32: Regulations of Wells and Preservation of Groundwater.	Well standards.

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County	Ordinance Number and Title	Description
Shasta	County Code Title 18: Environment 18.08: Groundwater Management.	Requires permit for groundwater extraction for use outside county.
Shasta	County Code Title 8: Health and Safety, 8.56: Water Wells.	Well standards.
Plumas	County Code Title 6: Sanitation and Health, Chapter 8: Water Wells.	Well standards. Groundwater management plans have been adopted in Plumas County, but not in the vicinity of the Study Area.
Tehama	County Code Title 9: Health and Safety, Chapter 9.40: Aquifer Protection.	Prohibits groundwater from being exported out of county. Requires permit to use groundwater from wells on a parcel on other parcels of land.
Tehama	County Code Title 9: Health and Safety, Chapter 9.42: Well Construction, Rehabilitation, Repair and Destruction.	Well standards.
Glenn	County Code Title 20: Water 20.030: Groundwater Coordinated Resource Management Plan.	Basin Management Objectives and monitoring network to detect changes in groundwater level, quality, land subsidence; and defines acceptable ranges of groundwater levels.
	County Code Title 20: Water, 20.080: Water Well Drilling Permits and Standards.	Well standards.
Colusa	County Code Chapter 43: Groundwater Management.	Requires permit for groundwater extraction for use outside county.
	County Code Chapter 35: Well Standards.	Well standards.
Butte	County Code Chapter 33A: Basin Management.	Basin Management Objectives for: groundwater quality and groundwater levels, and other protections to reduce land subsidence.
	County Code Chapter 23B: Water Wells.	Well standards.
Yuba	County Code Title VII: Health and Sanitation, Chapter 7.03: Water wells.	Well standards.

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County	Ordinance Number and Title	Description
Sutter	County Code Section 700: Health and Sanitation, Chapter 765: Water Wells.	Well standards.
Placer	County Code Chapter 13: Public Services, Article 13.08: Water Wells.	Well standards.
El Dorado	County Code Title 8: Health and Safety, Chapter 8.39: Well Standards.	Well standards. Groundwater management plans have been adopted in El Dorado County, but not in the vicinity of the Study Area.
Sacramento	County Code Title 6: Health and Sanitation, Chapter 6.28: Wells and Pumps.	Well standards.
Yolo	County Code Title 10: Environment Chapter 7: Groundwater.	Requires permit for groundwater extraction for use outside of the county.
	County Code Title 6: Sanitation and Health, Chapter 8: Water Quality, Article 10: Standards, Criteria, and Regulations of Wells.	Well standards.
Solano	County Code Chapter 13.6: Injection Wells.	Restricts operation of injection wells.
	County Code Chapter 13.10: Well Standards.	Well standards.
Napa	County Code Title 13: Waters, Sewers, and Public Services Chapter 13.15: Groundwater Conservation.	Regulates the use of groundwater.
	County Code Title 13: Waters, Sewers, and Public Services Chapter 13.12: Wells.	Well standards.
San Joaquin	County Code Title 5: Health and Sanitation, Division 4: Wells and Well Drilling.	Well standards.
	County Code Title 5: Health and Sanitation, Division 8: Groundwater.	Requires permit for groundwater use outside of the county.
Stanislaus	County Code Title 9: Health and Safety, Chapter 9.37: Groundwater Mining and Export Prevention.	Regulates groundwater use and prohibits export of water outside of the county (except as noted in the requirements).
	County Code Title 9: Health and Safety, Chapter 9.36: Water Wells.	Well standards.

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County	Ordinance Number and Title	Description
Madera	<p>County Code Title 13: Waters and Sewers, V Groundwater Exportation, Groundwater Banking, and Importation of Foreign Water, for Purposes of Groundwater Banking, to Areas of Madera County which are Outside of Local Water Agencies that Deliver Water to Lands Within their Boundaries.</p> <p>Chapter 13.1: Rules and Regulations Pertaining to Groundwater Banking— Importation of Foreign Water, for the Purpose of Groundwater Banking, to Areas of Madera County which are Outside of Local Water Agencies that Deliver Water to Lands within their Boundaries— Exportation of Groundwater Outside the County.</p>	Regulates development of groundwater banking, including importation of groundwater to be stored in the groundwater bank, and exportation of groundwater for use outside of the county; and prohibits groundwater injection.
	County Code Title 13: Waters and Sewers, I: Water, Chapter 13.52: Well Standards.	Well standards.
Merced	County Code Title 9: General Health and Safety, Chapter 9.28: Wells.	Well standards.
Fresno	County Code Title 14: Waters and Sewers, Chapter 14.03: Groundwater Management.	Regulates groundwater use outside of the county.
	County Code Title 14: Waters and Sewers, Chapter 14.04: Well Regulations – General Provisions.	Well standards.
	County Code Title 14: Waters and Sewers Chapter 14.08: Well Construction, Pump Installation and Well Destruction Standards.	Well standards.
Tulare	County Code Part IV: Health, Safety, and Sanitation, Chapter 13: Well.	Well standards.
Kings	County Code Chapter 14A: Water Wells.	Well standards.
Kern	County Code Title 14: Utilities Chapter 14.08: Water Supply Systems, Article III: Well Standards.	Well standards.
Contra Costa	County Code Title 4: Health and Safety, Chapter 414: Waterways and Water Supply, Chapter 414-4: Water supply.	Well standards.
Alameda	County Code Title 6: Health and Safety, Chapter 6.88: Water Wells.	Well standards.

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County	Ordinance Number and Title	Description
Santa Clara	Santa Clara Valley Water District Act (California Water Code Appendix, Chapter 60).	Santa Clara Valley Water District is the designated agency to manage water within Santa Clara County, including groundwater management to recharge the basin, conserve water, increase water supply, and prevent waste or diminution of the water supply.
	Santa Clara Valley Water District Well Ordinance 90-1.	Well standards.
San Benito	County Code Title 15: Public Works, Chapter 5.05: Water, Article I: Groundwater Aquifer Protections.	Regulates use of groundwater on non-contiguous parcels with separate owners than parcel with well, injection of groundwater, and operations that could adversely affect other groundwater users or the groundwater aquifer.
	County Code Title 15: Public Works, Chapter 5.05: Water, Article III: Well Standards.	Well standards.
San Luis Obispo	County Code Title 8: Health and Sanitation, Chapter 8.40: Construction, Repair, Modification and Destruction of Wells.	Well standards.
Santa Barbara	County Code Chapter 34A: Wells.	Well standards.
Ventura	County Code Division 4: Public Health, Chapter 8: Water, Article 1: Groundwater Conservation.	Well standards.
Los Angeles	County Code Title 11: Health and Safety, Chapter: 11.38 Water and Sewers, Part 2: Water and Water Wells.	Well standards.
Orange	County Code Title 4: Health and Sanitation and Animal Regulations, Division 5: Water Conservation, Article 3 Construction and Abandonment of Water Wells.	Well standards.

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County	Ordinance Number and Title	Description
San Diego	County Code Title 6: Health and Sanitation, Division 7: Water and Water Supplies, Chapter 4: Wells.	Well standards.
	County Code Title 6: Health and Sanitation, Division 7: Water and Water Supplies, Chapter 7: Groundwater.	Regulates actions for the protection, preservation, and maintenance of groundwater resources.
Riverside	County Code Title 13: Public Services, Chapter 13.20: Water Wells.	Well standards.
San Bernardino	County Code Title 3: Health and Sanitation, Division 3: Environmental Health, Chapter 6: Domestic Water Sources and Systems, Article 3: Water Wells.	Well standards.
	County Code Title 3: Health and Sanitation, Division 3: Environmental Health, Chapter 6: Domestic Water Sources and Systems, Article 5: Desert Groundwater Management.	Regulates groundwater basins not adjudicated by judicial decree; and wells not within the boundaries of the Mojave Water Agency and public water agencies within the Morongo Basin, incorporated areas, or Federal lands. This section does not apply to wells used for existing mining operations, small agricultural operations, small wells, or replacement wells of similar size to abandoned wells. This section does not apply to areas with a groundwater management plan and a memorandum of understanding with the county.

1 Sources: Trinity County 2014; Hoopa Valley Tribe 2008; Humboldt County 2014; Del
2 Norte County 2014; Shasta County 2014 a, b; Plumas County 2014; Tehama County
3 2014; Glenn County 2014; Colusa County 2014 a, b; Butte County 2014 a, b; Yuba
4 County 2014; Sutter County 2014; Placer County 2014; El Dorado County 2014;
5 Sacramento County 2014; Yolo County 2014; Solano County 2014; Napa County 2014;
6 San Joaquin County 2014; Stanislaus County 2014; Madera County 2014; Merced
7 County 2014; Fresno County 2014; Tulare County 2014; Kings County 2014; Kern
8 County 2014; Contra Costa County 2014; Alameda County 2014; SCVWD 2014 a, b; San
9 Benito County 2014; San Luis Obispo County 2014a; Santa Barbara County 2014;
10 Ventura County 2014; Los Angeles County 2014a; Orange County 2014; San Diego
11 County 2014; Riverside County 2014; San Bernardino County 2014

1 **7.3 Affected Environment**

2 This section describes groundwater resources that could be potentially affected by
3 the implementation of the alternatives considered in this EIS. Changes in
4 groundwater resources due to changes in CVP and SWP operations may occur in
5 the Trinity River, Central Valley, San Francisco Bay Area, Central Coast, and
6 Southern California regions.

7 Groundwater occurs throughout the Study Area. However, the groundwater
8 resources that could be directly or indirectly affected through implementation of
9 the alternatives analyzed in this EIS are related to groundwater basins which
10 include users of CVP and SWP water supplies that also use groundwater, and
11 areas along the rivers downstream of CVP or SWP reservoirs that use
12 groundwater supplies. Therefore, the following description of the affected
13 environment is limited to these areas and does not include groundwater basins or
14 subbasins that area not directly or indirectly affected by changes in CVP and
15 SWP operations.

16 **7.3.1 Overview of California Groundwater Resources**

17 As described in Chapter 5, Surface Water Resources and Water Supplies,
18 groundwater is a vital resource in California. Groundwater supplied about
19 37 percent of the state's average agricultural, municipal, and industrial water
20 needs between 1998 and 2010, and 40 percent or more during dry and critical
21 water years in that period (DWR 2013i). About 20 percent of the nation's
22 groundwater demand is supplied from the Central Valley aquifers, making it the
23 second-most-pumped aquifer system in the United States (USGS 2009). The
24 three Central Valley hydrologic regions (Tulare Lake, San Joaquin River, and
25 Sacramento River) account for about 75 percent of the state's average annual
26 groundwater use (DWR 2013i).

27 The DWR has delineated 515 distinct groundwater systems throughout the state,
28 as described in Bulletin 118-03 (DWR 2003a), that are considered to be the most
29 important groundwater basins. These basins and subbasins have various degrees
30 of supply reliability considering yield, storage capacity, and water quality, and are
31 typically alluvial, or non-consolidated (non-fractured rock) aquifers. Figure 7.1
32 shows the statewide occurrence of groundwater in the groundwater basins and
33 subbasins identified by DWR as Bulletin 118 basins. A majority of the
34 descriptions provided herein are summarized form DWR Bulletin 118 reports.

35 The importance of groundwater as a resource varies regionally. The Central
36 Coast has the most reliance on groundwater to meet its local uses, with more than
37 80 percent of the agricultural, municipal, and industrial water supplies by
38 groundwater in an average year. The central and southern San Joaquin Valley
39 (described as the Tulare Lake Area of the San Joaquin Valley Groundwater Basin
40 in this chapter) groundwater use, on average, meets about 50 percent of the total
41 water supplies. The Sacramento Valley and northern portion of the San Joaquin
42 Valley Groundwater Basin use groundwater to meet approximately 30 and
43 40 percent of the agricultural, municipal, and industrial water demand,

1 respectively. In the coastal areas of Southern California, groundwater use varies
2 from less than 10 percent in western San Diego County to between 35 and
3 50 percent of the agricultural, municipal, and industrial water supplies in counties
4 along the coast western Ventura, Los Angeles, and Riverside counties and Orange
5 County, on an annual average basis. In the inland areas of Southern California,
6 groundwater use varies from approximately 45 to over 90 percent of the
7 agricultural, municipal, and industrial water supplies (DWR 2013).

8 A comprehensive assessment of overdraft in all of the state's groundwater basins
9 has not been conducted since Bulletin 118-80 was published in 1980, but
10 overdraft is estimated at between 1 to 2 million acre-feet annually (DWR 2003a).
11 In DWR's Bulletin 118-80 (DWR 1980), an assessment of critically overdrafted
12 basins was conducted, as shown in Figure 7.2. In the past 20 years, specific
13 groundwater studies have been conducted by regional water agencies or the
14 U.S. Geological Survey (USGS) to update the statewide survey conducted by
15 DWR in 1980 (USGS 2000a, 2006, 2008, 2009, 2012, 2014). The results of many
16 of those studies are discussed in the following subsections of this chapter.

17 **7.3.2 Trinity River Region**

18 The Trinity River Region includes the area along the Trinity River from Trinity
19 Lake to the confluence with the Klamath River; and along the Klamath River
20 from the confluence with the Trinity River to the Pacific Ocean.

21 Most usable groundwater in the Trinity River Region occurs in widely scattered
22 alluvium filled valleys, such as those immediately adjacent to the Trinity River.
23 These valleys contain only small quantities of recoverable groundwater, and,
24 therefore, are not considered a major source. A number of shallow wells adjacent
25 to the river provide water for domestic purposes (Reclamation et al. 2006a;
26 NCRWQCB et al. 2009). Groundwater present in these alluvial valleys is in close
27 hydraulic connection with the Trinity River and its tributaries. Both groundwater
28 discharge to surface streams as well as leakage of steam flow to underlying
29 aquifers are expected to occur at various locations.

30 The Bulletin 118-03 (DWR 2003a, 2004do, 2004dp) identified only two
31 groundwater basins underlying the Trinity River Region in the Study Area, Hoopa
32 Valley and Lower Klamath River Valley groundwater basins, as shown in
33 Figure 7.3. These groundwater basins are small, isolated, valley-fill aquifers that
34 provide a very limited quantity of groundwater to satisfy local domestic,
35 municipal, and agricultural needs. Groundwater pumped from these aquifer
36 systems is used strictly for local supply.

37 As described in Chapter 5, Surface Water Resources and Water Supplies, several
38 communities use infiltration galleries along the Trinity River and the tributaries to
39 convey surface water to groundwater wells, including the Lewiston Community
40 Services District, Lewiston Valley Water Company, and Lewiston Park Mutual
41 Water Company (NCRWQCB et al. 2009).

1 Groundwater within the Hoopa Valley Indian Reservation occurs along alluvial
2 terraces (Hoopa Valley Tribe 2008). The aquifers are approximately 10 to 80 feet
3 deep. Some of the shallow wells are productive only during winter and early
4 spring months.

5 The Lower Klamath River Valley Groundwater Basin extends over 7,030 acres in
6 Del Norte and Humboldt counties, including areas along the Lower Klamath
7 River (Reclamation 2010a). Groundwater along the Lower Klamath River occurs
8 in alluvial fans near the confluences of major tributaries and along terrace and
9 floodplain deposits adjacent to the river (Yurok Tribe 2012). The aquifers range
10 in depth from 10 to 80 feet and are used by some members of the community.

11 The Hoopa Valley and Lower Klamath River Valley groundwater basins were
12 designated by the CASGEM program as very low and low priorities, respectively.

13 Groundwater quality is suitable for many beneficial uses in the region. In other
14 locations, the groundwater can include naturally occurring metals, including
15 manganese, cadmium, zinc, and barium (Hoopa Valley Tribe 2008). Other
16 groundwater quality issues include nitrate contamination (DWR 2013i).

17 Groundwater and surface water contamination is suspected at several former and
18 existing mill sites that historically used wood treatment chemicals. Discharges of
19 pentachlorophenol, polychlorodibenzodioxins, and polychlorodibenzofurans have
20 likely occurred due to the poor containment practices typically used in historical
21 wood treatment applications. Additional investigation, sampling and monitoring,
22 and enforcement actions have been limited by the insufficient resources that exist
23 to address this historical toxic chemical problem (NCRWQCB 2005).

24 **7.3.3 Central Valley Region**

25 The Central Valley Region extends from above Shasta Lake to the Tehachapi
26 Mountains, and includes the Sacramento Valley, San Joaquin Valley, Delta, and
27 Suisun Marsh.

28 Groundwater for the Central Valley Region is described in relation to the basins
29 described by DWR in Bulletin 118-03 (DWR 2003a). The overall area includes
30 the Sacramento Valley Basin which extends through the Sacramento Valley, and
31 the San Joaquin Valley Groundwater Basin (including the Tulare Lake Area,
32 which extends through the San Joaquin Valley). The Delta and Suisun Marsh
33 area are located partially in the Sacramento Valley Basin and partially in the
34 San Joaquin Valley Groundwater Basin. The Delta and Suisun Marsh area is
35 described separately because of its distinct characteristics as an estuary at the
36 confluence of the Sacramento and the San Joaquin rivers.

37 **7.3.3.1 Sacramento Valley**

38 The Sacramento Valley includes the Redding Groundwater Basin and the
39 Sacramento Valley Groundwater Basin. The Sacramento Valley Groundwater
40 Basin is one of the largest groundwater basins in the state, and extends from
41 Redding in the north to the Delta in the south (USGS 2009).

1 Approximately one-third of the Sacramento Valley's urban and agricultural water
2 needs are met by groundwater (DWR 2003a). The portion of the water diverted
3 for irrigation but not actually consumed by crops or other vegetation becomes
4 recharge to the groundwater aquifer or flows back to surface waterways.

5 Overall, the Sacramento Groundwater Basin is approximately balanced with
6 respect to annual recharge and pumping demand. However, there are several
7 locations showing early signs of persistent drawdown, suggesting limitations due
8 to increased groundwater use in dry years. Locations of persistent drawdown
9 include: Glenn County, areas near Chico in Butte County, northern Sacramento
10 County, and portions of Yolo County.

11 The water quality of groundwater in the Sacramento Valley is generally good, as
12 described below for individual basins. Several areas have localized aquifers with
13 high nitrate, total dissolved solids (TDS) or boron concentrations. High nitrate
14 concentrations frequently occur due to residuals from agricultural operations or
15 septic systems. High TDS, a measure of salinity, concentration can be an
16 indicator of brackish or connate water when it occurs in high concentrations.
17 High boron concentration usually is associated with naturally occurring deposits.

18 **7.3.3.1.1 Overview of Groundwater Basins in the Sacramento Valley**

19 The Sacramento Valley includes the Redding Groundwater Basin and the
20 Sacramento Valley Groundwater Basin. The Redding Groundwater Basin is
21 situated in the extreme northern end of the valley and is a separate, isolated
22 groundwater basin, but due to similarities in geology and stratigraphy is discussed
23 as part of the overall Sacramento Valley. It is bordered by the Coast Ranges on
24 the west, and by the Cascade Range and Sierra Nevada mountains on the east.

25 The Sacramento Valley Groundwater Basin has been divided into 17 subbasins by
26 DWR, as shown in Figure 7.4, based on groundwater characteristics, surface
27 water features, and political boundaries (DWR 2003a). However, from a
28 hydrologic standpoint, these individual groundwater subbasins have a high degree
29 of hydraulic connection because the rivers do not always act as barriers to
30 groundwater flow. Therefore, the Sacramento Valley Groundwater Basin
31 functions primarily as a single laterally extensive alluvial aquifer, rather than
32 numerous discrete, smaller groundwater subbasins.

33 For discussion purposes, and due to their common characteristics, the Sacramento
34 Valley is further sub-divided into the Upper Sacramento Valley, the Lower
35 Sacramento Valley West of the Sacramento River, and the Lower Sacramento
36 Valley East of the Sacramento River.

37 *General Hydrogeology of the Sacramento Valley*

38 Freshwater in the Sacramento Valley Groundwater Basin occurs within the
39 continental deposits. Hydrogeologic units containing freshwater along the eastern
40 portion of the basin, primarily occur in the Tuscan and Mehrten formations, and
41 are derived from the Sierra Nevada. Toward the southeastern portion of the
42 Sacramento Valley, the Mehrten formation is overlain by sediments of the
43 Laguna, Riverbank, and Modesto formations, which also originated in the

1 Sierra Nevada. The primary hydrogeologic unit in the western portion of the
2 Sacramento Valley is the Tehama formation, which was derived from the Coast
3 Ranges. In most of the Sacramento Valley, these deeper units are overlain by
4 younger alluvial and floodplain deposits. Generally, groundwater flows inward
5 from the edges of the basin toward the Sacramento River, then in a southerly
6 direction parallel to the river. Depth to groundwater throughout most of the
7 Sacramento Valley averages about 30 feet below the ground surface, with
8 shallower depths along the Sacramento River and greater depths along the basin
9 margins. Wells developed in the sediments of the valley provide excellent supply
10 to irrigation, municipal, and domestic uses. The deepest elevation of the base of
11 freshwater in the Sacramento Valley ranges between 400 feet and 3,350 feet
12 below mean sea level (Berkstresser 1973). The location where the base of
13 freshwater is the deepest occurs in the Delta near Rio Vista. Near the valley
14 margins and the Sutter Buttes, the base of freshwater is relatively shallow;
15 suggesting that the base of freshwater may coincide with bedrock or connate
16 water trapped in shallower deposits close to the basin margins
17 (Berkstresser 1973).

18 Today, groundwater levels are generally in balance valley-wide, with pumping
19 matched by recharge from the various sources annually. Some locales show the
20 early signs of persistent drawdown, especially in areas where water demands are
21 met primarily, and in some locales exclusively, by groundwater. These areas
22 include portions of the far west side of the Sacramento Valley in Glenn County,
23 portions of Butte County near Chico, in portions of Yolo County, and in the
24 northern Sacramento County area. The persistent areas of drawdown could be
25 early signs that the limits of sustainable groundwater use have been reached in
26 these areas. Due to the drought that started in 2011, surface water supplies have
27 declined and new wells have been installed. Between January and October 2014,
28 over 100 water supply wells were drilled in both Shasta and Butte counties
29 (DWR 2014d).

30 Land subsidence in the Sacramento Valley has resulted from inelastic deformation
31 (non-recoverable changes) of fine-grained sediments related to groundwater
32 withdrawal. Areas of subsidence from groundwater level declines have been
33 measured in the Sacramento Valley at several locations. Subsidence monitoring
34 was established following several studies in the 1990s that indicated more than
35 four feet of subsidence since 1954 in some areas, such as in Yolo County
36 (Ikehara 1994). Initial data from the Yolo County extensometers indicated
37 subsidence in the Zamora area, which has subsequently been confirmed with a
38 countywide global positioning system network installed in 1999 and monitored in
39 2002 and 2005. Subsidence up to 0.4 feet occurred between 1999 and 2005 in the
40 Zamora area (Frame Surveying and Mapping 2006). The Zamora area does not
41 currently use CVP or SWP water supplies. However, this area was designated as
42 part of the CVP Sacramento Valley Irrigation Canals service area in the
43 Reclamation Act of 1950 and as amended in the Reclamation Act of 1980 and
44 Central Valley Project Improvement Act.

1 7.3.3.1.2 Upper Sacramento Valley

2 The Upper Sacramento Valley includes the Redding Groundwater Basin and
3 upper portions of the Sacramento Valley Groundwater Basin (DWR 2003a). The
4 Redding Groundwater Basin extends from approximately Redding in Shasta
5 County through the northern portions of Tehama County. The portions of the
6 Sacramento Valley Groundwater Basin in the Upper Sacramento Valley are
7 located primarily in Tehama County with small portions extending into Glenn
8 County near Orland and Butte County near Chico in the south. The geology of
9 this area is dominated by the Tuscan and Tehama Formations. The hydrology of
10 this area is dominated by numerous smaller drainages that originate in the Sierra
11 Nevada and Coast Ranges and drain to the Sacramento River (DWR 2003a).

12 *Hydrogeology and Groundwater Conditions*

13 The Redding Groundwater Basin comprises the northernmost part of the
14 Sacramento Valley and is bordered by the Klamath Mountains to the north, the
15 Coast Ranges to the west, the Cascade Mountains to the east, and the Red Bluff
16 Arch to the south. This basin consists of a sediment-filled, symmetrical,
17 southward-dipping trough formed by folding of the marine sedimentary basement
18 rock. These deposits are overlain by a thick sequence of inter-bedded,
19 continentally-derived, sedimentary, and volcanic deposits of Late Tertiary and
20 Quaternary age. The primary fresh water-bearing deposits in the basin are the
21 Pliocene age volcanic deposits of the Tuscan Formation and the Pliocene age
22 continental deposits of the Tehama Formation (DWR 2003a, 2003b, 2004a,
23 2004b, 2004c, 2004d, 2004e, 2004f).

24 The Tehama Formation consists of unconsolidated to moderately consolidated
25 coarse and fine-grained sediments derived from the Coast Ranges to the west.
26 The Tehama Formation is up to 4,000 feet thick and varies in depth from a few
27 feet to several hundred feet below the land surface, with depth generally
28 increasing to the east towards the Sacramento River (DWR 2003a, 2004a, 2004b,
29 2004c, 2004d, 2004e, 2004f). The Tuscan formation is derived from the Cascade
30 Range to the east and is primarily composed of volcanoclastic sediments.

31 The Redding Groundwater Basin includes six subbasins: Anderson, Rosewood,
32 Bowman, Enterprise, Millville, and South Battle Creek (DWR 2003a, 2004a,
33 2004b, 2004c, 2004d, 2004e, 2004f). The Anderson subbasin is one of the main
34 groundwater units in the Redding Basin. Groundwater levels in the unconfined
35 and confined portions of the aquifer system fluctuate annually by 2 to 4 feet
36 during normal precipitation years and up to 10 to 16 feet during drought years
37 (DWR 2003b). Between spring 2010 and spring 2014 in the Redding
38 Groundwater Basin, recent information indicates that groundwater levels declined
39 at multiple wells by up to 10 feet. The groundwater levels in some areas declined
40 up to 10 feet between Fall 2013 and Fall 2014 (DWR 2014c, 2014d).

41 Tehama County overlies three subbasins within the Redding Groundwater Basin
42 and seven subbasins in the Sacramento Valley Groundwater Basin. The
43 Rosewood, South Battle Creek, and Bowman subbasins in the Redding
44 Groundwater Basin are located in Tehama County. The Red Bluff, Corning,

1 Bend, Antelope, Dye Creek, Los Molinos, and Vina subbasins in the Sacramento
2 Valley Groundwater Basin are located in Tehama County (DWR 2004b, 2004c,
3 2004f, 2004g, 2004h, 2004i, 2004j, 2004k, 2004l, 2006a). The Corning subbasin
4 extends into northern Glenn County near Orland. The Vina subbasin extends into
5 northern Butte County near Chico. Groundwater levels in these subbasins show a
6 significant seasonal variation due to high groundwater use for irrigation during
7 the summer months. Groundwater levels showed significant declines in some
8 wells associated with the 1976 to 1977 and 1987 to 1992 drought periods.
9 Groundwater levels appeared to recover quickly during subsequent wet years.
10 Groundwater levels in the Corning area of Tehama County showed a general
11 decline before 1965 due to increased groundwater pumping for agricultural uses.
12 Following construction by the CVP of the Tehama-Colusa Canal and the Corning
13 Canal, surface water was delivered to these areas and there was a subsequent
14 upward trend in groundwater levels following initial operations (Tehama County
15 Flood Control and Water Conservation District 1996). Between spring 2010 and
16 spring 2014 in the Upper portion of the Sacramento Valley Groundwater Basin,
17 recent information indicates that groundwater levels declined at multiple wells
18 approximately 2.5 feet to 10 feet (DWR 2014c, 2014d). The groundwater levels
19 in some areas declined up to 10 feet between fall 2013 and fall 2014, and in some
20 areas more than 10 feet.

21 Groundwater quality in the Redding Groundwater Basin is generally good to
22 excellent for most uses. Some areas of poor quality due to high salinity from
23 marine sedimentary rock exist at the margins of the basin. Portions of the basin
24 are characterized by high boron, iron, manganese, and nitrates in localized areas
25 (DWR 2004a, 2004b, 2004c, 2004d, 2004e, 2004f). In general, groundwater in
26 the Sacramento Valley Groundwater Basin within Tehama County is of excellent
27 quality, with some localized areas with groundwater quality concerns related to
28 boron, calcium, chloride, magnesium, nitrate, phosphorous, and TDS (DWR
29 2004g, 2004h, 2004i, 2004j, 2004k, 2004l, 2006a). In the vicinity of Antelope,
30 east of Red Bluff, historical high nitrates in groundwater occur. Higher boron
31 levels have been detected in wells located in the eastern portion of Tehama
32 County. High salinity occurs near Salt Creek, which most likely originates from
33 the Tuscan Springs, which is a source of high boron and sulfates.

34 The Vina subbasin was designated by the CASGEM program as high priority.
35 The Anderson, Enterprise, Bowman, Red Bluff, Corning, Antelope, Dye Creek,
36 and Los Molinos subbasins were designated medium priority. The Rosewood,
37 Millville, South Battle Creek, and Bend subbasins were designated very low
38 priority in the June 2014 CASGEM designation.

39 *Groundwater Use and Management*

40 Tehama County uses groundwater to meet approximately 65 percent of its total
41 water needs (Tehama County Flood Control and Water Conservation District
42 2008). Groundwater in the county provides water supply for agricultural,
43 domestic, environmental, and industrial uses.

1 One of the main users of groundwater in this area is the Anderson-Cottonwood
2 Irrigation District. Approximately 5 percent of the irrigated acres rely upon
3 groundwater (DWR 2003b). Groundwater also is the primary water supply for
4 residences and small scale agricultural operations.

5 **7.3.3.1.3 Lower Sacramento Valley (West of Sacramento River)**

6 The Lower Sacramento Valley area west of the Sacramento River includes
7 three main groundwater subbasins: Colusa, Yolo, and Solano (DWR 2003a,
8 2004m, 2004n, 2006b).

9 *Hydrogeology and Groundwater Conditions*

10 *Colusa Subbasin*

11 The Colusa subbasin is bordered by the Coast Ranges to the west, Stony Creek to
12 the north, Sacramento River to the east, and Cache Creek to the south. The
13 Colusa subbasin extends primarily in western Glenn and Colusa counties. This
14 subbasin is composed of continental deposits of late Tertiary age, including the
15 Tehama and the Tuscan Formations, to Quaternary age, including alluvial and
16 floodplain deposits as well as Modesto and Riverbank Formations. The Tehama
17 Formation represents the main water bearing formation for the Colusa subbasin
18 (DWR 2003b, 2006b). Groundwater levels are fairly stable in this subbasin,
19 except during droughts, such as in 1976 and 1977 and 1987 to 1992 (DWR
20 2013a). Groundwater levels in the Colusa subbasin declined in the 2008 drought,
21 and increased during the wetter periods of 2010 and 2011 to the pre-drought 2008
22 levels (DWR 2014c, 2014d). Historically, groundwater levels fluctuate by
23 approximately 5 feet seasonally during normal and dry years (DWR 2006b,
24 2013a). Recent information indicates that groundwater levels declined at multiple
25 wells in the Colusa subbasin approximately 10 to 20 feet between spring 2010 and
26 spring 2014 in southwestern Colusa subbasin (DWR 2014c, 2014d). The
27 groundwater levels in some areas declined up to 10 feet between fall 2013 and fall
28 2014, and in some areas more than 10 feet.

29 Groundwater quality for the Colusa subbasin is characterized by moderate to high
30 TDS; with localized areas of high nitrate and manganese concentrations near the
31 town of Colusa (DWR 2013a, 2006b). High TDS and boron concentrations have
32 been observed near Knights Landing. High nitrate levels have been observed near
33 Arbuckle, Knights Landing, and Willows.

34 The Colusa subbasin was designated by the CASGEM program as medium
35 priority.

36 *Yolo Subbasin*

37 The Yolo subbasin lies to the south of the Colusa subbasin primarily within Yolo
38 County. The primary water bearing formations for the Yolo subbasin are the
39 same as those for the Colusa subbasin. Younger alluvium from flood basin
40 deposits and stream channel deposits lie above the saturated zone and tend to
41 provide significant well yields. In general, groundwater levels are stable in this
42 subbasin, except during periods of drought, and in certain localized pumping
43 depressions in the vicinity of Davis, Woodland, and Dunnigan and Zamora areas

1 (DWR 2004m, 2013a). However, between spring 2010 and spring 2014 in the
2 Yolo subbasin, recent information indicates that groundwater levels declined at
3 multiple wells at least 10 feet and in some areas up to 20 feet (DWR 2014c,
4 2014d). The groundwater levels in some areas declined up to 10 feet between fall
5 2013 and fall 2014, and in some areas more than 10 feet.

6 Groundwater quality is generally good for beneficial uses except for localized
7 impairments including elevated concentrations of boron in groundwater along
8 Cache Creek and in the Cache Creek Settling Basin area, elevated levels of
9 selenium present in the groundwater supplies for the City of Davis, and localized
10 areas of nitrate contamination (DWR 2004m, 2013a). The cities of Davis and
11 Woodland, which heavily rely on groundwater supply, lost nine municipal wells
12 since 2011 due to high nitrate concentrations (YCFCWCD 2012). Sources of
13 high nitrate concentrations near these cities have been determined to be primarily
14 from agricultural and wastewater operations. High salinity levels have also been
15 reported in some areas that may be related to groundwater use for irrigation which
16 tends to increase salt concentrations in groundwater.

17 In Yolo County, as much as 4 feet of groundwater withdrawal-related subsidence
18 has occurred since the 1950s. Groundwater withdrawal-related subsidence has
19 damaged or reduced the integrity of highways, levees, irrigation canals, and wells
20 in Yolo County, particularly in the vicinities of Zamora, Knights Landing, and
21 Woodland (Water Resources Association of Yolo County 2007).

22 The Yolo subbasin was designated by the CASGEM program as high priority.

23 *Solano Subbasin*

24 The Solano subbasin includes most of Solano County, southeastern Yolo County,
25 and southwestern Sacramento County. In the Solano subbasin, general
26 groundwater flow directions are from the northwest to the southeast
27 (DWR 2004n, 2013a). Increasing agricultural and urban development in the
28 1940s in the Solano subbasin has caused significant groundwater level declines.
29 Today, groundwater levels are relatively stable but show significant declines
30 during drought cycles. Groundwater level data also suggest that these declines
31 tend to recover quickly during subsequent wet years. Between spring 2010 and
32 spring 2014 in the Solano subbasin, recent information indicates that groundwater
33 levels declined at multiple wells by at least 10 feet (DWR 2014c, 2014d).

34 Groundwater quality in the Solano subbasin is generally good and is deemed
35 appropriate for domestic and agricultural use (DWR 2004n, 2013a). However,
36 TDS concentrations are moderately high in the central and southern areas of the
37 basin with localized areas of high calcium and magnesium.

38 The Solano subbasin was designated by the CASGEM program as medium
39 priority.

40 *Groundwater Use and Management*

41 Many irrigators on the west side of the Sacramento Valley relied primarily on
42 groundwater prior to completion of the CVP Tehama-Colusa Canal facilities
43 which conveyed surface water to portions of Colusa County.

1 In the Colusa subbasin, although surface water is the primary source of water to
2 meet water supply needs, groundwater is also used to assist in meeting
3 agricultural, domestic, municipal, and industrial water needs, primarily in areas
4 outside of established water districts. The Tehama Colusa Canal Authority
5 service area is also an area of groundwater use in the Colusa subbasin. Although
6 the Tehama-Colusa Canal Authority delivers surface water to agricultural users
7 when the CVP water supplies are restricted due to hydrologic conditions, water
8 users rely upon groundwater to supplement limited surface water supplies.

9 Groundwater is the source of water for municipal and domestic uses in Yolo
10 County except for the City of West Sacramento, as described in Chapter 5,
11 Surface Water Resources and Water Supplies. Recently, in normal years,
12 approximately 40 percent of the irrigation users in Yolo County rely on
13 groundwater (Yolo County 2009). For the East Yolo South area of the County
14 (eastern Yolo subbasin), a 2006 study estimated that groundwater supplies
15 about 80 to 85 percent of the total annual water demand in the county
16 (YCFWCWD 2012).

17 Within Yolo and Sacramento counties portions of the Solano subbasin,
18 groundwater is primarily used for domestic and irrigation uses. Within Solano
19 County, groundwater is used exclusively by most rural residential landowners and
20 the cities of Rio Vista and Dixon (Solano County 2008). The City of Vacaville
21 uses groundwater to provide approximately 30 percent of the water supply. Other
22 communities rely upon surface water, as described in Chapter 5, Surface Water
23 Resources and Water Supplies. Irrigation users within the Solano Irrigation
24 District rely upon surface water. All other irrigation users rely upon groundwater.

25 **7.3.3.1.4 Lower Sacramento Valley (East of Sacramento River)**

26 The Lower Sacramento Valley area is located to the east of the Sacramento River,
27 and includes seven groundwater subbasins: West Butte, East Butte, North Yuba,
28 South Yuba, Sutter, North American, and South American (DWR 2003a, 2004o,
29 2004p, 2004q, 2006c, 2006d, 2006e, 2006f).

30 *Hydrogeology and Groundwater Conditions*

31 The aquifer system throughout the Lower Sacramento Valley east of the
32 Sacramento River is composed of Tertiary to late Quaternary age deposits. The
33 confined portion of the aquifer system includes the Tertiary-age Tuscan and
34 Laguna formations. The Tuscan formation consists of volcanic mudflows, tuff
35 breccia, tuffaceous sandstone, and volcanic ash deposits. The Laguna formation
36 consists of moderately consolidated and poorly to well cemented interbedded
37 alluvial sand, gravel, and silt with a low permeability, overall. The Quaternary
38 portion of the aquifer system, typically unconfined, is largely composed of
39 unconsolidated gravel, sand, silt, and clay stream channel and alluvial fan
40 deposits. South and east of the Sutter Buttes, the deposits contain Pleistocene
41 alluvium, which is composed of loosely compacted silts, sands, and gravels that
42 are moderately permeable; however, nearly impermeable hardpans and claypans
43 also exist in this deposit, which restrict the vertical movement of groundwater
44 (DWR 2003a, 2004o, 2004p, 2004q, 2006c, 2006d, 2006e, 2006f).

1 *West and East Butte Subbasins*

2 The West Butte subbasin is located within Butte, Glenn, and Sutter counties. In
3 the West Butte subbasin, groundwater levels declined during the 1976 to 1977
4 and 1987 to 1992 droughts, followed by a recovery in groundwater levels to
5 pre-drought conditions of the early 1980s and 1990s (DWR 2004o, 2013a). A
6 comparison of spring-to-spring groundwater levels from the 1950s and 1960s, to
7 levels in the early 2000s, indicates about a 10-foot decline in groundwater levels
8 in portions of this subbasin. Several groundwater depressions exist in the Chico
9 area, due to year-round groundwater extraction for municipal uses. Between
10 spring 2010 and spring 2014 in the West Butte subbasin, recent information
11 indicates that groundwater levels declined at multiple wells at least 10 feet and in
12 some areas up to 20 feet near Chico (DWR 2014c, 2014d). The groundwater
13 levels in some areas declined up to 10 feet between fall 2013 and fall 2014.

14 The East Butte subbasin is located with Butte and Sutter counties. In the northern
15 portion of the East Butte subbasin, annual groundwater fluctuations in the
16 confined and semi-confined aquifer system ranges from 15 to 30 feet during
17 normal years (DWR 2004p, 2013a). In the southern part of Butte County,
18 groundwater fluctuations for wells constructed in the confined and semi-confined
19 aquifer system average 4 feet during normal years and up to 5 feet during drought
20 years. Between spring 2010 and spring 2014 in the East Butte subbasin, recent
21 information indicates that groundwater levels either increased or declined at
22 multiple wells by approximately 2 to 3 feet near Oroville (DWR 2014c, 2014d).

23 High nitrates occur near the Chico area in the West Butte subbasin. There are
24 localized areas in the subbasin with high boron, calcium, electrical conductivity
25 (EC), and TDS concentrations (DWR 2004 o, 2013a). There are several
26 groundwater areas near Chico that historically had high perchloroethylene
27 concentrations from industrial sites. Following implementation of groundwater
28 treatment, the chemicals have not been detected (Butte County 2010).

29 There are localized high concentrations of calcium, salinity, iron, manganese,
30 magnesium, and TDS throughout the East Butte subbasin (DWR 2004p, 2013a).

31 The West Butte subbasin was designated by the CASGEM program as high
32 priority. The East Butte subbasin was designated as medium priority.

33 *North and South Yuba Subbasins*

34 The North Yuba subbasin is located within Butte and Yuba counties. The South
35 Yuba subbasin is located within Yuba County. In the North Yuba and South
36 Yuba subbasins areas along the Feather River, the groundwater levels have been
37 generally stable since at least 1960, with some seasonal fluctuations between
38 spring and summer conditions. Groundwater levels in the central parts of the two
39 subbasins declined until about 1980, when surface water deliveries were extended
40 to these areas and groundwater levels started to rise. Hydrographs in the central
41 portions of the North and South Yuba subbasins also show the effect of
42 groundwater substitution transfers (during 1991, 1994, 2001, 2002, 2008, and
43 2009), in the form of reduced groundwater levels followed by recovery to
44 pre-transfer levels (YCWA 2010). Between spring 2010 and spring 2014 in the

1 North Yuba and South Yuba subbasins, recent information indicates that
2 groundwater levels declined at multiple wells by 10 to 20 feet, especially near
3 Yuba City (DWR 2014c, 2014d). The groundwater levels in some areas declined
4 up to 10 feet between fall 2013 and fall 2014.

5 Historical water quality data show that in most areas of the North and South Yuba
6 subbasins, trends of increasing concentrations of calcium, bicarbonate, chloride,
7 alkalinity, and TDS occur. In general, groundwater salinity increases with
8 distance from the Yuba River. No groundwater quality impairments were
9 documented at the DWR monitoring wells in the North Yuba subbasin
10 (DWR 2006c). High salinity occurred in the Wheatland area of the South Yuba
11 subbasin within the South Yuba Water District and Brophy Irrigation District
12 (DWR 2006d; YCWA 2010).

13 The North Yuba and South Yuba subbasins were designated by the CASGEM
14 program as medium priority.

15 *Sutter Subbasin*

16 The Sutter subbasin is located in Sutter County. In the Sutter subbasin,
17 groundwater levels have remained relatively constant. The water table is very
18 shallow and most groundwater levels in the subbasin tend to be within about
19 10 feet of ground surface (DWR 2006e, 2013a). Between the spring 2010 and
20 spring 2014 in the Sutter subbasin, recent information indicates that groundwater
21 levels declined at multiple wells by up to 10 feet (DWR 2014c, 2014d). The
22 groundwater levels in some areas declined up to 10 feet between fall 2013 and
23 fall 2014, and in some areas more than 10 feet.

24 Groundwater quality in the western portion of the Sutter subbasin includes areas
25 with high concentrations of arsenic, boron, calcium magnesium bicarbonate,
26 chloride, fluoride, iron, manganese, sodium, and TDS. In the southern portion of
27 the subbasin, groundwater in the upper aquifer system tends to be high in salinity
28 (DWR 2003b, 2006e).

29 The Sutter subbasin was designated by the CASGEM program as medium
30 priority.

31 *North American Subbasin*

32 The North American subbasin underlies portions of Sutter, Placer, and
33 Sacramento Counties, including several dense urban areas. Since at least the
34 1950s, concentrated groundwater extraction occurred east of downtown
35 Sacramento, which resulted in a regionally extensive cone of depression.
36 Drawdown in the wells in this areas have been in excess of 70 feet over the past
37 60 years (SGA 2008). Water purveyors have constructed facilities to import
38 surface water to allow groundwater levels to recover from the historic levels of
39 drawdown. In general, since around the mid-1990s to the late 2000s, water levels
40 remained stable in the southern portion of the subbasin and in some cases
41 groundwater levels are continuing to increase slightly in response to increases in
42 conjunctive use and reductions in pumping near McClellan Air Force Base
43 (SGA 2014). Groundwater levels in Sutter and northern Placer Counties

1 generally have remained stable, although some wells in southern Sutter County
2 have experienced declines (DWR 2006f, 2013a). Overall, groundwater levels are
3 higher along the eastern portion of the North American subbasin and decline
4 towards the western portion (Roseville et al. 2007). There is a groundwater
5 depression in the southern Placer-Sutter counties area near the border with
6 Sacramento County. Between the spring 2010 and spring 2014 in the North
7 American subbasin, recent information indicates that groundwater levels declined
8 at multiple wells by up to 10 feet (DWR 2014c, 2014d). The groundwater levels
9 were relatively constant between fall 2013 and fall 2014.

10 The area along the Sacramento River extending from Sacramento International
11 Airport northward to the Bear River contains high levels of arsenic, bicarbonate,
12 chloride, manganese, sodium, and TDS (DWR 2006f, 2013a). In an area between
13 Reclamation District 1001 and the Sutter Bypass, high TDS concentrations occur.
14 There have been three sites within the subbasin with significant groundwater
15 contamination issues: the former McClellan Air Force Base, the Union Pacific
16 Railroad Rail Yard in Roseville, and the Aerojet Superfund Site. Mitigation
17 operations have been initiated for all of these sites. In the deeper portions of the
18 aquifer, the groundwater geochemistry indicates the occurrence of connate water
19 from the marine sediments underlying the freshwater aquifer, which mixes with
20 the fresh water. Water quality concerns due to this type of geology include
21 elevated levels of arsenic, bicarbonate, boron, chloride, fluoride, iron, manganese,
22 nitrate, sodium, and TDS (DWR 2003b).

23 The North American subbasin was designated by the CASGEM program as high
24 priority.

25 *South American Subbasin*

26 The South American subbasin is located within Sacramento County.
27 Groundwater levels in the South American subbasin have fluctuated over the past
28 40 years, with the lowest levels occurring during periods of drought. From 1987
29 to 1995, water levels declined by about 10 to 15 feet and then recovered to levels
30 close to the mid-80s by 2000. Over the past 60 years, a general lowering of
31 groundwater levels was caused by intensive use of groundwater in the region.
32 Areas affected by municipal pumping show a lower groundwater level recovery
33 than other areas (DWR 2004q, 2013a). A large cone of depression is centered in
34 the southwestern portion of the subbasin. Between the spring 2010 and spring
35 2014 in the South American subbasin, recent information indicates that
36 groundwater levels declined at multiple wells by up to 10 feet (DWR 2014c, 2014d).
37 The groundwater levels were relatively constant between fall 2013 and fall 2014.

38 The groundwater quality is characterized by low to moderate TDS concentrations
39 (DWR 2004q, 2013a). Seven sites historically had significant groundwater
40 contamination, including three Superfund sites near the Sacramento metropolitan
41 area. These sites are in various stages of cleanup.

42 The South American subbasin was designated by the CASGEM program as high
43 priority.

1 *Groundwater Use and Management*

2 In this area, groundwater is used for agricultural, domestic, municipal, and
3 industrial purposes. Most of the groundwater extraction occurs via privately
4 owned domestic and agricultural wells.

5 *West and East Butte Subbasins*

6 The primary water source in Butte County is surface water (approximately
7 70 percent, by volume), and groundwater use accounts for about 30 percent of
8 total county water use. In Butte County, most of the irrigation users rely upon
9 surface water and approximately 75 percent of the residential water users rely
10 upon groundwater (Butte County 2004, 2010).

11 The cities of Chico and Hamilton City are served by groundwater provided by
12 California Water Service Company (California Water Service Company 2011g).

13 *North and South Yuba Subbasins*

14 The Yuba County Water Agency actively manages surface water and groundwater
15 conjunctively to prevent groundwater overdraft in the North and South Yuba
16 subbasins. The majority of water demand in these subbasins is crop water use
17 from irrigated agriculture (YCWA 2010).

18 *Sutter Subbasin*

19 Agricultural water use in Sutter County is composed, on average, of
20 approximately 60 percent surface water, 20 percent groundwater, and 20 percent
21 of land irrigated by both surface water and groundwater. Permanent crops are
22 predominantly irrigated with groundwater. Groundwater is also used for small
23 communities and rural domestic uses (Sutter County 2011).

24 *North American Subbasin*

25 Several agencies manage water resources in the North American subbasin: South
26 Sutter Water District, Placer County Water Agency, Natomas Central Mutual
27 Water Company, and several urban water purveyors which are part of the
28 Sacramento Groundwater Authority (SGA), a joint powers authority (SGA 2014).
29 The northern portion of this subbasin is rural and agricultural, while the southern
30 portion is urbanized, including the Sacramento Metropolitan area. Many of the
31 urban agencies in Placer County rely upon surface water for normal operations,
32 and have developed or are planning on developing groundwater for emergency
33 situations (Roseville et al. 2007). In the urban area encompassed by SGA, some
34 agencies rely entirely on groundwater for their water supply (SGA 2014).

35 Local planning efforts have been implemented in a local groundwater planning
36 area known as the American River Basin region. This area encompasses
37 Sacramento County and the lower watershed portions of Placer and El Dorado
38 counties, and overlies the productive North American and South American
39 subbasins. Groundwater is a regionally significant source of water supply, and is
40 used as a primary source for many agencies in the region. However, in recent
41 years, regional conjunctive use programs have allowed for the optimization of
42 water supplies and a decrease in groundwater use has been observed in the past
43 5 years (RWA 2013).

1 Since 2000, groundwater extraction decreased in the northeastern portion of the
2 North American subbasin as additional surface water supplies were made
3 available under conjunctive use operations implemented following the Water
4 Forum Agreement in 2000. In 2007, groundwater extraction increased because
5 additional surface water was not available due to dry surface water supply
6 conditions (SGA 2008, 2011).

7 *South American Subbasin*

8 The South American subbasin lies entirely within Sacramento County and is
9 overlain by a majority of urban and densely populated areas. Many of the water
10 users in this subbasin use surface water.

11 The main water purveyors that use South American subbasin groundwater include
12 the Elk Grove Water District, California-American Water Company, Golden State
13 Water Company, and the Sacramento County Water Agency. The entities serve
14 the communities of Antelope, Arden, Lincoln Oaks, Parkway, Rosemont, and
15 portions of the City of Rancho Cordova (California-American Water Company
16 2011; EGWD 2011; Golden State Water Company 2011; Sacramento County
17 Water Agency 2011). The majority of groundwater pumping is for agricultural
18 uses (SCGA 2010). The South American subbasin also includes portions of the
19 area known as the American River Basin, as described above under the North
20 American subbasin section.

21 **7.3.3.2 Delta**

22 The Delta overlies the western portion of the area where the Sacramento River
23 and San Joaquin River groundwater basins converge, as shown in Figure 7.5.
24 The Delta includes the Solano subbasin and the South American subbasin in the
25 Sacramento Valley Groundwater Basin (as described above); the Tracy subbasin,
26 the Eastern San Joaquin subbasin, and the Cosumnes subbasin in the San Joaquin
27 Valley Groundwater Basin (as described in subsequent sections of this chapter for
28 the San Joaquin); and the Suisun-Fairfield Valley Basin (as described in
29 subsequent sections of this chapter for the San Francisco Bay Area Region).

30 **7.3.3.2.1 Hydrogeology and Groundwater Conditions**

31 In some areas of the western and central Delta floodplain, floodplain deposits
32 contain organic material (peat) that range in thickness from 0 to 150 feet. Below
33 the surficial floodplain deposits, unconsolidated non-marine sediments occur, at
34 depths of a few hundred feet near the Coast Range to nearly 3,000 feet near the
35 eastern margin of the Sacramento Valley Groundwater Basin. These non-marine
36 sediments form the major water-bearing formations in the Delta.

37 In general, shallow groundwater conditions and extensive groundwater-surface
38 water interaction characterize the Delta. Spring runoff generated by melting snow
39 in the Sierra Nevada increases flows in the Sacramento and San Joaquin rivers
40 and their tributaries and cause groundwater levels near the rivers to rise. Because
41 the Delta is a large floodplain and the shallow groundwater is hydraulically
42 connected to the surface water, changes in river stages affect groundwater levels
43 and vice versa. Groundwater levels in the central Delta are very shallow, and land

1 subsidence on several islands has resulted in groundwater levels close to the
2 ground surface. Maintaining groundwater levels below crop rooting zones is
3 critical for successful agriculture, especially for islands that lie below sea level.
4 Many farmers rely on an intricate network of drainage ditches and pumps to
5 maintain groundwater levels of about 3 to 6 feet below ground surface. The
6 accumulated agricultural drainage is discharged into adjoining surface water
7 bodies (USGS 2000a). Without this drainage system, many of the islands would
8 be subject to extremely high groundwater, bogs, or localized flooding.

9 Groundwater generally flows from the Sierra Nevada in the east toward the
10 low-lying lands of the Delta to the west. However, a number of pumping
11 depressions have reversed this trend, and groundwater inflow from the Delta
12 toward these pumping areas has been observed, primarily in the Stockton area.

13 Subsidence in the Delta is well-documented and a major source of concern for
14 farming operations. The oxidation of peat soils is the primary mechanism of
15 subsidence in the Delta, and some areas are located below sea level. Another
16 mechanism for subsidence is wind erosion. There is a possibility that certain
17 areas in the Delta could continue to subside 2 to 4 more feet over the next
18 35 years (DWR 2013i).

19 **7.3.3.2 Groundwater Use and Management**

20 Groundwater is used throughout the Delta for domestic and irrigation water
21 supplies. Irrigation supplies are provided by wells and plant uptake in the root
22 zone. An accurate accounting of groundwater used in the region is not available
23 because wells are not metered and there is no method to measure root-zone
24 irrigation.

25 Groundwater is used for potable water supplies by the Delta communities of
26 Clarksburg, Courtland, Freeport, Hood, Isleton, Rio Vista, Ryde, and Walnut
27 Grove. In the rural portions of the Delta, private groundwater wells provide
28 residential and agricultural water supplies (Sacramento County 2010; Yolo
29 County 2009; SCWA et al. 2005; Solano County 2008; San Joaquin County 2009;
30 Contra Costa County 2005). In some portions of the Delta, groundwater use is
31 limited because of low well yields and poor water quality. Shallow groundwater
32 in the western Delta may be saline due to hydraulic connection with western Delta
33 waterways that are influenced by sea water intrusion. Shallow groundwater levels
34 can be detrimental if the groundwater encroaches into the crop root zones.
35 Therefore, groundwater pumping frequently is used to drain shallow groundwater
36 and surface water from agricultural fields.

37 **7.3.3.3 Suisun Marsh**

38 To the west, the Suisun Marsh overlies the Suisun–Fairfield Valley subbasin. The
39 Suisun–Fairfield Groundwater Basin is adjacent to, but hydrogeologically distinct
40 from, the Sacramento River Groundwater Basin, and is adjacent to Suisun Bay.
41 This basin is bounded by the Coast Ranges to the north and west and the
42 Sacramento River Groundwater Basin in the east, as shown in Figure 7.5. It is
43 separated from the Sacramento River Groundwater Basin by the English Hills.

1 **7.3.3.3.1 Hydrogeology and Groundwater Conditions**

2 In the Suisun-Fairfield Valley Groundwater Basin, freshwater occurs within the
3 alluvial deposits that overlie the Sonoma volcanics (Travis AFB 1997;
4 USGS 1960).

5 The overall direction of groundwater flow in the Suisun-Fairfield Valley
6 Groundwater Basin is from the uplands toward Suisun Marsh (USGS 1960;
7 Reclamation et al. 2011). Depth to groundwater varies seasonally, with higher
8 groundwater levels occurring during the rainy season (Solano County 2008).
9 Prior to implementation of the Solano Project that conveys water into Solano
10 County from Lake Berryessa as part of the Solano Project and the SWP North
11 Bay Aqueduct, groundwater depressions were occurring near Fairfield.
12 Following importation of surface water from the Solano Project and the North
13 Bay Aqueduct, surface water was used more extensively to reduce the
14 groundwater overdraft (Solano County 2008; Travis AFB 1997). Few
15 groundwater monitoring sites exist in the basin, and most are near ongoing
16 groundwater investigations. Data from these groundwater investigations suggest
17 that groundwater levels in the basin are generally stable.

18 Groundwater quality issues within the Suisun-Fairfield Valley Groundwater Basin
19 include high boron, TDS, and volatile organic compound concentrations near
20 Travis Air Force Base (USGS 1960, 2008). Volatile organic compound plumes at
21 Travis Air Force Base are largely contained on base, but volatile organic
22 compound constituents have migrated up to 0.5-mile off base at three sites.
23 Containment and remediation is occurring at each of these sites (Travis
24 AFB 2005).

25 The Suisun-Fairfield Valley Groundwater Basin was designated by the CASGEM
26 program as very low priority.

27 **7.3.3.3.2 Groundwater Use and Management**

28 Information on groundwater supplies in the Suisun-Fairfield Valley Groundwater
29 Basin is limited. Groundwater was the primary water source for the Suisun-
30 Fairfield Valley Groundwater Basin, including the cities of Fairfield and Suisun
31 City, through the 1950s. This groundwater production resulted in local areas of
32 depressed groundwater levels. As surface water became available, groundwater
33 use declined. Studies have shown that the basin provides low well yields and
34 therefore is probably not used as a major water supply (Reclamation et al. 2011).
35 Many private well owners in the Suisun-Fairfield Valley Groundwater Basin use
36 groundwater for irrigation. However, due to the brackish quality of the
37 groundwater, surface water is used for potable water supplies
38 (Reclamation et al. 2011).

39 **7.3.3.4 San Joaquin Valley**

40 The San Joaquin Valley Groundwater Basin extends from the Sacramento-San
41 Joaquin Delta in the north to the Tehachapi Mountains in the South. Groundwater
42 is estimated to provide over 47 percent of the overall water supply in the
43 San Joaquin Valley, including 70 percent of municipal uses and 43 percent of

1 irrigation supplies from 2005 through 2010 (DWR 2013i). The San Joaquin
2 Valley has an average annual precipitation between 5 to 18 inches. Due to the
3 low amounts of average annual precipitation, limited surface water supply and
4 extensive agricultural water use, there are areas of significant overdraft that exist
5 in the San Joaquin Valley Groundwater Basin. Eight subbasins in the San Joaquin
6 Valley Groundwater Basin were identified in a state of critical overdraft:
7 Chowchilla, Eastern San Joaquin, Madera, Kings, Kaweah, Tule, Tulare Lake,
8 and Kern (DWR 1980). Three of these subbasins are on the eastern side of the
9 San Joaquin River: Eastern San Joaquin, Chowchilla, and Madera. Recent studies
10 have indicated that overdraft continues to exist in these subbasins (DWR 2013i).
11 By 1970, over 5,200 square miles of irrigable land had subsided by a minimum of
12 1 foot. The maximum subsidence occurred near Mendota at almost 30 feet
13 (9 meters) (Reclamation 2013a). Due to the drought that started in 2011, surface
14 water supplies have declined and new wells have been constructed. Between
15 January and October 2014, over 100 wells were drilled in both Kern and Kings
16 counties, almost 200 in Stanislaus County, almost 250 in Merced County, and
17 over 350 in both Fresno and Tulare counties (DWR 2014d).

18 The elevation of the base of freshwater in the western and central San Joaquin
19 Valley ranges from 600 to 800 feet below mean sea level (WWD 2013). This
20 area has experienced subsidence of up to 28 feet between 1926 and 1970
21 (USGS 2009). The water quality of the semi-perched aquifer on the western side
22 of the San Joaquin Valley is impaired with high salinity, selenium, and boron
23 concentrations. These constituents are from both naturally occurring deposits in
24 the Coast Ranges to the west and agricultural activities. The chemicals become
25 trapped in the soil matrix due to the low permeability clay layers close to the
26 surface. There are also localized areas with high concentrations of naturally
27 occurring arsenic or selenium.

28 Portions of the San Joaquin Valley Groundwater Basin in the Cosumnes, Tracy,
29 and Eastern San Joaquin subbasins were designated by the State Water Resources
30 Control Board in 2000 as Hydrogeologically Vulnerable Areas and Groundwater
31 Protection Areas based on hydrogeologic permeability. These areas could be
32 more vulnerable to groundwater quality impairment if applied surface water,
33 including recycled water, contained high concentrations of constituents of concern
34 to the beneficial users of the groundwater (CVRWQCB 2014b).

35 **7.3.3.4.1 Northern Portions of the San Joaquin Valley Groundwater Basin**

36 Extending south into the Central Valley from the Delta to the southern extent
37 marked by the San Joaquin River, DWR has delineated nine subbasins within the
38 northern portion of the San Joaquin Valley Groundwater Basin based on
39 groundwater divides, barriers, surface water features, and political boundaries
40 (DWR 2003a), as shown in Figure 7.6. The Cosumnes, Eastern San Joaquin, and
41 Tracy subbasins partially underlie the Delta. The Delta-Mendota, Modesto,
42 Turlock, Merced, Chowchilla, and Madera subbasins are located between the
43 Delta and the San Joaquin River.

1 The northern portion of the San Joaquin Valley Groundwater Basin is marked by
2 laterally extensive deposits of thick fine-grained materials deposited in lacustrine
3 and marsh depositional systems. These units, which can be tens to hundreds of
4 feet thick, create vertically differentiated aquifer systems within the subbasins.
5 The Corcoran Clay (or E-Clay), occurs in the Tulare Formation and separates the
6 alluvial water-bearing formations into confined and unconfined aquifers. The
7 direction of groundwater flow generally coincides with the primary direction of
8 surface water flows in the area, which is to the northwest toward the Delta
9 (DWR 2003a, 2004r, 2004s, 2004t, 2004u, 2006g, 2006h, 2006k). Groundwater
10 levels fluctuate seasonally and a strong correlation exists between depressed
11 groundwater levels and periods of drought, when more groundwater is pumped in
12 the area to support agricultural operations.

13 Water users in the northern portion of the San Joaquin Valley Groundwater Basin
14 rely upon groundwater, which is used conjunctively with surface water for
15 agricultural, industrial, and municipal supplies (DWR 2003a). Groundwater is
16 estimated to account for about 38 percent of the overall water supply in the
17 northern portion of the San Joaquin Valley Groundwater Basin (DWR 2013i).
18 Annual groundwater pumping in the northern portion of the San Joaquin Valley
19 Groundwater Basin accounts for about 19 percent of all groundwater pumped in
20 the state of California. Groundwater use in the northern portion of the San
21 Joaquin Valley Groundwater Basin is estimated to average 3.2 million acre-feet
22 per year between 2005 and 2010.

23 According to the Draft California Water Plan 2013 Update (DWR 2013i), three
24 planning areas within the northern portion of the San Joaquin Valley Groundwater
25 Basin rely heavily on groundwater pumping: the Eastern Valley Floor Planning
26 Area, the Lower Valley Eastside Planning Area, and the Valley West Side
27 Planning Area. Each of these areas has limited local surface water supplies and
28 uses extensive groundwater pumping for their agricultural water supply
29 (DWR 2013i).

30 The northern portion of the San Joaquin Valley Groundwater Basin discussion is
31 divided into two sub-regions: West of the San Joaquin River, and East of the
32 San Joaquin River, as described below.

33 *West of the San Joaquin River*

34 The Tracy and the Delta-Mendota subbasins are located on the west side of the
35 San Joaquin River.

36 *Hydrogeology and Groundwater Conditions*

37 Along the western portion of the San Joaquin Valley, the Tulare formation
38 comprises the primary freshwater aquifer. The Tulare Formation originated as
39 reworked sediments from the Coast Ranges re-deposited in the San Joaquin
40 Valley as alluvial fan, flood basin, deltaic (pertaining to a delta) or lacustrine, and
41 marsh deposits (USGS 1986).

1 *Tracy Subbasin*

2 The Tracy subbasin underlies eastern Contra Costa County and western
3 San Joaquin County. A large portion of the subbasin is located within the Delta.
4 In the Tracy subbasin, groundwater generally flows from south to north and
5 discharges into the San Joaquin River. According to DWR and the San Joaquin
6 County Flood Control and Water Conservation District, groundwater levels in the
7 Tracy subbasin have been relatively stable over the past 10 years, apart from
8 seasonal variations resulting from recharge and pumping (DWR 2006g, 2013b).
9 Recent information indicates that between the spring 2010 and spring 2014,
10 groundwater levels declined at some wells in the Tracy subbasin by up to 10 feet
11 (DWR 2014c, 2014d). The groundwater levels in some areas declined up to
12 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet.

13 In the Tracy subbasin, areas of poor water quality exist throughout the area.
14 Elevated chloride concentrations are found along the western side of the subbasin
15 near the City of Tracy and along the San Joaquin River. Overall, Delta
16 groundwater wells in the Tracy subbasin are characterized by high levels of
17 chloride, TDS, arsenic, and boron (DWR 2006g, 2013b; USGS 2006). The
18 Central Valley Regional Water Quality Board recently adopted general waste
19 discharge requirements to protect groundwater, as well as surface water, within
20 the San Joaquin County and Delta areas, including the Tracy subbasin
21 (CVRWQCB 2014b). Supporting information recognizes the potential for
22 groundwater impairment due to the water quality of applied water to crops if the
23 applied water quality contains high concentrations of constituents of concern.

24 The Tracy subbasin was designated by the CASGEM program as medium
25 priority.

26 *Delta-Mendota Subbasin*

27 The Delta-Mendota subbasin underlies portions of Stanislaus, Merced, Madera,
28 and Fresno counties. The geologic units present in the Delta-Mendota subbasin
29 consist of the Tulare Formation, terrace deposits, alluvium, and flood-basin
30 deposits. Groundwater occurs in three water-bearing zones: the lower zone
31 contains confined fresh water in the lower section of the Tulare Formation; the
32 upper zone contains confined, semi-confined, and unconfined water in the upper
33 section of the Tulare formation; and a shallow zone that contains unconfined
34 water (DWR 2006h, 2013b). The groundwater is characterized by moderate to
35 extremely high salinity with localized areas of high iron, fluoride, nitrate, and
36 boron (DWR 2006h, 2013b).

37 In the Delta-Mendota subbasin, groundwater levels have generally declined by as
38 much as 20 feet in the northern portion of the basin near Patterson between 1958
39 and 2006. Surface water imports in the early 1970s resulted in decreased
40 pumping, and a steady recovery of groundwater levels. However, the lack of
41 imported surface water availability during the drought periods of 1976 to 77, 1986
42 to 1992, and 2007 to 2009 resulted in increases in groundwater pumping, and
43 associated declines in groundwater levels to near-historic lows (USGS 2012).
44 Recent information indicates that between the spring 2010 and spring 2014,

1 groundwater levels declined at some wells in the Delta-Mendota subbasin by up
2 to 20 feet (DWR 2014c, 2014d).

3 In areas adjacent to the Delta-Mendota Canal in this subbasin, extensive
4 groundwater withdrawal has caused land subsidence of up to 10 feet in some
5 areas. Land subsidence can cause structural damage to the Delta-Mendota Canal
6 which has caused operational issues for CVP water delivery. Historical wide-
7 spread soil compaction and land subsidence between 1926 and 1970 has caused
8 reduced freeboard and flow capacity of the Delta-Mendota Canal, the California
9 Aqueduct, other canals, and roadways in the area. To better understand
10 subsidence issues near the Delta-Mendota Canal and improve groundwater
11 management in the area, the U.S. Geological Survey (USGS) provided and
12 evaluated information on groundwater conditions and the potential for additional
13 land subsidence in the San Joaquin Valley (USGS 2013a). Results show that at
14 least 1.8 feet of subsidence occurred near the San Joaquin River and the Eastside
15 Bypass from 2008 to 2010 period, affecting the southern part of the Delta-
16 Mendota Canal by about 0.8 inches of subsidence during the same period. It was
17 estimated that subsidence rates doubled in 2008 in some areas. The subsidence
18 measured was primarily inelastic (or permanent, not reversible, due to the
19 compaction of fine-grained material). The area of maximum active subsidence is
20 shown to be located southwest of Mendota and extends into the Merced subbasin
21 to the south of El Nido. Land subsidence in this area is expected to continue to
22 occur due to uncertainties and limitations (especially climate-related changes) in
23 surface water supplies to meet irrigation demand and the continuous need to
24 supplement water supply with groundwater pumping.

25 *Groundwater Use and Management*

26 In this area, groundwater is used for agricultural, domestic, municipal, and
27 industrial purposes.

28 *Tracy Subbasin*

29 The primary water source in Contra Costa County is surface water. Groundwater
30 is used by individual homes and businesses and the communities of Brentwood,
31 Bethel Island, Knightsen, Byron and Discovery Bay (Contra Costa County 2005).

32 The Diablo Water District groundwater blending facility provides water to users
33 in the City of Oakley by blending groundwater and treated water from Contra
34 Costa Water District (DWD 2011).

35 Contra Costa Water District has an agreement with the East Contra Costa
36 Irrigation District to purchase surplus irrigation water for municipal and industrial
37 purposes in East Contra Costa Irrigation District's service area (CCWD 2011).
38 The agreement includes an option to implement an exchange of surface water for
39 groundwater that can be used in the Contra Costa Water District service area
40 when the CVP allocations are less than full contract amounts. This groundwater
41 exchange water was implemented during the 2007 to 2009 drought.

1 Groundwater and surface water are used within western San Joaquin County for
2 agricultural operations and for the cities of Stockton, Lathrop, and Tracy
3 (San Joaquin 2009). In the 1980s, about 30 percent of the water supplies in
4 San Joaquin County were based on groundwater (including the Tracy, Cosumnes,
5 and Eastern San Joaquin subbasins). By 2007, groundwater was used to supply
6 over 60 percent of water demand in the county.

7 *Delta-Mendota Subbasin*

8 Groundwater is used for agricultural and domestic water supplies in the
9 Delta-Mendota subbasin (Reclamation and DWR 2011). Groundwater is
10 primarily used for domestic and industrial water supplies in Stanislaus County,
11 including for the City of Patterson (Stanislaus County 2010; Patterson 2014). In
12 the Delta-Mendota subbasin within Merced County, approximately 3 percent of
13 groundwater withdrawals are used for municipal and industrial purposes
14 (including uses in the city of Gustine, Los Banos, and Santa Nella), and
15 97 percent of the groundwater withdrawals are used for agricultural purposes
16 (Merced County 2012). Most of the portions of Madera County within the
17 Delta-Mendota subbasin use groundwater for domestic and agricultural uses
18 (Madera County 2002, 2008). In portions of Western Fresno County within the
19 Delta-Mendota subbasin, domestic water users rely upon groundwater (including
20 the cities of Mendota and Firebaugh), and agricultural water users rely upon
21 surface water and/or groundwater (Mendota 2009; Firebaugh 2015;
22 Fresno County 2000).

23 *East of the San Joaquin River*

24 The east side of the San Joaquin River is underlain by seven groundwater
25 subbasins: the Cosumnes, Eastern San Joaquin, Modesto, Turlock, Merced,
26 Chowchilla, and Madera subbasins. Three of these subbasins are in a critical state
27 of overdraft: the Chowchilla, Eastern San Joaquin, and Madera (DWR 2013i).

28 *Hydrogeology and Groundwater Conditions*

29 Several of the hydrogeologic units present in the southern Sacramento Valley
30 extend south into the San Joaquin Valley. Along the eastern boundary of the
31 Central Valley, the Ione, Mehrten, Riverbank, and Modesto formations are
32 primarily composed of sediments originating from the Sierra Nevada.

33 Historically, surface water and groundwater were hydraulically connected in most
34 areas of the San Joaquin River and its tributaries. This resulted in a significant
35 quantity of groundwater actively discharging into streams in most of this
36 watershed. However this condition changed as increased groundwater pumping
37 in the area lowered groundwater levels and reversed the hydraulic gradient
38 between the surface water and groundwater systems, resulting in surface water
39 recharging the underlying aquifer system through streambed seepage. Long-term
40 groundwater production throughout this basin has lowered groundwater levels
41 faster than natural recharge rates. Areas where this overdraft has occurred include
42 eastern San Joaquin County, Merced County, and western Madera County. This
43 occurs along the San Joaquin River where the riverbed is highly permeable and
44 river water readily seeps into the underlying aquifer. This condition reduces

1 groundwater and surface water outflows to the Delta, lowers the water table, and
2 may increase the potential for land subsidence (USFWS 2012).

3 Generally, the groundwater in the San Joaquin River subbasins east of the San
4 Joaquin River is of suitable quality for most urban and agricultural uses with only
5 local impairments. There are localized areas with high concentrations of boron,
6 chloride, iron, nitrate, TDS, and organic compounds (DWR 2003a, 2004r, 2004s,
7 2004t, 2004u, 2006i, 2006j, 2006k). The use of groundwater for agricultural
8 supply is impaired in western Stanislaus and Merced counties due to elevated
9 boron concentrations. Groundwater use for drinking water supply is also
10 impaired in the Tracy, Modesto-Turlock, Merced, and Madera areas due to
11 elevated nitrate concentrations (USFWS 2012).

12 Dibromochloropropane (DBCP), a soil fumigant that was extensively used on
13 grapes and cotton before it was banned, is prevalent in groundwater near Merced
14 and Stockton and in the Merced, Modesto, Turlock, Cosumnes, and Eastern San
15 Joaquin subbasins (CVRWQCB 2011; DWR 2004r; USFWS 2012). Many areas
16 with high concentrations of DBCP have undergone groundwater remediation, and
17 the DBCP concentrations are declining.

18 Declining groundwater levels in the subbasins east of the San Joaquin River have
19 resulted in an area approximately 16-miles long with high salinity due to saltwater
20 intrusion from the Delta (USFWS 2012).

21 *Cosumnes Subbasin*

22 The Cosumnes subbasin underlies western Amador County, northwestern
23 Calaveras County, southeastern Sacramento County, and northeastern San
24 Joaquin County. Groundwater levels in the Cosumnes subbasin have fluctuated
25 significantly over the past 40 years, with the lowest levels occurring during
26 periods of drought. From 1987 to 1995, water levels declined by about 10 to
27 15 feet and then recovered by that same amount through 2000. Areas affected by
28 municipal pumping show a lower magnitude of groundwater level recovery
29 during this period than in other areas of the subbasin (DWR 2006i, 2013b).
30 Within the portion of Sacramento County in the Cosumnes subbasin, it is
31 estimated that the recent average annual decline in groundwater levels has been
32 approximately 1 foot, with a lower rate of decline in more recent years (South
33 Area Water Council 2011). Recent information indicates that between the spring
34 2010 and spring 2014, groundwater levels declined at some wells in the
35 Cosumnes subbasin by up to 10 feet (DWR 2014c, 2014d).

36 The Cosumnes subbasin contains groundwater of very good quality, with
37 localized high concentrations of calcium bicarbonate and pesticides
38 (DWR 2006i, 2013b).

39 The Cosumnes subbasin was designated by the CASGEM program as medium
40 priority.

41 *Eastern San Joaquin Subbasin*

42 The Eastern San Joaquin subbasin underlies western Calaveras County, a large
43 portion of San Joaquin County, and a portion of Stanislaus County. Groundwater

1 levels in the Eastern San Joaquin subbasin have continuously declined in the past
2 40 years due to groundwater overdraft. Cones of depression are present near
3 major pumping centers such as the City of Stockton and the City of Lodi
4 (DWR 2006j, 2013b). Groundwater level declines of up to 100 feet have been
5 observed in some wells. In the 1990s, groundwater levels were so low that many
6 wells were inoperable and many groundwater users were obligated to construct
7 new deeper wells (NSJCGBA 2004). Recent information indicates that between
8 the spring 2010 and spring 2014, groundwater levels declined at some wells in the
9 Eastern San Joaquin subbasin by up to 20 feet (DWR 2014c, 2014d).

10 In the Eastern San Joaquin subbasin, the groundwater is characterized with low to
11 high salinity levels and localized areas of high calcium or magnesium
12 bicarbonate, salinity, nitrates, pesticides, and organic constituents (DWR 2006j,
13 2013b). The high groundwater salinity is attributed to poor-quality groundwater
14 intrusion from the Delta caused by the pumping-induced decline in groundwater
15 levels, especially in the groundwater underlying the Stockton area since the 1970s
16 (SJCFCWCD 2008). High chloride concentrations have also been observed in the
17 Eastern San Joaquin subbasin. Ongoing studies are evaluating the sources of
18 chloride in groundwater along a line extending from Manteca to north of
19 Stockton. Initial concern was that long-term overdraft conditions in the eastern
20 portion of the subbasin were enabling more saline water from the Delta to migrate
21 inland. Other possible sources include upward movement of deeper saline
22 formation water and agricultural practices (USGS 2006). In addition, large areas
23 of groundwater with elevated nitrate concentrations have been observed in several
24 portions of the subbasin, such as areas southeast of Lodi and south of Stockton
25 and east of Manteca, and in areas extending towards the San Joaquin-Stanislaus
26 County line (USFWS 2012).

27 The Eastern San Joaquin subbasin was designated by the CASGEM program as
28 high priority.

29 *Modesto Subbasin*

30 The Modesto subbasin underlies northern Stanislaus County. In the Modesto
31 subbasin, water levels have declined nearly 15 feet on average between 1970 and
32 2000 (DWR 2004r, 2013b), with the major declines occurring in the eastern
33 portion of the subbasin. Recent information indicates that between the spring
34 2010 and spring 2014, groundwater levels declined at some wells in the Modesto
35 subbasin by up to 20 feet (DWR 2014c, 2014d).

36 The groundwater is characterized by low to high TDS concentrations with
37 localized areas of boron, chlorides, DBCP, iron, manganese, and nitrate
38 concentrations (DWR 2004r, 2013b; Stanislaus County 2010).

39 The Modesto subbasin was designated by the CASGEM program as high priority.

40 *Turlock Subbasin*

41 The Turlock subbasin underlies portions of Stanislaus and Merced counties. In
42 the Turlock subbasin, water levels declined nearly 7 feet on average from 1970
43 through 2000 (DWR 2006k, 2013b). Comparison of groundwater contours from

1 1958 and 2006 shows that historically, groundwater flows occurred from east to
2 west, toward the San Joaquin River. Groundwater pumping centers to the east of
3 the City of Turlock have drawn the groundwater toward these cones of
4 depression, allowing less water to flow toward the San Joaquin River, and
5 diminishing the discharge of groundwater to the river. Recent information
6 indicates that between the spring 2010 and spring 2014, groundwater levels
7 declined at some wells in the Turlock subbasin by up to 20 feet (DWR 2014c,
8 2014d). The storage capacity of the Turlock subbasin is estimated at about
9 15,800,000 acre-feet (DWR 2006k, 2013b).

10 The groundwater quality is characterized with low to high concentrations of TDS
11 and localized high concentrations of boron, chlorides, DBCP, nitrates, and TDS
12 (DWR 2013b).

13 The Turlock subbasin was designated by the CASGEM program as high priority.

14 *Merced Subbasin*

15 The Merced subbasin underlies most of Merced County. In the Merced subbasin,
16 water levels have declined nearly 30 feet on average from 1970 through 2000.
17 Water level declines have been more severe in the eastern portion of the subbasin
18 (DWR 2004s, 2013b). The estimated specific yield of the groundwater subbasin
19 is 9 percent. Recent information indicates that between the spring 2010 and
20 spring 2014, groundwater levels declined at some wells in the Merced subbasin
21 by up to 20 feet (DWR 2014c, 2014d).

22 The groundwater quality is characterized by low to high TDS concentrations and
23 localized areas with high concentrations of chloride, DBCP, iron, and nitrate
24 (DWR 2004s, 2013b; USFWS 2012).

25 The Merced subbasin was designated by the CASGEM program as high priority.

26 *Chowchilla Subbasin*

27 The Chowchilla subbasin underlies southwestern Merced County and
28 northwestern Madera County. In the Chowchilla subbasin, water levels declined
29 nearly 40 feet on average from 1970 to 2000. Water level declines were more
30 severe in the eastern portion of the subbasin from 1980 to present, but the western
31 portion of the subbasin showed the strongest declines before 1980 (DWR 2004t,
32 2013b). Groundwater recharge in this subbasin is primarily from irrigation water
33 percolation. Recent information indicates that between the spring 2010 and
34 spring 2014, groundwater levels declined at some wells in the western Chowchilla
35 subbasin by up to 10 feet (DWR 2014c, 2014d).

36 There are localized areas with high concentrations of chloride, iron, nitrate, and
37 hardness (DWR 2004t, 2013b). Organic chemicals were detected in some wells
38 in the Chowchilla subbasin between 1983 and 2003 (CVRWQCB 2011).

39 The Chowchilla subbasin was designated by the CASGEM program as high
40 priority.

1 *Madera Subbasin*

2 The Madera subbasin underlies most of Madera County. In the Madera subbasin,
3 water levels have declined nearly 40 feet on average from 1970 through 2000.
4 Water level declines have been more severe in the eastern portion of the subbasin
5 from 1980 to the present, but the western subbasin showed the strongest declines
6 before this period (DWR 2004u, 2013b). Recent information indicates that
7 between the spring 2010 and spring 2014, groundwater levels declined at some
8 wells in the western Chowchilla subbasin by up to 10 feet (DWR 2014c, 2014d).

9 Groundwater in the Madera subbasin is characterized by low to high TDS and
10 localized areas with high concentrations of chlorides, iron, nitrates, and hardness
11 (DWR 2004u, 2013b). Occurrences of organic chemicals have been observed
12 including DBCP and pesticides (CVRWQCB 2011; DWR 2004u, 2013b).

13 The Madera subbasin was designated by the CASGEM program as high priority.

14 *Groundwater Use and Management*

15 In this area, groundwater is used for agricultural, domestic, municipal, and
16 industrial purposes.

17 *Cosumnes Subbasin*

18 Currently, urban and agricultural water users on the valley floor are reliant on
19 groundwater for water supply. Water demands in the Cosumnes Subbasin area
20 are supported by nearly 95 percent groundwater (South Area Water Council
21 2011). Groundwater and surface water are used for agricultural and domestic
22 water supplies in the Cosumnes subbasin (CVRWQCB 2011). Groundwater is
23 used by many agricultural water users and the community of Galt
24 (CVRWQCB 2011; South Area Water Council 2011).

25 The Central Valley Regional Water Quality Board recently adopted general waste
26 discharge requirements to protect groundwater, as well as surface water, within
27 the San Joaquin County and Delta areas, including the Cosumnes subbasin. The
28 new requirements do not address protection of groundwater related to use of
29 recycled water on crops because those operations would require separate
30 discharge permits from the Central Valley Regional Water Quality Board and are
31 not anticipated to be widely used in this area due to availability of recycled water
32 near farms. However, the supporting information recognizes the potential for
33 groundwater impairment due to the water quality of applied water to crops if the
34 applied water quality contains high concentrations of constituents of concern
35 (CVRWQCB 2014b).

36 *Eastern San Joaquin Subbasin*

37 Groundwater and surface water are used for agricultural and domestic water
38 supplies in the Eastern San Joaquin subbasin (CVRWQCB 2011). Groundwater
39 is the major source of water supply for agricultural areas in eastern San Joaquin
40 County (NSJCGBA 2007). Groundwater is used by many agricultural water users
41 and the communities of Escalon, Lodi, Manteca, Ripon, and Stockton
42 (NSJCGBA 2004, 2007). The cities of Manteca and Stockton use both groundwater

1 and surface water, while Lodi, Escalon, and Ripon primarily use groundwater for
2 their municipal needs.

3 The City of Stockton uses both surface water and groundwater for its municipal
4 and industrial water needs. Due to overdraft of the aquifer beneath Stockton, the
5 city has limited annual groundwater extraction. All of these demands on the finite
6 groundwater resources available in the basin historically have resulted in annual
7 groundwater withdrawals in excess of the natural recharge volume in the East San
8 Joaquin subbasin (DWR 2003a, 2006j). This extensive use of groundwater to
9 meet local demand results in localized overdraft conditions within the subbasin.

10 The Northeastern San Joaquin County Groundwater Banking Authority is a joint-
11 powers authority that develops local projects to strengthen water supply reliability
12 in Eastern San Joaquin County. The Northeastern San Joaquin County
13 Groundwater Banking Authority facilitated the development and adoption of the
14 Eastern San Joaquin Groundwater Basin Groundwater Management Plan and
15 completed an Integrated Regional Water Management Plan (IRWMP). This plan
16 outlines the requirements for an integrated conjunctive use program that takes into
17 account the various surface water and groundwater facilities in eastern San
18 Joaquin County and promotes better groundwater management to meet future
19 basin demands (NSJCGBA 2004). Conjunctive use refers to the use and
20 management of the groundwater resource in coordination with surface water
21 supplies by users overlying the basin. Potential projects that could be
22 implemented to improve groundwater conditions in the area include urban and
23 agricultural water use efficiency projects, recycled municipal water projects,
24 groundwater banking operations, new surface water storage opportunities,
25 improved conveyance facilities, and utilizing new sources of surface water
26 (NSJCGBA 2007). Pursuant to the IRWMP, a program-level Environmental
27 Impact Report identified potential changes to the environmental and mitigation
28 measures to reduce identified significant adverse impacts (NSJCGBA 2011).

29 The Farmington Groundwater Recharge Program led by Stockton East Water
30 District, in conjunction with the U.S. Army Corp of Engineers, and other local
31 water agencies, was developed to utilize flood-season and excess irrigation water
32 supplies in the Eastern San Joaquin groundwater subbasin to recharge the
33 groundwater aquifer. This program supports replenishment of a critically
34 overdrafted groundwater basin by recharging an average of 35,000 acre-feet of
35 water annually into the Eastern San Joaquin subbasin. The program includes
36 recharge of surface water on 800 to 1,200 acres of land using direct field-
37 flooding. In addition, the program increases surface water deliveries in-lieu of
38 groundwater pumping to reduce overdraft (Farmington Program 2012).

39 A joint conjunctive use and groundwater banking project was evaluated by the
40 East San Joaquin Parties Water Authority and East Bay Municipal Utility District,
41 named the Mokelumne Aquifer Recharge and Storage Project (NSJCGBA 2004).
42 The goal of this project was to store surface water underground in wet years, and
43 in dry years, East Bay Municipal Utility District would extract and export the
44 recovered water supply (NSJCGBA 2004, 2009). Several studies have concluded

1 that the test area is suitable for recharge and recovery of groundwater; however,
2 more testing needs to be done to further evaluate the feasibility of this project.
3 The Central Valley Regional Water Quality Control Board recently adopted
4 general waste discharge requirements to protect groundwater, as well as surface
5 water, within the San Joaquin County and Delta areas. The new requirements do
6 not address protection of groundwater related to use of recycled water on crops
7 because those operations would require separate discharge permits from the
8 Central Valley Regional Water Quality Board and are not anticipated to be widely
9 used in this area due to availability of recycled water near farms. However, the
10 supporting information recognizes the potential for groundwater impairment due
11 to the water quality of applied water to crops if the applied water quality contains
12 high concentrations of constituents of concern (CVRWQCB 2014b).

13 *Modesto Subbasin*

14 Groundwater is used for agricultural and domestic water supplies in the Modesto
15 subbasin (Reclamation and DWR 2011). Groundwater is used by many
16 agricultural water users and the community of Modesto (DWR 2004r; Stanislaus
17 County 2010).

18 *Turlock Subbasin*

19 Groundwater is used for agricultural and domestic water supplies in the Turlock
20 subbasin (Reclamation and DWR 2011). Groundwater is used by many
21 agricultural water users and the community of Turlock in Stanislaus County and
22 the communities of Delhi and Hilmar in Merced County (DWR 2006k; Stanislaus
23 County 2010; Merced County 2012).

24 *Merced Subbasin*

25 Groundwater is used for agricultural and domestic water supplies in the Merced
26 subbasin (Reclamation and DWR 2011). Groundwater is used by many
27 agricultural water users and the communities of Atwater, El Nido, Le Grand,
28 Livingston, Merced, Planada, and Winton (DWR 2004s; Merced County 2012).

29 *Chowchilla Subbasin*

30 Groundwater is used for agricultural and domestic water supplies in the
31 Chowchilla subbasin (Reclamation and DWR 2011). Groundwater is used by
32 many agricultural water users and the community of Chowchilla (DWR 2006k;
33 Madera County 2002).

34 *Madera Subbasin*

35 Groundwater is used for agricultural and domestic water supplies in the Madera
36 subbasin (Reclamation and DWR 2011). Groundwater is used by many
37 agricultural water users and the community of Madera (DWR 2006k; Madera
38 County 2002, 2008).

39 **7.3.3.4.2 Tulare Lake Area of the San Joaquin Valley Groundwater Basin**

40 The Tulare Lake Area overlies seven groundwater subbasins of the San Joaquin
41 Valley Groundwater Basin, as defined by DWR (DWR 2003a): the Westside,
42 Kings, Tulare Lake, Kaweah, Tule, Pleasant Valley, and Kern subbasins, as

1 shown in Figure 7.7. The Kern and Pleasant Valley subbasins have distinct
2 hydrogeology and groundwater management from the other subbasins, and
3 therefore are described separately.

4 *Northern Tulare Lake Area: Westside, Kings, Tulare Lake, Kaweah, Tule,*
5 *Pleasant Valley, and Kern Subbasins*

6 *Hydrogeology and Groundwater Conditions*

7 *Hydrogeology*

8 The aquifer system in the Tulare Lake Area consists of younger and older
9 alluvium, flood-basin deposits, lacustrine and marsh deposits and unconsolidated
10 continental deposits. These deposits are configured within most parts of the basin
11 to form an unconfined to semi-confined upper aquifer and a confined lower
12 aquifer. These aquifers are separated by the Corcoran Clay (E-Clay) member of
13 the Tulare Formation, which occurs at depths between 200 and 850 feet within the
14 central and western portions of the basin, specifically in the Westside and Tulare
15 Lake subbasins and in the western Kings, Kaweah, and Tule subbasins.
16 Fine-grained lacustrine deposits up to 3,600 feet thick also are present in the
17 Tulare Lake region (DWR 2003a, 2004v, 2004w, 2006l, 2006m, 2006n, 2006o,
18 2006p).

19 Prior to extensive use of groundwater in the basin, groundwater generally flowed
20 toward Tulare Lake. Due to depressed groundwater levels and interception of
21 surface water, the Tulare Lake Area is dry except during extreme flood events;
22 and recharge of the Tulare Lake Area is limited.

23 Groundwater withdrawals in the Tulare Lake Area account for approximately
24 38 percent of the total groundwater withdrawals in the state of California
25 (DWR 2013i). The CVP and SWP surface water supplies are used by many
26 agricultural water users and several communities in the Tulare Lake Area to
27 reduce reliance on groundwater and allow for groundwater recharge. In drier
28 years when the CVP and SWP water supplies are limited, extensive groundwater
29 pumping occurs to meet the water demands. In drier years, water users in the
30 Westside, Kings, Tulare Lake, and Kaweah subbasins may use groundwater for
31 up to 75 percent of their water supply (DWR 2013i).

32 Areal recharge from precipitation provides most of the groundwater recharge, and
33 seepage from stream channels provides the remaining groundwater recharge.
34 Most of the recharge occurs as mountain-front recharge in the coarse-grained
35 upper alluvial fans where streams enter the basin (USGS 2009). Prior to
36 development of the Tulare Lake Area, surface water and groundwater exchange
37 occurred throughout the basin in response to hydrologic conditions. When rapid
38 agricultural growth and groundwater development occurred, the primary
39 interaction of surface water with groundwater occurred as stream flow loss to
40 underlying aquifers. In areas of severe overdraft in the Tulare Lake Area of the
41 San Joaquin Valley Groundwater Basin, complete disconnection between
42 groundwater and overlying surface water systems has occurred. In some areas
43 with disconnected hydrology where streambeds are used as conveyance elements
44 for irrigation purposes and to recharge groundwater, the streams become losing

1 streams. Recent information indicates that between the spring 2010 and spring
2 2014, groundwater levels declined at some wells in this area by up to 10 feet
3 (DWR 2014c, 2014d). The groundwater levels in some areas declined up to
4 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet.

5 *Groundwater Quality*

6 In the northern Tulare Lake Area (including the Westside, Tulare Lake, Kings,
7 Kaweah, and Tule subbasins), groundwater in the upper unconfined/semi-
8 confined aquifer is characterized by high calcium and magnesium sulfate as well
9 as high TDS (DWR 2006l, 2006m, 2006n, 2013c). The lower confined aquifer is
10 approximately 300 feet below the ground surface and above the Corcoran Clay,
11 and is characterized by high sodium sulfates and less dissolved solids than the
12 upper aquifer.

13 Groundwater quality in the northern Tulare Lake Area is poor in portions of the
14 upper aquifer, due to agricultural drainage issues and naturally occurring high
15 salinity soils. Groundwater in the Westside subbasin is of poor quality due to
16 historical agricultural drainage. The high clay content of the soils that comprise
17 the upper aquifer restricts the movement of groundwater in the aquifer, further
18 contributing to water quality impacts from root zone drainage. Studies have
19 shown that the quality of the upper 20 to 200 feet of the saturated groundwater
20 zone have been affected by crop irrigation and drainage issues (Reclamation
21 2006). The eastward movement of saline groundwater from the Westside
22 subbasin also adversely affects the groundwater quality in adjacent subbasins,
23 such as in the vicinity of the City of Mendota and Fresno Slough
24 (Reclamation 2006).

25 The Westside and Kings subbasins also have localized areas with high boron
26 concentrations (CVRWQCB 2011). The Kings and Tulare Lake subbasins have
27 localized areas with high arsenic and hydrogen sulfide. In the Kaweah subbasin
28 and the northern portion of the Tule subbasin, groundwater is of the calcium
29 bicarbonate type with high TDS and localized areas with high nitrate
30 concentrations (DWR 2004v, 2004w, 2013c). In the Kaweah subbasin,
31 groundwater is characterized by moderate to high TDS concentrations
32 (DWR 2004v, 2013c). In the Tule subbasin, low to moderate TDS concentrations
33 occur in the most of the subbasin with high concentrations in areas with poor
34 drainage (DWR 2004w, 2013c). On the western side of the subbasin there is
35 shallow saline water. The eastern side of the subbasin has areas of high nitrates
36 (DWR 2013c, 2004b). The Westside and Kings subbasins also have localized
37 areas with high boron concentrations (CVRWQCB 2011). The Kings and Tulare
38 Lake subbasins have localized areas with high arsenic and hydrogen sulfide. In
39 the Kaweah subbasin and the northern portion of the Tule subbasin, groundwater
40 is of the calcium bicarbonate type with high TDS and localized areas with high
41 nitrate concentrations (DWR 2004v, 2004w, 2013c). Portions of the Kings
42 subbasin is characterized by high nitrate concentrations due to historical
43 agricultural practices (CVRWQCB 2011; DWR 2006n, 2013c). High DBCP and
44 other pesticides concentrations occur in localized areas within the Westside,
45 Kings, Tulare Lake, Kaweah, and Tule subbasins (CVRWQCB 2011).

1 A recent study evaluated high nitrate concentrations in groundwater and related
2 public health issues in four community water systems with recorded violations
3 related to nitrates in drinking water (Pacific Institute 2011). The communities
4 served by the water systems were evaluated to assess the quality of groundwater
5 provided by their water distribution systems and potential costs to the
6 communities. Overall, this significant degradation of groundwater quality
7 throughout the area has implications on public health and economic sustainability
8 of the region. The findings of the report indicated that improved notification
9 procedures, new funding mechanisms, and improved regulations and incentives
10 are needed to provide safe drinking water, as described in Chapter 18, Public
11 Health. The four water systems included Beverly Grand Mutual Water Company
12 (Tule subbasin), Lemon Cove Water Company (east of Tule subbasin), El Monte
13 Village Mobile Home Park (Kings subbasin), and Soult's Mutual Water Company
14 (Kings subbasin) in Tulare County.

15 High groundwater salinity occurs in many locations in the Tulare Lake Area.
16 Salts are imported into the Tulare Lake Area through irrigation with Delta water
17 and salts added through application of fertilizers, and other salt containing
18 materials. Except in very wet years, the Tulare Lake Area has no natural
19 drainage, so imported salts accumulate in the groundwater unless captured and
20 sequestered. This salt accumulation causes groundwater quality degradation for
21 potable and agricultural uses.

22 To the high nitrate and salinity problems, the Central Valley Salinity
23 Alternatives for Long-Term Sustainability (CV-Salts) was formed as a strategic
24 initiative to address accumulation of salts and nitrates throughout the region in a
25 comprehensive, consistent and sustainable manner (CVRWQCB 2015; SWRCB
26 2015). The Central Valley Regional Water Quality Control Board and the State
27 Water Resources Control Board in cooperation with stakeholders and the Central
28 Valley Salinity Coalition collaborate to review and update the Water Quality
29 Control Plans for the Sacramento Valley and San Joaquin Valley groundwater
30 basins and the Delta Plan for salinity management, as described in Chapter 6,
31 Surface Water Quality. The goals of this program are to address groundwater
32 nitrate legacy conditions and current loadings, direct impacts of high nitrates on
33 drinking water supplies from diverse sources, and economic costs for water
34 treatment or alternate supplies. A final Salinity and Nitrate Management Plan is
35 scheduled to be completed in May 2016.

36 *Overall Groundwater Conditions*

37 The Westside, Kings, Tulare Lake, Kaweah, Tule, and Kern subbasins were
38 designated by the CASGEM program as high priority. The Pleasant Valley
39 subbasin was designated as low priority.

40 *Groundwater Use and Management*

41 The northern Tulare Lake Area uses groundwater for its many water needs.
42 Groundwater is used conjunctively with surface water, where possible, when
43 surface water supplies are not sufficient to meet the region's demand for
44 agricultural, industrial, and municipal uses (DWR 2003a). For example, the cities

1 of Fresno and Visalia are almost entirely dependent on groundwater for their
2 water supplies. Most groundwater subbasins in the Tulare Lake Area are in a
3 state of overdraft as a consequence of groundwater pumping that exceeds the
4 basin's safe yield (the amount of natural and induced recharge available to
5 replenish the basin). As a result, the aquifers in these groundwater basins contain
6 a significant amount of potential storage space that can be filled with additional
7 recharged water. However, cities in the northern Tulare Lake Area are
8 considering other water sources and/or groundwater banking programs.

9 *Westside Subbasin*

10 The Westside subbasin is located within western Fresno County and northwestern
11 Kings County. The majority of lands within the Westside subbasin are within the
12 Westlands Water District which uses CVP surface water, water transferred from
13 other agencies, and groundwater. Groundwater levels in the Westside subbasin
14 have fluctuated over the past 46 years in response to the availability of surface
15 water deliveries from the CVP (WWD 2013). The lowest recorded average
16 groundwater level below the Corcoran Clay between 1950 and 1968 (prior to
17 delivery of CVP water to the subbasin) was 156 feet below mean sea level, which
18 occurred in 1967. Groundwater elevations increased after 1968 to 89 feet above
19 mean sea level in 1987.

20 Groundwater levels are closely related to the availability of surface water. In the
21 1977 drought when CVP water supplies were substantially reduced, groundwater
22 withdrawals decreased the groundwater elevation by 97 feet in 1 year
23 (WWD 2013). In 1991 and 1992 (during the 1987 to 1992 drought), the
24 groundwater elevation declined to 62 feet below mean sea level. In 1996, the
25 Westlands Water District adopted a groundwater management plan to preserve
26 and enhance reliable groundwater resources; provide long-term availability of
27 high quality groundwater; maintain local control of groundwater in the district;
28 and minimize the cost and impact of groundwater use (WWD 2013a). The
29 groundwater levels recovered following the drought that ended in 1992.
30 However, in 2010, the CVP allocation was 45 percent of the contract amount, and
31 the average groundwater elevation was 9 feet above mean sea level (WWD 2011).
32 In 2012, the CVP allocation was 40 percent of the contract amount, and the
33 average groundwater elevation decreased to 1 foot above mean sea level (WWD
34 2013). Recent information indicates that between the spring 2013 and spring
35 2014, groundwater levels have declined at some wells in the Westside subbasin
36 by up to 40 feet within the 1-year period (DWR 2014c, 2014d).

37 Subsidence has occurred in the Westside subbasin as a result of the high rate of
38 historic groundwater pumping resulting in reduced groundwater levels and the
39 compaction of fine grained soils. In some areas, the land surface elevation has
40 decreased substantially. It is estimated that extensive groundwater pumping prior
41 to delivery of CVP water resulted in compaction of water bearing sediments and
42 land subsidence of 1 to 24 feet between 1926 and 1972 (WWD 2013). The
43 Westland Water District has referenced that the Department of Water Resources
44 estimated the amount of subsidence since 1983 to be almost 2 feet in some areas
45 of the District with most of that subsidence occurring since 1989 (WWD 2013).

1 The USGS monitoring between 2003 and 2010 indicated no subsidence in the
2 Westside subbasin area during the same time period while at least 1.8 feet of
3 subsidence occurred in the Delta-Mendota subbasin area near the southern part of
4 the Delta-Mendota Canal (USGS 2013a).

5 *Kings Subbasin*

6 The Kings subbasin includes most of central and eastern Fresno County, and
7 northern Kings and Tulare County (DWR 2006n, 2013c). Two major
8 groundwater depressions occur near the Fresno-Clovis urban area and
9 approximately 20 miles southwest of Fresno in the Raisin City Water District
10 (DWR 2013c). On average, the majority of this subbasin has experienced
11 generalized declines in groundwater levels of approximately 20 feet between 2003
12 and 2011 (KRCD 2012a). The Kings subbasin is in overdraft condition and
13 overdraft continues to be a major long-term problem due to increasing water
14 demand and reduced surface water supply reliability. Recent information
15 indicates that between the spring 2010 and spring 2014, groundwater levels
16 declined at some wells in the Kings subbasin by up to 20 feet (DWR 2014c,
17 2014d).

18 Groundwater is used for a portion of agricultural water demands and for most of
19 the domestic and industrial water demands in Fresno County, including for water
20 users in the communities of Fresno, Clovis, Sanger, Fowler, Selma, Kingsburg,
21 Reedley, Dinuba, Orange Cove, Raisin City, and Riverdale (CVRWQCB 2011;
22 Fresno County 2000; KRCD 2012a).

23 The City of Fresno, which previously used groundwater for the municipal water
24 supplies, has developed a surface water supply program. The groundwater is
25 recharged through direct recharge and from applied agricultural water, and
26 groundwater inflows from the adjacent foothills (City of Fresno 2015).

27 Several water agencies are coordinating efforts in the Kings subbasin to mitigate
28 the extensive historical declines in groundwater levels resulting from pumping
29 withdrawals. Current Kings subbasin groundwater recharge efforts include a total
30 of 4,000 acres of dedicated recharge ponds (CGRA 2012). One of the biggest
31 groundwater recharge efforts in the Kings subbasin area is the McMullin On-farm
32 Flood Capture and Recharge Project near Raisin City (KRCD 2013).

33 *Tulare Lake Subbasin*

34 The Tulare Lake subbasin includes most of Kings County (DWR 2006m, 2013c).
35 In the Tulare Lake subbasin, water levels have declined nearly 17 feet on average
36 from 1970 through 2000. Fluctuations in water levels have been most
37 exaggerated in the Tulare Lakebed area of the subbasin, which has experienced
38 both the steepest declines and the steepest rises over time. Groundwater overdraft
39 conditions also prevail in this subbasin, similar to the Kings subbasin. Recent
40 information indicates that between the spring 2010 and spring 2014, groundwater
41 levels declined at some wells in the Tulare Lake subbasin by up to 20 feet
42 (DWR 2014c, 2014d).

1 Groundwater is used for a portion of agricultural water demands and for most of
2 the domestic and industrial water demands in Kings County, including the
3 communities of Corcoran, Hanford, Lemoore, and Kettleman Hills
4 (CVRWQCB 2011; KRCD 2012a).

5 *Kaweah Subbasin*

6 The Kaweah subbasin includes a portion of eastern Kings County and
7 northwestern Tulare County. Water levels in this subbasin declined about 12 feet
8 on average from 1970 through 2000 (DWR 2004v, 2013c). The basin is subject
9 to large fluctuations in water levels since the 1970s to as low as 35 feet lower than
10 the 1970 water level in 1995 to 25 feet higher in 1988. These fluctuations
11 correspond to successive dry years (declines) and wet years (rebounds),
12 respectively. Recent information indicates that between the spring 2010 and
13 spring 2014, groundwater levels declined at some wells in the Kaweah subbasin
14 by up to 20 feet (DWR 2014c, 2014d). The Kaweah Delta Water Conservation
15 District operates recharge facilities to supplement groundwater recharge that
16 occurs along the natural stream channels (KDWCD 2006). Water is released
17 from the Terminus Reservoir on the Kaweah River to flow into over 40 recharge
18 basins throughout the basin. Use of CVP water from the Friant-Kern Canal by
19 Tulare Irrigation District and Ivanhoe Irrigation District reduces the need for
20 groundwater withdrawals when the CVP water is available.

21 Groundwater is used for a portion of agricultural water demands and for most of
22 the domestic and industrial water demands in the subbasin, including for water
23 users in the communities of Visalia, Tulare, and Lindsay (CVRWQCB 2011;
24 Tulare County 2010).

25 *Tule Subbasin*

26 The Tule subbasin includes southwestern Tulare County. Water levels in this
27 subbasin increased by about 4 feet on average from 1970 through 2000
28 (DWR 2004w, 2013c). Water levels have fluctuated during dry and wet years
29 between 16 feet below the 1970 water level in 1995 to 20 feet above the 1970
30 water level in 1988. Recent information indicates that between the spring 2010
31 and spring 2014, groundwater levels declined at some wells in the Tule subbasin
32 by up to 20 feet (DWR 2014c, 2014d). The Deer Creek and Tule River Authority
33 implemented a groundwater management plan in 2006 in the Tule Subbasin
34 (DCTRA 2012). The plan participants include Lower Tule River Irrigation
35 District, Pixley Irrigation District, Porterville Irrigation District, Terra Bella
36 Irrigation District, Saucelito Irrigation District, Tea Pot Dome Irrigation District,
37 Vandalia Irrigation District, Tipton Community Services District, Poplar
38 Community Services District (primarily the City of Porterville), and Woodville
39 Public Utility District. Many of these agencies have CVP water service contracts
40 and some of these agencies have surface water rights. Groundwater recharge
41 occurs in more than 25 groundwater recharge basins and along the Tule River and
42 Deer Creek channels.

1 *Southern Tulare Lake Area: Kern County Subbasin*

2 The Kern County subbasin is located between the Tule and Tulare Lake
3 groundwater subbasins on the north, the Sierra Nevada and Tehachapi Mountains
4 granitic rock on the east, and the marine sediments of the Coast Ranges on the
5 west. The major water suppliers within the Kern County subbasin include Kern
6 County Water Agency and the City of Bakersfield.

7 *Hydrogeology and Groundwater Conditions*

8 The unconfined aquifer in the Kern County Groundwater subbasin is composed
9 primarily of sediments that were deposited during the tertiary and quaternary age.
10 The Tulare Formation, located in the western portion of the subbasin, includes the
11 Corcoran Clay unit which occurs at depths of 300 to 650 feet and overlies the
12 confined aquifer (DWR 2006o, 2013c).

13 Net groundwater level changes in the Kern County subbasin varied in different
14 portions of the subbasin between 1970 and 2000 (DWR 2006o, 2013c). Since the
15 late 1970s, the groundwater levels have ranged from an increase of over 30 feet in
16 the southeastern portion of the subbasin to a decrease of up to 25 feet near
17 Bakersfield and 50 feet near McFarland/Shafter. Recent information indicates
18 that between the spring 2013 and spring 2014, groundwater levels declined at
19 some wells in the Kern County subbasin by up to 40 feet (DWR 2014c, 2014d).
20 The groundwater levels in some areas declined up to 10 feet between fall 2013
21 and fall 2014, and in some areas more than 10 feet.

22 Complete hydraulic disconnection between the groundwater and overlying surface
23 water systems has occurred in the Kern County area. Kern River, a losing stream,
24 is used as a conveyance element for irrigation purposes and to recharge
25 groundwater.

26 Groundwater quality in the region is generally characterized by calcium
27 bicarbonate in the shallow aquifers, and the groundwater quality is generally
28 suitable for most uses. Lower aquifers have higher sodium concentrations
29 (DWR 2006o, 2013c). Salinity is a significant groundwater quality issue in the
30 region. Salt from imported CVP and SWP water accumulates annually in
31 groundwater because the Tulare Lake is a closed system without any natural
32 outlets (KCWA 2011).

33 Shallow groundwater with high salinity occurs in the western and southern
34 portions of the Kern County subbasin and is related to drainage problems for
35 irrigated agriculture (DWR 2006o, 2013c). An agricultural drainage study
36 showed that shallow groundwater occurs between 0 and 30 feet below the ground
37 surface in the southern portion of the Kern County subbasin (DWR 2013j). The
38 shallow groundwater is characterized by high TDS, sodium chloride, selenium,
39 and sulfates (DWR 2013j). Areas with high nitrate and pesticide concentrations
40 occur in localized areas due to historic agricultural practices including irrigation
41 and dairy wastes (CVRWQCB 2011; DWR 2006o). Elevated arsenic
42 concentrations tend to occur in isolated areas associated with lakebed deposits.
43 Selenium and chromium also naturally occur in portions of the subbasin
44 (KCWA 2011).

1 *Groundwater Use and Management*

2 The Kern County subbasin is located in western Kern County. The majority of
3 the lands within the Kern County subbasin are within Kern County Water Agency
4 or the City of Bakersfield. Water supplies in the subbasin include local surface
5 water, CVP and SWP water supplies, and groundwater. The subbasin includes a
6 portion of the land evaluated in the Tulare Lake Basin Portion of the Kern Region
7 IRWMP. It is estimated that over the long-term, approximately 39 percent of
8 water supplies in this area are met by groundwater (KCWA 2011). Groundwater
9 can provide up to 60 percent of the total water supply in drier years.

10 Much of the groundwater is withdrawn by individuals or farmers who do not
11 maintain groundwater extraction records. Historically, groundwater extractions
12 were estimated based upon electricity use, changes in groundwater storage, or
13 changes in crop patterns and/or water requirements (DWR 2004o, 2013c;
14 KCWA 2011).

15 Most of the groundwater is used by agriculture and the communities of
16 Bakersfield, Rosedale, Shafter, Delano, Taft, and Wasco (KCWA 2011). The
17 City of Bakersfield and surrounding unincorporated areas use surface water and
18 groundwater. The groundwater supplies in 2010 include water provided by
19 California Water Service Company; East Niles Community Services District;
20 Kern County Water Agency Improvement District No. 4 and North of the River
21 Municipal Water District; and Vaughn Water Company (California Water Service
22 Company 2011a; ENCSD 2011; KCWA 2011; KCWA and NORMWD 2011;
23 Vaughn Water Company, Inc. 2011). The water entities along with adjacent
24 water agencies manage the groundwater basin levels through ongoing recharge
25 projects and conjunctive use projects.

26 *Conjunctive Use and Groundwater Banking*

27 Conjunctive use is an important component of water management in the Kern
28 County subbasin. Many groundwater banking facilities supplement water
29 supplies delivered to customers in dry years, when insufficient surface water
30 supplies are available to meet demands.

31 More than 30,000 acres of groundwater recharge ponds are estimated to exist in
32 the Kern County subbasin area (KCWA 2011). Infrastructure used for
33 groundwater banking includes recharge basins, recharge canals, recovery wells,
34 and conveyance pipelines. In addition, connections to regional conveyance
35 infrastructure conveys water from the local water supplies, including the Kern
36 River; Friant-Kern Canal; the Cross Valley Canal; and California Aqueduct to the
37 recharge areas. Groundwater banking programs have developed various interties
38 to the regional conveyance systems, such as the Semitropic Water Storage District
39 Intake Canal and the Kern Water Bank Canal (KCWA 2011).

40 The major groundwater banking programs in Kern County include the Kern
41 Water Bank operated by the Kern Water Bank Authority; the Semitropic
42 Groundwater Bank, operated by the Semitropic Water Storage District; a
43 groundwater bank operated by the North Kern Water Storage District; a

- 1 groundwater bank operated by the City of Bakersfield; and a groundwater bank
2 operated by Rosedale-Rio Bravo Water Storage District.
- 3 The Kern Water Bank Authority is located west of Bakersfield and covers nearly
4 30 square miles of the Kern County subbasin. The Kern Water Bank includes
5 recharge ponds where water from local surface streams and the SWP infiltrates
6 into the aquifer (KCWA n.d.; KWBA 2011). Eighty-four recovery wells are used
7 to pump groundwater out of the aquifer in dry years when additional water is
8 needed for irrigation since the program began operations in 1995 (KCWA 2011).
- 9 The Semitropic Water Storage District is located west of Wasco and covers more
10 than 220,000 acres (SWSD 2011a). The Semitropic Water Storage District Stored
11 Water Recovery Unit (a subunit of the overall Semitropic Water Storage District
12 Water Bank) partnered with the Antelope Valley Water Bank, located close to
13 Rosamond in the Kern County portion of the Antelope Valley, to form the
14 Semitropic-Rosamond Water Bank Authority (SWSD 2011b). The major banking
15 partners of Semitropic Water Storage District include (SWSD 2014):
- 16 • Metropolitan Water District of Southern California
 - 17 • Santa Clara Valley Water District
 - 18 • Alameda County Water District
 - 19 • Zone 7 Water Agency
 - 20 • Poso Creek Water Company
 - 21 • Newhall Land & Farming Company
 - 22 • San Diego County Water Authority
 - 23 • Homer, LLC
 - 24 • City of Tracy
 - 25 • Harris Farms
- 26 Other banking programs include (KCWA and NORMWD 2011; KCWA
27 2011, n.d.):
- 28 • Arvin-Edison Water Storage District Banking
 - 29 • Buena Vista Water Storage District Banking
 - 30 • Cawelo Water District Banking
 - 31 • City of Bakersfield 2800 Acres Recharge Facility
 - 32 • Kern County Water Agency Improvement District No. 4 Pioneer Project and
33 Allen Road Complex Well Field
 - 34 • Kern Delta Water District Banking
 - 35 • Kern Tulare and Rag Gulch Water Districts Banking
 - 36 • Rosedale-Rio Bravo Water Storage District Banking (developed with Kern
37 County Water Agency Improvement District No. 4)

1 *Western Tulare Lake Area: Pleasant Valley Subbasin*

2 The Pleasant Valley subbasin is located within the western portions of Fresno and
3 Kings Counties.

4 *Hydrogeology and Groundwater Conditions*

5 Tertiary continental and marine sediments of the Coast Ranges and Kettleman
6 Hills form the western boundary of the Pleasant Valley subbasin (DWR 2006p,
7 2013c). Alluvium of the San Joaquin Valley extends into the subbasin from the
8 north, east, and south. Ephemeral streams from the Coast Ranges and Kettleman
9 Hills flow into the subbasin. Groundwater recharge occurs primarily along these
10 and other streams within the subbasin.

11 In the Pleasant Valley subbasin, groundwater levels are generally continuing a
12 historical trend of decline. DWR measurements indicated a decline of 5 to 25 feet
13 during the 1990s (DWR 2006p, 2013c).

14 Water quality in the Pleasant Valley subbasin is characterized by high TDS
15 (CVRWQCB 2011; DWR 2006p, 2013c). Localized areas of high concentrations
16 of boron, calcium, chlorides, magnesium, pesticides, sodium, bicarbonates, and
17 sulfates occur in the groundwater.

18 The Pleasant Valley subbasin was designated by the CASGEM program as low
19 priority.

20 *Groundwater Use and Management*

21 Groundwater is used to meet agricultural and municipal water demands in the
22 Pleasant Valley subbasin (DWR 2006p, 2013c). Due to limited recharge
23 capabilities in the subbasin, surface water is used either completely or
24 conjunctively in western Fresno and Kings Counties. The communities of Avenal
25 and Coalinga use CVP surface water due to groundwater quality, as described in
26 Chapter 5, Surface Water Resources and Water Supplies (Reclamation 2012).

27 **7.3.4 San Francisco Bay Area Region**

28 The San Francisco Bay Area Region includes portions of Contra Costa, Alameda,
29 Santa Clara, and San Benito counties that are within the CVP and SWP service
30 areas. The SWP water users in Napa County do not use groundwater. Therefore,
31 groundwater resources for Napa County are not described in this EIS.

32 There are several groundwater basins in the San Francisco Bay Area Region;
33 however, only some of the basins are within the CVP and SWP service areas
34 evaluated in this EIS. The portions of the San Francisco Bay Area Region within
35 the CVP and/or SWP service areas include the Pittsburg Plain, Clayton Valley,
36 Ygnacio Valley, Arroyo Del Hambre Valley, San Ramon Valley, Livermore
37 Valley, Castro Valley, and Santa Clara Valley groundwater basins within the San
38 Francisco Bay Hydrologic Region; and Gilroy-Hollister Valley Groundwater
39 Basin within the Central Coast Hydrologic Region.

40 Groundwater represents approximately 15 percent of the agricultural, municipal,
41 and industrial water supplies in the San Francisco Bay Area (DWR 2013i).

1 Conjunctive use programs have been implemented by several agencies to
2 optimize the use of groundwater and surface water sources.

3 Groundwater quality in the San Francisco Bay Area is generally suitable for most
4 agricultural and municipal uses, but concerns exist about groundwater
5 contamination from industrial and agricultural chemical spills, leaky underground
6 and above ground storage tanks, landfill leachate, and poorer-quality surface
7 water bodies. There were over 800 groundwater cleanup projects in the area with
8 the majority resulting from leaky fuel tanks (DWR 2013i). Portions of the San
9 Francisco Bay Area Region along the shorelines include aquifers that are
10 susceptible to seawater intrusion.

11 In the southern San Francisco Bay Area Region, groundwater and surface water
12 are connected through in-stream and off-stream artificial recharge projects, in
13 which surface water is delivered to water bodies that permit the infiltration of
14 water to recharge underlying aquifers. Surface waters recharge aquifers in other
15 regions of the San Francisco Bay Area Region along streambeds, especially in
16 areas with depressed groundwater levels that have resulted from extensive
17 groundwater pumping.

18 This section describes groundwater in subbasins within CVP and/or SWP water
19 service areas, including Pittsburg Plain, Clayton Valley, Arroyo Del Hambre
20 Valley, Ygnacio Valley, and San Ramon Valley subbasins in Contra Costa
21 County; East Bay Plain and Livermore Valley subbasins in Contra Costa and
22 Alameda counties; Castro Valley subbasin in Alameda County; Santa Clara and
23 Llagas Area subbasins in Santa Clara County; and Bolsa, Hollister, and San Juan
24 Bautista Area subbasins in San Benito County, as shown in Figure 7.8.

25 **7.3.4.1 San Francisco Bay Hydrologic Region**

26 **7.3.4.1.1 Hydrogeology and Groundwater Conditions**

27 Each of these groundwater basins in the San Francisco Bay Hydrologic Region
28 contains unique hydrogeologic characteristics. However, generally the water
29 bearing materials consist of alluvial, unconsolidated sand, sand and gravel, and
30 clay (DWR 2004x, 2004y, 2004z, 2004aa, 2004ab, 2004ac, 2004ad, 2004ae,
31 2006q, 2006r, 2013d). Aquifers in these basins are hydrologically connected to
32 surface water bodies, such as the San Joaquin River, Suisun Bay, local streams,
33 and San Francisco Bay.

34 The movement of groundwater is locally influenced by features such as faults and
35 structural depressions and operating production wells; however, groundwater
36 generally flows toward the nearby bays. Groundwater levels in the area exhibit
37 seasonal variation and have been historically depressed from significant
38 groundwater use. However, as groundwater use decreased over the last few
39 decades following implementation of surface water projects, groundwater levels
40 have risen significantly. Over the entire period of record, groundwater levels
41 have shown only a slight decline and are stable in more recent years.

1 *Pittsburg Plain, Clayton Valley, Ygnacio Valley, and Arroyo Del Hambre Valley*
2 *Groundwater Basins*

3 The Pittsburg Plain, Clayton Valley, Ygnacio Valley, and Arroyo Del Hambre
4 Valley groundwater basins represent the majority of groundwater storage in
5 northern Contra Costa County. Except for portions of the Pittsburg Plain, most of
6 these groundwater basins are not located within the Delta.

7 These basins extend inland from Suisun Bay towards Mt. Diablo. The Pittsburg
8 Plain Groundwater Basin is composed of Pleistocene deposits of consolidated and
9 unconsolidated clay sediments; overlain by alluvial soft water-saturated muds,
10 peat, and loose sands (DWR 2004x, 2013d). The Clayton Valley and Ygnacio
11 Valley groundwater basins are composed of unconsolidated alluvium and semi-
12 consolidated alluvium interbedded with clay, sand, and gravel lenses. Along
13 Suisun Bay, the water bearing formations are composed of alluvial soft water-
14 saturated muds, peat, and loose sands (DWR 2004y, 2004z, 2004aa, 2013d).

15 Groundwater levels are relatively stable because the groundwater is recharged
16 from streams (DWR 2004x, 2004y, 2004z, 2004aa, 2013d). The streams include
17 Kirker and Willow creeks in the Pittsburg Plain Groundwater Basin; Marsh Creek
18 in the Clayton Valley Groundwater Basin; Walnut and Grayson creeks in the
19 Ygnacio Valley Groundwater Basin; and Alhambra Creek in the Arroyo Del
20 Hambre Valley Groundwater Basin. There are no recent data for these basins
21 related to groundwater levels or storage capacities.

22 The groundwater in this area is characterized by moderate to high TDS
23 (DWR 2004x, 2004y, 2004z, 2004aa, 2013d). High nitrate concentrations occur
24 in some rural areas of these basins (Contra Costa County 2005).

25 The Pittsburg Plain, Clayton Valley, Ygnacio Valley, and Arroyo Del Hambre
26 Valley groundwater basins were designated by the CASGEM program as very
27 low priority.

28 *San Ramon Valley Groundwater Basin*

29 The San Ramon Valley Groundwater Basin is located in southern Contra Costa
30 County and extends from the Alamo area southward under the Town of Danville
31 and City of San Ramon to the county boundary.

32 The basin is a closed basin characterized by alluvial fan deposits of sand, gravel,
33 silt, and clay sediments (DWR 2004ab, 2013d). Multiple faults within the basin
34 affect groundwater movement.

35 There are no recent data for this basin related to groundwater levels, storage
36 capacities, or quality (DWR 2004ab, 2013d).

37 The San Ramon Valley Groundwater Basin was designated by the CASGEM
38 program as very low priority.

39 *Livermore Valley Groundwater Basin*

40 The Livermore Valley Groundwater Basin extends under northeastern Alameda
41 County and southern Contra Costa County. The Livermore Valley Groundwater

1 Basin contains groundwater-bearing materials originating from continental
2 deposits from alluvial fans, outwash plains, and lakes (DWR 2006q, 2013d).

3 The Main Basin is the aquifer that includes the highest yielding aquifers and
4 highest quality groundwater (Zone 7 2012). The Main Basin generally is divided
5 into the Upper Aquifer Zone and Lower Aquifer Zone which are separated by a
6 relatively continuous silty clay lens. Water from the Upper Aquifer Zone moves
7 into the Lower Aquifer Zone when groundwater levels in the upper zone are high.

8 Well yields are mostly adequate and in some areas can produce large quantities of
9 groundwater for all types of wells (DWR 2006q, 2013d). The movement of
10 groundwater is locally impeded by structural features such as faults that act as
11 barriers to groundwater flow, resulting in varying water levels in the basin.
12 Groundwater follows a westerly flow pattern, similar to the surface water streams,
13 along the structural central axis of the valley toward municipal pumping centers
14 (Zone 7 2005).

15 Groundwater levels in the main portion of the Livermore Valley Groundwater
16 Basin started declining in the early 1900s when groundwater pumping removed
17 large quantities of groundwater (Zone 7 2005, 2010, 2013). This trend continued
18 until the late 1960s when Zone 7 Water Agency began importing SWP water.
19 Subsequently, Zone 7 Water Agency developed surface water projects to capture
20 local runoff. Local runoff and SWP water is stored in Lake Del Valle and used to
21 recharge groundwater within the Livermore Valley. The importation of additional
22 surface water alleviated the pressure on the aquifer, and groundwater levels
23 started to rise in the 1970s. However, historical lows were reached during periods
24 of drought. During the recent dry period, groundwater levels declined 7 to 17 feet
25 throughout the aquifers used by Zone 7 Water Agency between 2011 and 2012.

26 The Livermore Valley Groundwater Basin is characterized by localized areas of
27 high boron, nitrate, and TDS (DWR 2006q, 2013; Zone 7 2012). High boron
28 levels can be attributed to marine sediments adjacent to the basin.

29 Nitrate concentrations generally are within potable water criteria; however, high
30 nitrate concentrations occur in some locations of the upper aquifer (Zone 7 2012).
31 The source of nitrates appears to be related to agricultural activities, wastewater
32 disposal, and natural sources from decaying vegetation.

33 Salinity of the aquifer depends upon the quality of the water used for recharge
34 operations. Salinity has increased over the past 30 years (Zone 7 2012) especially
35 in the western portion of the Main Basin. Aquifers in the central and eastern
36 portions of the Livermore Valley Groundwater Basin are generally recharged
37 through streambeds and are characterized by lower salinity due to the high
38 recharge rate.

39 The Livermore Valley Groundwater Basin was designated by the CASGEM
40 program as medium priority.

1 *Castro Valley Groundwater Basin*

2 The Castro Valley Groundwater Basin is located in the Castro Valley area of
3 Alameda County between San Lorenzo Creek on the east and the Hayward Fault
4 on the west (Castro Valley 2012).

5 The basin is composed of alluvial deposits of sand, gravel, silt, and clay sediments
6 (DWR 2004ac, 2013d). Previous studies indicated that the maximum yield was
7 about 140,000 gallons per day (Castro Valley 2012).

8 The groundwater is characterized by bicarbonates with calcium and sodium.
9 Localized contamination has occurred in this shallow aquifer related to
10 agricultural activities and underground storage tanks (Castro Valley 2012).

11 The Castro Valley Groundwater Basin was designated by the CASGEM program
12 as very low priority.

13 *Santa Clara Valley Groundwater Basin*

14 The Santa Clara Valley Groundwater Basin includes three subbasins in areas that
15 are within the CVP and/or SWP service areas. The three subbasins include the
16 East Bay Plain subbasin in Contra Costa and Alameda counties, Niles Cone
17 subbasin in Alameda County, and Santa Clara subbasin in Santa Clara County.

18 *East Bay Plain Subbasin*

19 The East Bay Plain subbasin is an alluvial plain that extends from San Pablo Bay
20 southward to the Niles Cone subbasin, and extends under San Francisco Bay
21 (DWR 2004ad, 2013d; EBMUD 2013). The alluvium consists of unconsolidated
22 sediments of mud, silts, sands, and clays. Multiple faults within the subbasin
23 affect groundwater movement. Groundwater levels declined to approximately
24 250 feet below the ground surface until the mid-1960s when groundwater levels
25 began to increase. By 2000, groundwater levels were close to the ground surface.
26 The groundwater quality is characterized as calcium and sodium bicarbonate with
27 moderate to high TDS. Higher TDS concentrations occur near San Francisco Bay
28 where localized sea water intrusion has occurred. High nitrate concentrations
29 occur in localized areas due to historic agricultural activities.

30 The East Bay Plain subbasin was designated by the CASGEM program as
31 medium priority.

32 *Niles Cone Subbasin*

33 The Niles Cone subbasin is mainly comprised of the alluvial fan along Alameda
34 Creek. The Hayward Fault crosses the Niles Cone subbasin and further separates
35 the subbasin into the Below Hayward Fault (west of the Hayward Fault) and
36 Above Hayward Fault (east of the Hayward Fault) subbasins (ACWD 2012;
37 DWR 2006r, 2013d).

38 The Niles Cone subbasin was in overdraft condition through the early 1960s.
39 After 1962, groundwater levels increased as SWP water was delivered to the area
40 and used to recharge the groundwater subbasin (DWR 2006r, 2013d).

41 The main groundwater quality impairment in the Niles Cone subbasin is saltwater
42 intrusion caused by groundwater pumping (ACWD 2012; DWR 2006r, 2013d).

1 In the 1950s the migration of saline water extended into the Above Hayward Fault
2 subbasin, and migrated into deeper aquifers. Alameda County Water District has
3 developed aquifer reclamation programs to help control the movement of saline
4 water and restore the quality of groundwater in the affected aquifers, as described
5 below.

6 Niles Cone subbasin was designated by the CASGEM program as medium
7 priority.

8 *Santa Clara Subbasin*

9 The Santa Clara subbasin is located within Santa Clara County along a structural
10 trough that parallels the Coast Ranges and extends from the Diablo Range and
11 Santa Cruz Mountains. The water bearing formations of the Santa Clara subbasin
12 include unconsolidated to semi-consolidated gravel, sand, silt and clay
13 (DWR 2004ac, 2013d). The upper alluvial fan in the northern portion of the
14 subbasin is characterized by coarse-grained sediments (SCVWD 2010). Towards
15 the central portion of the subbasin, thick silty clay lenses are inter-bedded with
16 thin sand and gravel lenses. The northern and central portions of the subbasin are
17 referred to as the Santa Clara Plain subbasin of the Santa Clara subbasin
18 (SCVWD 2011). The southern portion of the subbasin consists of extensive
19 alluvial deposits of unconsolidated and semi-consolidated sediments and is
20 referred to as the Coyote subbasin of the Santa Clara subbasin (SCVWD 2010).
21 The central portions and areas along the edges of the Santa Clara Plain subbasin
22 consist of unconfined aquifers that provide recharge, also known as the Shallow
23 Aquifer (SCVWD 2010, 2011). The Principal Aquifer provides most of the
24 groundwater supply for the Santa Clara Valley and is separated from the Shallow
25 Aquifer by a confining lens. The groundwater recharge primarily occurs due to
26 percolation of water on the soil from precipitation or artificial recharge operations
27 (as described below), seepage from stream beds, and subsurface inflow from
28 surrounding hills.

29 In the Coyote subbasin, the groundwater aquifer is primarily unconfined with
30 areas of perched groundwater above discontinuous clay deposits (SCVWD 2010,
31 2011). Groundwater recharge occurs along the streambeds. When the
32 groundwater levels are high in the Coyote subbasin, groundwater seeps into the
33 streams.

34 The movement of groundwater in the Santa Clara subbasin is locally influenced
35 by groundwater recharge activities, proximity to streams, and operating
36 production wells (SCVWD 2010). Regionally, groundwater in Santa Clara
37 County generally flows northwest toward the San Francisco Bay and Delta.

38 The Santa Clara subbasin has historically experienced decreasing groundwater
39 level trends. Between 1900 and 1960, water level declines of more than 200 feet
40 from groundwater pumping have induced unrecoverable land subsidence of nearly
41 13 feet (SCVWD 2011). Importation of surface water using CVP, SWP, and San
42 Francisco Public Utilities District water supplies; and the development of an
43 artificial recharge program has resulted in rising groundwater levels since 1965.

1 The groundwater levels in some portions of this subbasin declined up to 10 feet
 2 between fall 2013 and fall 2014, and in some areas more than 10 feet.

3 The groundwater quality in the Santa Clara subbasin is of good to excellent
 4 mineral composition and suitable for most beneficial uses. The groundwater
 5 meets all drinking water standards and can be used without additional treatment
 6 (SCVWD 2001, 2010). Some areas affected by historical saltwater intrusion exist
 7 in the northern portion of the Santa Clara subbasin in the Shallow Aquifer
 8 especially near areas of historical subsidence. Recent groundwater monitoring
 9 has indicated that seawater intrusion appears to be stabilizing (SCVWD 2012a).
 10 High nitrate and organic carbon concentrations occur in localized areas of the
 11 Santa Clara Plain subbasin. Ongoing programs have been implemented to
 12 cleanup contamination related to high perchlorate concentrations near historic
 13 industrial sites in southern Santa Clara County (SCVWD 2012b).

14 Santa Clara subbasin was designated by the CASGEM program as medium
 15 priority.

16 **7.3.4.1.2 Groundwater Use and Management**

17 Use of groundwater in the San Francisco Bay Hydrologic Region varies
 18 extensively. In the basins within Contra Costa County (Pittsburg Plain, Clayton
 19 Valley, Ygnacio Valley, Arroyo Del Hambre Valley, and San Ramon Valley),
 20 local wells are used for small agricultural activities and landscape irrigation by
 21 individual land owners. In the Livermore Valley Groundwater Basin,
 22 groundwater is used for a major portion of the water supply.

23 *Pittsburg Plain, Clayton Valley, Ygnacio Valley, and Arroyo Del Hambre Valley* 24 *Groundwater Basins*

25 Groundwater use is limited within northern Contra Costa County within the
 26 Pittsburg Plain, Clayton Valley, Ygnacio Valley, and Arroyo Del Hambre Valley
 27 groundwater basins. This area is located within the Contra Costa Water District
 28 or East Bay Municipal Utilities District service areas. These districts provide
 29 surface water to most water users in this area.

30 Within the Contra Costa Water District service area, groundwater use is limited
 31 (CCWD 2011). The use of existing Contra Costa Water District wells at the
 32 Mallard Well Fields is limited because of the threat of contamination from
 33 adjacent industrial areas.

34 The City of Pittsburg operates two municipal wells from the Pittsburg Plain
 35 Groundwater Basin (Pittsburg 2011).

36 The City of Martinez operates up to two wells in the Arroyo Del Hambre Valley
 37 Groundwater Basin to provide irrigation water to a municipal park
 38 (Martinez 2011).

39 *San Ramon Valley Groundwater Basin*

40 Groundwater use is limited within the San Ramon Valley Groundwater Basin
 41 located in southern Contra Costa County. Local wells are used for small
 42 agricultural activities and landscape irrigation by individual land owners. This

1 area is located within the East Bay Municipal Utilities District service area. The
2 district provides surface water to most water users in this area.

3 *Livermore Valley Groundwater Basin*

4 In the Livermore Valley Groundwater Basin, Zone 7 Water Agency administers
5 oversight of the groundwater basins used for water supply and provides water to
6 California Water Service Company, Dublin San Ramon Services District, City of
7 Livermore, and City of Pleasanton. Zone 7 Water Agency only withdraws
8 groundwater that has been recharged using surface water supplies (Zone 7 2010).
9 The California Water Service Company, Dublin San Ramon Services District, and
10 City of Pleasanton also withdraw groundwater (California Water Service
11 Company 2011h; DSRSD 2011; City of Livermore 2011; City of
12 Pleasanton 2011).

13 Zone 7 Water Agency manages the groundwater levels and quality in the
14 Livermore Valley Groundwater Basin to maintain groundwater levels that would
15 avoid subsidence and provide emergency reserves for the worst credible drought
16 (DWR 2006q, 2013d).

17 Zone 7 Water Agency artificially recharges the Livermore Valley Groundwater
18 Basin with local surface water supplies and SWP water by releasing the surface
19 waters into the Arroyo Mocho and Arroyo Valle (Zone 7 2005, 2010). The
20 infiltrated water is then pumped from the groundwater basin for various uses,
21 mostly during the summer and during drought periods when local surface water
22 supplies are diminished and the available SWP water supplies are less than the
23 entitlement value Zone 7 Water Agency, City of Livermore, City of Pleasanton,
24 Dublin San Ramon Services District, and California Water Service Company are
25 permitted to withdraw groundwater from this subbasin.

26 In 2009, the Zone 7 Water Agency began operation of the Mocho Groundwater
27 Demineralization Plant (Zone 7 2010). This plant is a wellhead treatment plant
28 that produces potable water using reverse osmosis to remove TDS and hardness
29 from the Main Basin.

30 *Castro Valley Groundwater Basin*

31 Groundwater use is limited within the Castro Valley Groundwater Basin. Local
32 wells are used for small agricultural activities and landscape irrigation by
33 individual land owners (Castro Valley 2012). This area is located within the East
34 Bay Municipal Utilities District service area. The district provides surface water
35 to most water users in this area.

36 *Santa Clara Valley Groundwater Basin*

37 The Santa Clara Valley Groundwater Basin includes the East Bay Plain, Niles
38 Cone, and Santa Clara subbasins.

39 *East Bay Plain Subbasin*

40 Groundwater use is limited within the East Bay Plains subbasin. Local wells are
41 used for small agricultural activities and landscape irrigation by individual land
42 owners (DWR 2004ad, 2013d; EBMUD 2013). Well fields that served the
43 communities were initially constructed in the late 1800s and early 1900s, and

1 were closed by 1930. This area is located within the East Bay Municipal Utilities
2 District service area. The district provides surface water to most water users in
3 this area. East Bay Municipal Utilities District initiated the Bayside Groundwater
4 Project in 2009 to store surface water in wet years for use during droughts.

5 *Niles Cone Subbasin*

6 Alameda County Water District is the primary water agency that relies upon the
7 Niles Cone subbasin. This Alameda County Water District uses fresh
8 groundwater from the Niles Cone subbasin and desalinated brackish groundwater
9 in addition to local and imported surface water supplies. The Niles Cone subbasin
10 is primarily recharged in the Alameda Creek watershed by percolation of local
11 runoff and SWP water (ACWD 2011, 2012). In wetter years, when local water
12 supplies are abundant, Alameda County Water District diverts some of the SWP
13 allocation to the Semitropic Water Storage District in Kern County through a
14 water banking agreement (as described above for the Kern County subbasin).
15 This agreement allows Alameda County Water District to subsequently recover
16 this water during drier years through an exchange agreement with Semitropic
17 Water Storage District (ACWD 2012).

18 Alameda County Water District provides retail water supplies to the cities of
19 Fremont, Newark, and Union City. The district has implemented treatment of
20 brackish groundwater to allow previously unused groundwater to be used as a
21 potable water source (ACWD 2011, 2012). In 2003, the Alameda County Water
22 District Newark Desalination Facility began to remove salts and other constituents
23 from the Niles Cone subbasin groundwater that is subject to seawater intrusion
24 using a reverse-osmosis process. The aquifer reclamation program also includes
25 withdrawing water to prevent a plume of brackish water in the Centerville-
26 Fremont Aquifer from further migrating toward the Alameda County Water
27 District Mowry Wellfield. Future groundwater desalination facilities are being
28 evaluated by the district.

29 *Santa Clara Subbasin*

30 Local water agencies and individual landowners use groundwater in the Santa
31 Clara subbasin. The Santa Clara subbasin is primarily recharged from percolation
32 of local runoff and water supplied by the CVP and/or SWP that is discharged to
33 streambeds and recharge facilities (SCVWD 2011).

34 Treated water is provided by the Santa Clara Valley Water District to retail water
35 agencies in order to promote conjunctive use of groundwater. The water entities
36 in the Santa Clara subbasin that use treated surface water include the cities of
37 Milpitas, Mountain View, Palo Alto, San Jose, Santa Clara, and Sunnyvale;
38 California Water Service (Los Altos), Great Oaks Water Company, Purissima
39 Water District, and San Jose Water Company. Several of these entities also use
40 surface water from San Francisco Public Utilities Commission as part of their
41 overall water supply.

42 In the Santa Clara subbasin, groundwater is withdrawn by local water suppliers
43 and private well owners to meet municipal, domestic, agricultural, and industrial
44 water needs (SCVWD 2011). Groundwater provides approximately 40 to

1 50 percent of total water supply in Santa Clara County in average water year
2 conditions (SCVWD 2010). Within the Santa Clara subbasin, the users of the
3 most groundwater include San Jose Water Company, City of Santa Clara, Great
4 Oaks Water Company, California Water Service, and individual land owners
5 primarily in the southern portion of the subbasin (SCVWD 2012a).

6 The Santa Clara Valley Water District is responsible for groundwater
7 management in the Santa Clara subbasin, and operates a robust and flexible
8 conjunctive use program that uses a variety of surface water sources: local
9 supplies, imported SWP and CVP supplies, and imported transfer options in
10 conjunction with surface water supplied to some water users by the San Francisco
11 Public Utilities Commission (SCVWD 2001, 2010). The district operates an
12 extensive system of in-stream and off-stream artificial recharge facilities to
13 replenish the groundwater basin and provide more flexibility to manage water
14 supplies. Eighteen major recharge systems allow local reservoir water and
15 imported water to be released in over 30 local creeks and 71 percolation ponds
16 that provide 393 acres for artificial recharge to the groundwater basin. Recharge
17 in this subbasin occurs along streambeds and off-stream managed basins. Most of
18 the recharge facilities are located in the Santa Clara subbasin. Two major
19 recharge facilities, the Lower Llagas and Upper Llagas recharge systems) are
20 located in the Llagas subbasin of the Gilroy-Hollister Groundwater Basin, as
21 described below) (SCVWD 2011, 2012a). The amount of water artificially
22 recharged throughout the entire district depends upon the availability of local,
23 CVP, and/or SWP surface water supplies.

24 **7.3.4.2 Central Coast Hydrologic Region: Gilroy-Hollister Valley** 25 **Groundwater Basin**

26 Portions of the Gilroy-Hollister Valley Groundwater Basin within the CVP and/or
27 SWP water service areas include the Llagas Area, Hollister Area, and San Juan
28 Bautista Area subbasins.

29 **7.3.4.2.1 Hydrogeology and Groundwater Conditions**

30 Each of these groundwater basins in the Gilroy-Hollister Valley Groundwater
31 Basin contains unique hydrogeologic characteristics. However, generally the
32 water bearing materials consist of alluvial, unconsolidated sand, sand and gravel,
33 and clay. Within four subbasins in the Study Area of this EIS, groundwater flows
34 towards the Pajaro River which flows to Monterey Bay (DWR 2004af, 2004ag,
35 2004ah, 2004ai, 2013d).

36 *Llagas Area Subbasin*

37 The water bearing formations of the Llagas subbasin include continental deposits
38 of unconsolidated to semi-consolidated gravel, sand, silt and clay (DWR 2004af,
39 2013d; SCVWD 2010, 2011). Alluvium along the edges and the center portions
40 of the subbasin are underlain by dense clayey soils. Younger alluvium does not
41 have a well-defined clay subsoil.

42 As described above for the Santa Clara subbasin in the Santa Clara Valley
43 Groundwater Basin, Santa Clara Valley Water District manages groundwater in

1 the Llagas Area subbasin. Groundwater withdrawals in the Llagas subbasin have
2 been relatively stable in recent years; and groundwater elevation has been stable
3 since the late 1990s (SCVWD 2012a).

4 The groundwater quality in the Llagas subbasin is of good to excellent mineral
5 composition and suitable for most beneficial uses (SCVWD 2010, 2012a). High
6 nitrate concentrations occur in localized areas throughout the subbasin due to
7 historical agricultural practices and wastewater effluent disposal. Santa Clara
8 Valley Water District implemented a Nitrate Management Program in 1997 and
9 nitrate concentrations are beginning to decline.

10 *Bolsa Area, Hollister Area, and San Juan Bautista Subbasins*

11 The Bolsa Area, Hollister Area, and San Juan Bautista Area subbasins extend
12 over northern San Benito County. The subbasins are comprised of a sedimentary
13 sequence that contains the principal aquifers underlying the Hollister and San
14 Juan Valleys. The water bearing formation includes clay, silt, sand, and gravel
15 (DWR 2004ag, 2004ah, 2004ai, 2013e).

16 The main water bearing formation in this area is composed of alluvium in the
17 Bolsa Area and Hollister Area subbasins (San Benito County Water District
18 2012). The water bearing formations in the northern San Juan Bautista Area
19 consist of alluvium (San Benito County Water District 2012). Groundwater
20 movement within the aquifers is affected by the numerous faults, including the
21 San Andreas and Calaveras Faults. Groundwater aquifers in this area include
22 both unconfined and confined aquifer conditions with surficial clay deposits in the
23 northern portions of these subbasins.

24 Groundwater in these subbasins is characterized by artesian conditions when
25 groundwater levels are high, such as in the early 1900s (San Benito County Water
26 District 2012). After the mid-1940s, groundwater levels declined with increased
27 withdrawals. One of the lowest levels occurred in the late 1970s when the
28 groundwater elevation was approximately 150 feet lower than the high water level
29 conditions. In 2012, groundwater elevations ranged from 80 feet above mean sea
30 level in the Bolsa Area subbasin to 700 feet above mean sea level in the San Juan
31 Bautista Area subbasin.

32 The Bolsa Area, Hollister Area, and San Juan Bautista Area subbasins have
33 localized areas with high concentrations of boron, chloride, hardness, metals,
34 nitrate, sulfate, potassium, and TDS (San Benito County Water District 2012).
35 The most substantial constituents include high TDS concentrations in the
36 southeastern Bolsa Area subbasin, Hollister Area subbasin, and northern San Juan
37 Bautista Area subbasin. High nitrate concentrations occur in the northern San
38 Juan Bautista Area subbasin.

39 *Overall Groundwater Conditions*

40 The Llagas Area subbasin was designated by the CASGEM program as high
41 priority. The Hollister Area and San Juan Bautista Area subbasins were
42 designated as medium priority.

1 **7.3.4.2.2 Groundwater Use and Management**

2 *Llagas Area Subbasin*

3 As described in Chapter 5, Surface Water Resources and Water Supplies,
4 groundwater is the primary water supply for local water agencies and individual
5 landowners in the Llagas Area subbasin. The subbasin is primarily recharged
6 from percolation of local runoff and water supplied by the CVP that is discharged
7 to recharge facilities managed by Santa Clara Valley Water District, as described
8 above for the Santa Clara subbasin in the Santa Clara Valley Groundwater Basin
9 (SCVWD 2011). The two major recharge facilities in the Llagas Area subbasin
10 include the Lower Llagas and Upper Llagas recharge systems (SCVWD 2010).

11 The primary municipal water suppliers are the cities of Gilroy and Morgan Hill.
12 Groundwater is used by these local water suppliers and private well owners to
13 meet municipal, domestic, agricultural, and industrial water needs
14 (SCVWD 2011).

15 *Bolsa Area, Hollister Area, and San Juan Bautista Subbasins*

16 Local water agencies and individual landowners use groundwater in the Bolsa
17 Area, Hollister Area, and San Juan Bautista subbasins. The subbasins are
18 primarily recharged from percolation of local runoff in streambeds, including
19 water from Hernandez and Paicines Reservoirs that is released to Tres Pinos
20 Creek (San Benito County Water District 2012).

21 San Benito County Water District provides CVP water to the cities of Hollister
22 and San Juan Bautista, Sunnyslope County Water District, residential areas
23 surrounding Hollister and Tres Pinos, and agricultural areas in northern San
24 Benito County to reduce groundwater use by these areas (San Benito County
25 Water District 2012). Most other water users in the subbasins rely upon
26 groundwater and/or local surface water stored in Hernandez and Paicines
27 Reservoirs.

28 In 2011, groundwater supplies provided 49 percent of the water used for
29 agriculture, municipal, domestic, and industrial supply in the areas of the subbasin
30 supplied by CVP water (San Benito County Water District 2012).

31 **7.3.5 Central Coast Region**

32 The Central Coast Region includes portions of San Luis Obispo and Santa
33 Barbara counties served by the SWP. The Central Coast Region encompasses the
34 southern planning area of the Central Coast Hydrologic Region (DWR 2009a).

35 The SWP water is provided to the Central Coast Region by the Central Coast
36 Water Authority (CCWA 2013a). The facilities divert water from the SWP
37 California Aqueduct at Devil's Den and convey the water to the 43 million gallon
38 per day water treatment plant at Polonto Pass. The treated water is conveyed to
39 municipal water users in San Luis Obispo and Santa Barbara counties to reduce
40 groundwater overdraft in these areas.

1 Portions of the Central Coast Region that use SWP water are included in the
2 Central Coast Hydrologic Region which includes 50 delineated groundwater
3 basins, as defined by DWR (DWR 2003a). The basins vary from large extensive
4 alluvial aquifers to small inland valleys and coastal terraces. Groundwater in the
5 large alluvial aquifers exists in thick unconfined and confined basins.
6 Groundwater is generally used for urban and agricultural use in the Central Coast
7 Region.

8 **7.3.5.1 Hydrogeology and Groundwater Conditions**

9 The areas within the SWP service area in the Central Coast Region include the
10 Morro Valley and Chorro Valley groundwater basins in San Luis Obispo County;
11 Santa Maria River Valley Groundwater Basin in San Luis Obispo and Santa
12 Barbara counties; and San Antonio Creek Valley, Santa Ynez River Valley,
13 Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria groundwater basins in
14 Santa Barbara County, as shown in Figure 7.9.

15 **7.3.5.1.1 Morro Valley and Chorro Valley Groundwater Basins**

16 In the portions of San Luis Obispo County within the SWP service area near
17 Morro Bay, groundwater is provided by Morro Valley and Chorro Valley
18 groundwater basins. The water bearing formations are alluvium that consists of
19 clays, silts, sands, and gravel that extend into the Pacific Ocean (DWR 2004aj,
20 2004ak, 2013e). The alluvium is recharged by seepage from streambeds and
21 precipitation and irrigation water applied to the soils.

22 The groundwater has moderate TDS (DWR 2004aj, 2004ak, 2013e). Localized
23 areas have high nitrate concentrations (Morro Bay 2011). Localized areas with
24 organic contamination are also present; however, actions have been implemented
25 to reduce the concentrations. Seawater intrusion occurs in localized areas near the
26 Pacific Ocean.

27 The Morro Valley and Chorro Valley groundwater basins were designated by the
28 CASGEM program as high priority.

29 **7.3.5.1.2 Santa Maria River Valley Groundwater Basin**

30 The Santa Maria River Valley Groundwater Basin is located in San Luis Obispo
31 and Santa Barbara counties. The water bearing formation is primarily unconfined
32 alluvium with localized confined areas near the coast (DWR 2004 al, 2013e;
33 SMVMA 2012). Recharge occurs along the streambeds. Groundwater levels in
34 the Basin have fluctuated over the past 100 years with declining groundwater
35 levels until the mid-1970s, recovery through the mid-1980s, and declining levels
36 through the mid-1990s. Following importation of SWP water, groundwater levels
37 increased to historic high levels. However, in the last decade, groundwater levels
38 have gradually declined which could be partially due to reductions in Twitchell
39 Reservoir releases for groundwater recharge since 2000. Groundwater levels
40 have been maintained at levels above 15 feet above mean sea level in shallow and
41 deep aquifers near the coast to avoid seawater intrusion. Groundwater recharge

1 occurs along streambeds. Water released from Twitchell and Lopez reservoirs
2 increase groundwater recharge rates (SMVMA 2012).

3 Groundwater quality issues in the Santa Maria Valley Groundwater Basin include
4 hardness, nitrates, salinity, sulfate and volatile organic compounds (DWR 2004a,
5 2013e; San Luis Obispo County 2011; SMVMA 2012). TDS concentrations are
6 moderate to high. There are localized areas in the basin with high sulfate
7 concentrations. Volatile organic compound contamination was a major issue for
8 two wells used by the City of San Luis Obispo in the late 1980s. High nitrate
9 concentrations occur in the shallow aquifer due to historic agricultural practices.
10 Higher salinity levels occur in the shallow aquifer near the coast than within the
11 inland areas or in the deep aquifer.

12 The Santa Maria River Valley Groundwater Basin was designated by the
13 CASGEM program as high priority.

14 **7.3.5.1.3 San Antonio Creek Valley Groundwater Basins**

15 San Antonio Creek Valley Groundwater Basin is located along the Pacific Ocean
16 within San Luis Obispo and Santa Barbara counties. The water bearing
17 formations are characterized by unconsolidated alluvial and terrace deposits of
18 sand, clay, silt, and gravel (DWR 2004dq, 2013e). Groundwater flows towards
19 the Pacific Ocean. A groundwater barrier to the east of the Pacific Ocean creates
20 the Barka Slough. Groundwater has declined in some areas of the basin over the
21 past 60 years. Groundwater quality issues include areas with high salinity near
22 the Pacific Ocean.

23 The San Antonio Creek Valley Groundwater Basin was designated by the
24 CASGEM program as medium priority.

25 **7.3.5.1.4 Santa Ynez River Valley Groundwater Basins**

26 Several groundwater basins in Santa Barbara County are in a state of overdraft,
27 including the Santa Ynez River Valley Groundwater Basin. The Santa Ynez
28 Groundwater Basin is located along the Pacific Ocean in southwestern Santa
29 Barbara County. The water bearing formations are characterized by
30 unconsolidated alluvial and terrace deposits of gravel, sand, silt, and clay
31 (DWR 2004an, 2013e). Groundwater flows towards the Santa Ynez River, and
32 then towards the Pacific Ocean. Groundwater recharge occurs along the stream
33 beds.

34 Groundwater quality is generally good for municipal and agricultural uses. There
35 are localized areas with high TDS near the Pacific Ocean due to seawater
36 intrusion (DWR 2004an, 2013e).

37 The Santa Ynez River Valley Groundwater Basin was designated by the
38 CASGEM program as medium priority.

1 **7.3.5.1.5 Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria** 2 **Groundwater Basins**

3 The Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria groundwater
4 basins are located in southwestern Santa Barbara County along the Pacific Ocean
5 and near the boundary with Ventura County. The water bearing formations in the
6 Goleta, Foothill, Santa Barbara, and Montecito groundwater basins are
7 unconsolidated alluvium of clay, silt, sand, and/or gravel that overlays the
8 generally confined Santa Barbara Formation of marine sand, silt, and clay
9 (DWR 2004an, 2004ao, 2004ap, 2004aq, 2013e).

10 In the Carpinteria Groundwater Basin, the alluvium extends under the agricultural
11 plain (DWR 2004ar, 2013e). A confined aquifer occurs under a thick clay bed in
12 the lower part of the alluvium. This basin includes the Santa Barbara Formation;
13 as well as the Carpinteria Formation, of unconsolidated to poorly consolidated
14 sand with gravel and cobble; and the Casitas Formation, of poorly to moderately
15 consolidated clay, silt, sand, and gravel.

16 Several faults restrict groundwater flow throughout these basins. Recharge occurs
17 along streambeds and from subsurface inflow into the basin from upland areas.
18 Water released from Lake Cachuma increases groundwater recharge rates.

19 The groundwater levels in portions of these groundwater basins declined up to
20 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet
21 (DWR 2014d).

22 Groundwater quality is generally good for municipal and agricultural uses. There
23 are localized areas with high TDS near the Pacific Ocean due to seawater
24 intrusion (DWR 2004an, 2004ao, 2004ap, 2004aq, 2004ar, 2013e; GWD and
25 LCMWC 2010). High concentrations of nitrate, iron, and manganese occur in
26 localized areas in the Goleta Groundwater Basin. Localized areas of high nitrate
27 and sulfate concentrations occur within the Foothill Groundwater Basin. High
28 concentrations of calcium, magnesium, bicarbonate, and sulfate occur in localized
29 areas of the Santa Barbara Groundwater Basin. High concentrations of iron and
30 manganese occur in localized areas of the Montecito Groundwater Basin.

31 Localized areas with high nitrates occur within the Carpinteria Groundwater
32 Basin. Other basins are in equilibrium due to management of the basin through
33 conjunctive use by local water districts (Santa Barbara County 2007). The Goleta
34 Groundwater Basin generally is near or above historical groundwater conditions
35 (Goleta Groundwater Basin and La Cumbre Mutual Water Company 2010), with
36 the northern and western portions of the basin having groundwater levels near the
37 ground surface. High groundwater levels may result in degradation to building
38 foundations and agricultural crops (water levels within the crop root zone).

39 The Goleta Groundwater Basin was designated by the CASGEM program as
40 medium priority. Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria
41 groundwater basins were designated as very low priority.

1 **7.3.5.2 Groundwater Use and Management**

2 Groundwater is an important source of water supply for the population of the
3 Central Coast; it is the region's primary water source.

4 **7.3.5.2.1 Morro Valley and Chorro Valley Groundwater Basins**

5 As described in Chapter 5, Surface Water Resources and Water Supplies, the City
6 of Morro Bay uses groundwater from Morro Valley and Chorro Valley
7 groundwater basins. These basins have been designated by the State Water
8 Resources Control Board as riparian underflow basins. The City of Morro Bay
9 and other users of these basins have received water rights permits which limits the
10 rate and volume of groundwater withdrawals (Morro Bay 2011).

11 **7.3.5.2.2 Santa Maria River Valley Groundwater Basin**

12 The Santa Maria River Valley Groundwater Basin is the primary water supply for
13 irrigation in southwestern San Luis Obispo County and northwestern Santa
14 Barbara County. Groundwater also is a major portion of the water supplies for
15 the communities of Pismo Beach, Grover Beach, Arroyo Grande, Oceano,
16 Nipomo, and several smaller communities in San Luis Obispo County; and
17 Guadalupe, Santa Maria, and Orcutt in Santa Barbara County (City of Grover
18 Beach 2011). In many cases, groundwater is the total water supply for these
19 communities including Nipomo Community Services District (NCSD 2011).

20 The groundwater basin was adjudicated as defined by a settlement agreement, or
21 stipulation, in 2005 that was filed in 2008. The stipulation defined the safe yield
22 of the basin and measures to protect groundwater supplies (Pismo Beach 2011,
23 Arroyo Grande 2012, NCSD 2011, Santa Maria 2011). The stipulation provided
24 for the Northern Cities Management Area, Nipomo Mesa Management Area, and
25 Santa Maria Valley Management Area. The groundwater adjudication considers
26 groundwater recharge from precipitation and applied irrigation water; and water
27 released from Reclamation's Twitchell Reservoir and San Luis Obispo Flood
28 Control and Water Conservation District's Lopez Reservoir that recharge the
29 basin from the downstream stream beds.

30 The cities of Pismo Beach, Grover Beach, Arroyo Grande; Oceano Community
31 Services District; San Luis Obispo County; and San Luis Obispo Flood Control
32 and Water Conservation District have formed the Northern Cities Management
33 Area to manage and protect groundwater supplies in accordance with the
34 adjudication stipulation (Pismo Beach 2011, Arroyo Grande 2012, NCSD 2011).
35 Historical monitoring reporting indicates that the groundwater levels have varied
36 from 20 feet above to 20 feet below mean sea level. When groundwater levels are
37 below mean sea level, there is a potential for sea water intrusion. In 2008,
38 groundwater levels in this area were approximately 10 feet below mean sea level.
39 In 2010, groundwater levels had recovered and ranged from 0 to 20 feet above
40 mean sea level. Overdraft conditions occurred more frequently prior to the
41 groundwater adjudication and completion of the Central Coast Water Authority
42 project that provides SWP water supplies to the area. There is a deep aquifer

1 under the City of Arroyo Grande (Pismo Formation) that provides groundwater
2 not addressed in the adjudicated Santa Maria Groundwater Basin.

3 Agricultural water users and the communities of Guadalupe, Orcutt, and Santa
4 Maria use groundwater in the Santa Maria Valley Management Area of the Santa
5 Maria Groundwater Basin (SMVMA 2012). Historically, groundwater was used
6 to provide almost 50 percent of the water supply to the City of Santa Maria.
7 Recently, groundwater supplies have become 10 to 20 percent of the total water
8 supply to the city (Santa Maria 2011). Groundwater provides most of the water
9 supplies in Orcutt (Golden State Water Company 2011a).

10 **7.3.5.2.3 San Antonio Creek Valley Groundwater Basin**

11 Groundwater is used for agricultural and domestic water supplies in the San
12 Antonio Creek Valley Groundwater Basin, including the Los Alamos area
13 (DWR 2004dq, 2013e).

14 **7.3.5.2.4 Santa Ynez River Valley Groundwater Basin**

15 Groundwater is used for agricultural and domestic water supplies in the Santa
16 Ynez River Valley Groundwater Basin. As described in Chapter 5, Surface Water
17 Resources and Water Supplies, groundwater is used by all agricultural water users
18 and the communities of Buellton, Lompoc, Solvang, Mission Hills, Vandenberg
19 Village, and Santa Ynez (DWR 2004am, 2013e; Santa Barbara County 2007).

20 **7.3.5.2.5 Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria** 21 **Groundwater Basins**

22 Groundwater is used agricultural and domestic water supplies in the Goleta,
23 Foothill, Santa Barbara, Montecito, and Carpinteria groundwater basins within
24 Santa Barbara County. Goleta Water District and La Cumbre Mutual Water
25 Company are the major communities that use groundwater in the Goleta
26 Groundwater Basin (DWR 2004an; GWD 2011; GWD and LCMWC 2010). This
27 basin is operated under an adjudication settlement in 1989 and a voter-passed
28 groundwater management plan. Historically, Goleta Water District provided up
29 to 14 percent of the water supply by groundwater. As described in Chapter 5,
30 Surface Water Resources and Water Supplies, Goleta Water District has increased
31 use of surface water from Lake Cachuma and the SWP; and decreased long-term
32 average use of groundwater to about 5 percent of the total water supply.

33 Portions of the La Cumbre Mutual Water Company and City of Santa Barbara use
34 groundwater from the Foothill Groundwater Basin. The City of Santa Barbara
35 also relies upon groundwater from the Santa Barbara Groundwater Basin. The
36 City of Santa Barbara manages groundwater in accordance with the Pueblo Water
37 Rights (Santa Barbara 2011).

38 Montecito Water District uses groundwater from the Montecito Groundwater
39 Basin. Carpinteria Valley Water District uses groundwater from the Carpinteria
40 Groundwater Basin (Carpinteria Valley WD 2011). Total groundwater pumping
41 averages approximately 3,700 acre-feet per year.

1 **7.3.6 Southern California Region**

2 The Southern California Region includes portions of Ventura, Los Angeles,
3 Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.
4 The Southern California Region groundwater basins are as varied as the geology
5 that occurs in different geographic portions of the region. Therefore, the
6 following discussions are organized in the following subregions.

- 7 • Ventura County and northwestern Los Angeles County
- 8 • Central and southern Los Angeles County and Orange County
- 9 • Western San Diego County
- 10 • Western and central Riverside County and southern San Bernardino County
- 11 • Antelope Valley and Mojave Valley

12 **7.3.6.1 Western Ventura County and Northwestern Los Angeles County**

13 The areas within the SWP service area in Ventura County and northwestern
14 Los Angeles County in the Southern California Region include the Acton Valley
15 Groundwater Basin in Los Angeles County; Santa Clara River Valley, Thousand
16 Oaks Area, and Russell Valley groundwater basins in Ventura and Los Angeles
17 counties; and Simi Valley, Las Posas Valley, Pleasant Valley, Arroyo Santa Rosa
18 Valley, Tierra Rejada, and Conejo Valley groundwater basins in Ventura County,
19 as shown in Figure 7.10.

20 **7.3.6.1.1 Hydrogeology and Groundwater Conditions**

21 *Acton Valley Groundwater Basin*

22 The Acton Valley Groundwater Basin is located upgradient of the Santa Clara
23 River Valley Groundwater Basin and drains towards the Santa Clara River.
24 Water bearing formations include unconsolidated alluvium of sand, gravel, silt,
25 and clay with cobbles and boulders; and poorly consolidated terraced deposits
26 (DWR 2004as; 2013f). Recharge occurs along the streambed, water applied to
27 the soils, and subsurface inflow. Groundwater is characterized by calcium,
28 magnesium, and sulfate bicarbonate with localized areas of high concentrations of
29 TDS, sulfate, nitrate, and chlorides.

30 Acton Valley Groundwater Basin was designated by the CASGEM program as
31 very low priority.

32 *Santa Clara River Valley Groundwater Basin*

33 The Santa Clara River Valley Groundwater Basin is the source of local
34 groundwater along the Santa Clara River watershed from the Santa Clarita Valley
35 in northwestern Los Angeles County to the Pacific Ocean near the City of Oxnard
36 in Ventura County. The Santa Clara River Valley Groundwater Basin includes
37 the Piru, Fillmore, Santa Paula, Mound, and Oxnard subbasins in Ventura county;
38 and Santa Clara River Valley East Subbasin in Los Angeles County.
39 Groundwater movement is effected by the occurrence of several fault zones
40 (DWR 2004at, 2004au, 2006s, 2006t, 2006u, 2013f). Groundwater recharge
41 occurs along the Santa Clara River and its tributaries, and by percolation of
42 precipitation and applied irrigation water.

1 The Santa Clara River Valley East Subbasin is characterized by unconsolidated
2 alluvium of sand, gravel, silt, and clay; poorly consolidated terrace deposits of
3 gravel, sand, and silt; and the Saugus Formation of poorly consolidated sandstone,
4 siltstone, and conglomerate (DWR 2006s, 2013f).

5 The Piru, Fillmore, Santa Paula, Mound, and Oxnard subbasins are characterized
6 by alluvium of silts and clays interbedded with sand and gravel lenses; and the
7 San Pedro Formation of fine sands and gravels over the alluvium (DWR 2004at,
8 2004au, 2006t, 2006u, 2006v, 2013f).

9 Groundwater quality in the Santa Clara River Valley Groundwater Basin is
10 suitable for a variety of beneficial uses. However, some areas have been impaired
11 by elevated TDS, nitrate, and boron concentrations (DWR 2004at, 2004au, 2006t,
12 2006u, 2006v, 2013f; CLWA et al. 2012). Groundwater quality is characterized
13 by fluctuating salinity that increases during dry periods. Localized areas of high
14 nitrates and organic compounds occur due to historic agricultural activities and
15 wastewater disposal.

16 The Piru, Oxnard, and Santa Clara River Valley East subbasins were designated
17 by the CASGEM program as high priority. The Fillmore, Santa Paula, and
18 Mound subbasins were designated as medium priority.

19 *Simi Valley Groundwater Basin*

20 The Simi Valley Groundwater Basin is located in Ventura County (DWR 2004av,
21 2013f). Water bearing formations in this basin are characterized by generally
22 unconfined alluvium of gravel, clays, and sands; with local clay lenses that
23 provide confined aquifers. The Simi Fault confines the basin on the northern
24 boundary. Groundwater recharge occurs along stream beds. Groundwater quality
25 is characterized as calcium sulfate with localized areas of high TDS and organic
26 contaminants.

27 Simi Valley Groundwater Basin was designated by the CASGEM program as low
28 priority.

29 *Las Posas Valley and Pleasant Valley Groundwater Basins*

30 The Las Posas Valley and Pleasant Valley groundwater basins are located in
31 western Ventura County. Groundwater is found within these basins in thick
32 alluvium that is dominated by sand and gravel in the eastern part of the Las Posas
33 Valley Groundwater Basin; and by silts and clays with lenses of sands and gravels
34 in the western part of the Las Posas Valley Groundwater Basin and the Pleasant
35 Valley Groundwater Basin (DWR 2006w, 2006x, 2013f). Underlying the
36 alluvium are the San Pedro and Santa Barbara formations of gravels, sands, silts
37 and clays with a discontinuous aquitard located within the Santa Barbara
38 Formation. The movement of groundwater is locally influenced by features such
39 as faults, structural depressions and constrictions and operating production wells;
40 however, groundwater generally flows west-southwest toward the Oxnard
41 Subbasin. Hydrographs from the Las Posas Valley and Pleasant Valley
42 Groundwater Basins have exhibited a variety of groundwater-level histories over
43 the past couple decades. Most hydrographs in the eastern part of the Las Posas

1 Valley Groundwater Basin indicate relatively unchanged groundwater levels or a
2 slight rise since 1994. Most hydrographs in the western Las Posas Valley and
3 Pleasant Valley groundwater basins indicate that groundwater levels have risen to
4 and been maintained at moderate levels since 1992.

5 Groundwater quality in the Las Posas Valley and Pleasant Valley groundwater
6 basins is suitable for a variety of beneficial uses. Moderate to high TDS
7 concentrations occur in the Las Posas Valley Groundwater Basin and the Pleasant
8 Valley Groundwater Basin (DWR 2006w, 2006x, 2013f).

9 The Las Posas Valley and Pleasant Valley groundwater basins were designated by
10 the CASGEM program as high priority.

11 *Arroyo Santa Rosa Valley Groundwater Basin*

12 The Arroyo Santa Rosa Valley Groundwater Basin is located within Ventura
13 County. The water bearing formations include alluvium of gravel, sand, and clay;
14 and the alluvial San Pedro Formation of sand and gravel (DWR 2006y, 2013f).
15 Groundwater recharge occurs along the Santa Clara River and the tributaries, and
16 by percolation of precipitation and applied irrigation water. Fault zones affect
17 groundwater movement within the basin. Groundwater quality is adequate for
18 community and agricultural water uses. Localized areas of high sulfate and
19 nitrate concentrations occur within the basin.

20 Arroyo Santa Rosa Valley Groundwater Basin was designated by the CASGEM
21 program as medium priority.

22 *Tierra Rejada Valley, Conejo Valley, and Thousand Oaks Area Groundwater* 23 *Basins*

24 The Tierra Rejada Valley, Conejo Valley, and Thousand Oaks groundwater basins
25 in southern Ventura County are characterized by shallow alluvium that overlays
26 marine sandstone and shale of the Modelo and Topanga formations (DWR
27 2004aw, 2004ax, 2004ay, 2013f). In some portions of the basin, the Topanga
28 Formation of volcanic tuff, debris flow, and basaltic flow occurs. Groundwater
29 recharge occurs along the streambeds and by percolation of precipitation and
30 applied irrigation water. Fault zones affect groundwater movement within the
31 basins. Groundwater quality is adequate for community and agricultural water
32 uses. Localized areas of high alkalinity and nitrate concentrations occur within
33 the basins. High iron and TDS occur in the Thousand Oaks Area Groundwater
34 Basin (Thousand Oaks 2011).

35 Conejo Valley Groundwater Basin was designated by the CASGEM program as
36 low priority. The Tierra Rejada Valley and Thousand Oaks Area groundwater
37 basin were designated as very low priority.

38 *Russell Valley Groundwater Basin*

39 The Russell Valley Groundwater Basin is located along the boundaries of Ventura
40 and Los Angeles counties (DWR 2004az, 2013f). This small groundwater basin
41 is characterized by unconsolidated, poorly bedded, sand, gravel, silt, and clay with
42 cobbles and boulders. The groundwater is recharged by precipitation within the

1 basin. Groundwater quality is characterized by sodium bicarbonate and calcium
2 bicarbonate with high sulfates and TDS in some localized areas.
3 Russell Valley Groundwater Basin was designated by the CASGEM program as
4 very low priority.

5 **7.3.6.1.2 Groundwater Use and Management**

6 Groundwater is an important water supply throughout the Southern California
7 Region. Many of the basins have been adjudicated and groundwater management
8 agencies have been established to manage, preserve, and regulate groundwater
9 withdrawals and recharge actions. In Ventura County, the Fox Canyon
10 Groundwater Management Agency was established in 1982 to implement a
11 groundwater plan that identifies withdrawal allocations and groundwater elevation
12 and quality criteria (MWDSC 2007).

13 *Acton Valley Groundwater Basin*

14 As described in Chapter 5, Surface Water Resources and Water Supplies, the
15 Acton community primarily uses groundwater supplemented by SWP water
16 treated at the Antelope Valley East Kern Acton Water Treatment Plant (Los
17 Angeles County 2014b).

18 *Santa Clara River Valley Groundwater Basin*

19 Communities and agricultural water users in the Santa Clara River Valley
20 Groundwater Basin use a combination of surface water and groundwater to meet
21 water demands. Agricultural use of groundwater is greater than community use
22 of groundwater in this basin (UCWD 2012).

23 Four retail water purveyors provide water service to most residents of the Santa
24 Clara River Valley East Subbasin. These water purveyors include the Castaic
25 Lake Water Agency; Santa Clarita Water Division, Los Angeles County
26 Waterworks District Number 36; Newhall County Water District; and Valencia
27 Water Company. Groundwater is used by the communities of Santa Clarita,
28 Saugus, Canyon Country, Newhall, Val Verde, Hasley Canyon, Valencia, Castaic,
29 Stevenson Ranch (CLWA et al. 2012).

30 Water purveyors in the Piru, Fillmore, Santa Paula, Mound, and Oxnard subbasins
31 include United Water Conservation District and Ventura County. United Water
32 Conservation District operates surface water facilities to encourage groundwater
33 protection through conjunctive use (UWCD 2012). Groundwater issues within
34 the United Water Conservation District service area (which includes all of the
35 basin) include overdraft conditions, sea water intrusion, and high nitrate
36 concentrations.

37 *Simi Valley Groundwater Basin*

38 The Simi Valley area primarily relies upon surface water supplies, including SWP
39 water supplies. Groundwater is used to supplement these supplies and by users
40 that cannot be easily served with surface water. Groundwater is provided by
41 Golden State Water Company service area and Ventura County Waterworks
42 District No. 8. The Golden State Water Company provides less 10 percent of the

1 total water supply to the area (Golden State Water Company 2011b). Ventura
2 County Waterworks District No. 8 provides groundwater to a golf course, nursery,
3 and industrial user in the Simi Valley area (VCWD8 2011).

4 *Las Posas Valley and Pleasant Valley Groundwater Basins*

5 Communities and agricultural water users in the Las Posas Valley and Pleasant
6 Valley groundwater basins use a combination of surface water and groundwater to
7 meet water demands. Agricultural use of groundwater is greater than community
8 use of groundwater in this basin (UCWD 2012). United Water Conservation
9 District and Ventura County manage water service to many residents of the Las
10 Posas Valley and Pleasant Valley groundwater basins.

11 As described above, United Water Conservation District operates surface water
12 facilities to encourage groundwater protection through conjunctive use
13 (UWCD 2012). Groundwater is used within the United Water Conservation
14 District service area, which includes western Las Posas Valley and Pleasant
15 Valley groundwater basins. The Oxnard Subbasin of the Santa Clara River
16 Valley Groundwater Basin and Las Posas Valley and Pleasant Valley
17 groundwater basins are within the groundwater management plan established by
18 the Fox Canyon Groundwater Management Agency (Fox Canyon GMA 2013).
19 The groundwater management agency manages and monitors groundwater in
20 areas with groundwater overdraft and seawater intrusion which includes the
21 communities of Port Hueneme, Oxnard, Camarillo, and Moorpark. The long-term
22 average groundwater use within Fox Canyon Groundwater Management Agency
23 includes a portion of the withdrawals reported by United Water Conservation
24 District.

25 The Calleguas Municipal Water District, in partnership with Metropolitan Water
26 District of Southern California (Metropolitan), operates the Las Posas Basin
27 Aquifer Recharge and Recovery project. Calleguas Municipal Water District
28 stores SWP surplus water in the Las Posas Valley Groundwater Basin, near the
29 City of Moorpark. The current Aquifer Recharge and Recovery system includes
30 18 wells (Calleguas MWD 2011).

31 *Arroyo Santa Rosa Valley Groundwater Basin*

32 Communities and agricultural water users in the Arroyo Santa Rosa Valley
33 Groundwater Basin use a combination of surface water and groundwater to meet
34 water demands. Camarosa Water District and Fox Canyon Groundwater
35 Management Agency manage groundwater supplies within the basin (Camarosa
36 WD 2013).

37 *Tierra Rejada Valley, Conejo Valley, and Thousand Oaks Area Groundwater 38 Basins*

39 Groundwater in the Tierra Rejada Valley, Conejo Valley, and Thousand Oaks
40 Area groundwater basins is primarily used by agricultural and individual
41 residential water users. Portions of the Tierra Rejada Valley Groundwater Basin
42 is within the Camarosa Water District; however, this area is primarily open space
43 and agricultural land uses with individual wells (Camarosa WD 2013). The City
44 of Thousand Oaks does operate two wells; however, the city primarily relies upon

1 SWP water supplies because of the high iron concentrations and salinity in the
2 groundwater (Thousand Oaks 2011).

3 *Russell Valley Groundwater Basin*

4 Most groundwater users in the Russell Valley Groundwater Basin are agricultural
5 and individual residential water users. Portions of the basin are located within the
6 Calleguas Municipal Water District. However, the district does not use water
7 from this basin (Calleguas MWD 2011). The Las Virgenes Municipal Water
8 District withdraws groundwater from the Russell Basin to augment recycled water
9 supplies (GLCIRWMR 2014).

10 **7.3.6.2 Western Los Angeles County and Orange County**

11 The areas within the SWP service area in Central and Southern Los Angeles
12 County and Orange County in the Southern California Region include the San
13 Fernando Valley, Raymond, San Gabriel Valley, Coastal Plain of Los Angeles,
14 and Malibu Valley groundwater basins in Los Angeles County; Coastal Plain of
15 Orange County and San Juan Valley groundwater basins in Orange County, as
16 shown in Figure 7.10.

17 **7.3.6.2.1 Hydrogeology and Groundwater Conditions**

18 *San Fernando Valley Groundwater Basin*

19 The San Fernando Valley Groundwater Basin extends under the Los Angeles
20 River watershed. Groundwater flows toward the middle of the basin, beneath the
21 Los Angeles River Narrows, to the Central Subbasin of the Coastal Plain of
22 Los Angeles Basin. The water bearing formation is mainly unconfined gravel and
23 sand with clay lenses that provide some confinement in the western part of the
24 basin (DWR 2004ba).

25 Groundwater movement is affected by the occurrence of several fault zones
26 (DWR 2004ba). Groundwater is recharged naturally from precipitation and
27 stream flow and from imported water and reclaimed wastewater that percolates
28 into the groundwater from stormwater spreading grounds.

29 In the San Fernando Valley Groundwater Basin, the groundwater is characterized
30 by calcium, magnesium, radioactive material, and sulfate bicarbonate with
31 localized areas of high TDS, volatile organic compounds, petroleum compounds,
32 chloroform, pesticides, nitrate, and sulfate (DWR 2004ba, ULARAW 2013).
33 There are several ongoing groundwater remediation programs within the
34 groundwater basin to reduce volatile organic compounds and one program to
35 reduce hexavalent chromium.

36 San Fernando Valley Groundwater Basin was designated by the CASGEM
37 program as medium priority.

38 *Raymond Groundwater Basin*

39 The Raymond Groundwater Basin is located to the north of the San Gabriel
40 Valley Groundwater Basin. Groundwater flow is affected by the occurrence of
41 several fault zones; and causes the groundwater to flow into the San Gabriel
42 Valley Groundwater Basin. The water bearing formations are mainly

1 unconsolidated gravel, sand, and silt with local areas of confinement
2 (DWR 2004bb). Groundwater is recharged naturally from precipitation and
3 stream flow and from water that percolates into the groundwater from spreading
4 grounds and local dams.

5 In the Raymond Groundwater Basin, the groundwater is characterized by calcium,
6 magnesium, and sulfate bicarbonate with localized areas of high volatile organic
7 compounds, nitrate, radioactive material, and perchlorate (DWR 2004bb). There
8 is an ongoing groundwater remediation program within the groundwater basin to
9 reduce volatile organic compounds and perchlorate.

10 Raymond Groundwater Basin was designated by the CASGEM program as
11 medium priority.

12 *San Gabriel Valley Groundwater Basin*

13 Groundwater in the San Gabriel Valley Groundwater Basin flows from the
14 San Gabriel Mountains towards the west under the San Gabriel Valley to the
15 Whittier Narrows where it discharges into the Coastal Plain of the Los Angeles
16 Groundwater Basin (DWR 2004bc). Groundwater in the San Gabriel Valley
17 Groundwater Basin also is interconnected to groundwater in the Chino subbasin
18 of the Upper Santa Ana Valley Groundwater Basin in Riverside County. The
19 northeastern portion of the San Gabriel Valley Groundwater Basin adjacent to the
20 Chino subbasin includes six subbasins and is known as “Six Basins.” The water-
21 bearing formations include unconsolidated to semi-consolidated alluvium deposits
22 of gravel, sands, and silts.

23 Groundwater recharge occurs from direct percolation of precipitation and stream
24 flow, including treated wastewater effluent conveyed in the San Gabriel River
25 (DWR 2004bc). In the San Gabriel Valley Groundwater Basin, the groundwater
26 is characterized by calcium bicarbonate with localized areas of high TDS, carbon
27 tetrachloride nitrate, and volatile organic compounds (DWR 2004bc).

28 San Gabriel Valley Groundwater Basin was designated by the CASGEM program
29 as high priority.

30 *Coastal Plain of Los Angeles Groundwater Basin*

31 The Coastal Plain of Los Angeles Groundwater Basin includes the Hollywood,
32 Santa Monica, Central, and West Coast subbasins.

33 *Hollywood Subbasin*

34 The Hollywood subbasin is located to the north of the Central subbasin and
35 upgradient of the Santa Monica subbasin. Groundwater flows towards the Pacific
36 Ocean (DWR 2004bd). The water bearing formations are mainly alluvial gravel.
37 Groundwater is recharged naturally from precipitation and stream flow.

38 The Hollywood subbasin was designated by the CASGEM program as very low
39 priority.

40 *Santa Monica Subbasin*

41 The Santa Monica subbasin is located to the north of the West Coast subbasin and
42 to the west of the Hollywood subbasin. Groundwater flows towards the west and

1 the Hollywood subbasin (DWR 2004be). The water bearing formations are
2 mainly alluvial gravel and sand with semi-perched areas over silt and clay
3 deposits. Unconfined shallow aquifers occur in the northern and eastern portions
4 of the subbasin. Confined deeper aquifers occur in the remaining portion of the
5 subbasin. Groundwater is recharged naturally from precipitation and stream flow.

6 The Santa Monica subbasin was designated by the CASGEM program as high
7 priority.

8 *Central Subbasin*

9 The Central subbasin is located to the east of the West Coast subbasin. The
10 Central subbasin is characterized by shallow sediments and extends from the Los
11 Angeles River Narrows with groundwater flows from the San Gabriel Valley
12 (DWR 2004bf).

13 The non-pressurized, or forebay, portions of the subbasin are located in the
14 northern portion of the subbasin in unconfined aquifers underlying the Los
15 Angeles and San Gabriel rivers (DWR 2004bf). These areas provide the major
16 recharge areas for the subbasin. The “pressure” areas are confined aquifers
17 composed of permeable sands and gravel separated by less permeable sandy clay
18 and clay, and constitute the main water-bearing formations. Several faults and
19 uplifts create some restrictions to groundwater flow in the subbasin while others
20 run parallel to the groundwater flow and do not restrict flow.

21 In the Central subbasin, the groundwater is characterized by localized areas of
22 high inorganics and volatile organic compounds (DWR 2004bf).

23 The Central subbasin was designated by the CASGEM program as high priority.

24 *West Coast Subbasin*

25 The West Coast subbasin is located on the southern coast of Los Angeles County
26 to the west of the Central subbasin. The water bearing formations are composed
27 of unconfined and semi-confined aquifers composed of sands, silts, clays, and
28 gravels (DWR 2004bg). Several fault zones paralleling the coast act as partial
29 barriers to groundwater flow in certain areas. The general regional groundwater
30 flow pattern is southward and westward toward the Pacific Ocean. Recharge
31 occurs through groundwater flow from the Central subbasin, and from infiltration
32 along the Los Angeles and San Gabriel rivers. Seawater intrusion occurs along
33 the Pacific Ocean coast.

34 In the West Coast subbasin, the most critical issue is high TDS along the Pacific
35 Ocean coast due to seawater intrusion. As described below, several agencies have
36 implemented sea water barrier projects to protect the groundwater quality.

37 The West Coast subbasin was designated by the CASGEM program as high
38 priority.

39 *Malibu Valley Groundwater Basin*

40 The Malibu Valley Groundwater Basin is an isolated alluvial basin in northern
41 Los Angeles County along the Pacific Ocean Coast under the Malibu Creek
42 watershed (DWR 2004bh). Groundwater flows towards the Pacific Ocean. The

1 water bearing formations are mainly gravel, sand, clays, and silt (DWR 2004bb).
2 Groundwater is recharged naturally from precipitation and stream flow.

3 In the Malibu Valley Groundwater Basin, the groundwater is characterized by
4 localized areas of high TDS due to sea water intrusion along the Pacific Ocean
5 coast (DWR 2004bh).

6 The Malibu Valley Groundwater Basin was designated by the CASGEM program
7 as very low priority.

8 *Coastal Plain of Orange County Groundwater Basin*

9 The Coastal Plain of Orange County Groundwater Basin is located under a coastal
10 alluvial plain in northern Orange County (DWR 2004 bi). Groundwater is
11 recharged naturally from precipitation and injection wells to reduce seawater
12 intrusion. The water bearing formations are mainly interbedded marine and
13 continental sand, silt, and clay deposits (DWR 2004bi). The Newport-Inglewood
14 fault zone parallels the coast and generally forms a barrier to groundwater flow.
15 Groundwater recharge occurs along the Santa Ana River. Water levels are
16 characterized by seasonal fluctuations (DWR 2013f; Orange County 2009).
17 Groundwater flowed towards the Pacific Ocean prior to recent development.
18 However, due to extensive groundwater withdrawals, there are groundwater
19 depressions that result in potential sea water intrusion. Groundwater levels have
20 increased since the 1990s following implementation of several recharge programs.

21 In the Coastal Plain of Orange County Groundwater Basin, the groundwater is
22 characterized as sodium-calcium bicarbonate with localized areas of high TDS
23 due to sea water intrusion along the Pacific Ocean coast, as well as nitrate, and
24 volatile organic compounds (DWR 2004bi).

25 The Coastal Plain of Orange County Groundwater Basin was designated by the
26 CASGEM program as medium priority.

27 *San Juan Valley Groundwater Basin*

28 The San Juan Valley Groundwater Basin is located in southern Orange County
29 (DWR 2004bj). Groundwater flows towards the Pacific Ocean. The water
30 bearing formations are mainly sand, clays, and silt. Groundwater is recharged
31 naturally from precipitation and stream flows from San Juan and Oso creeks and
32 Arroyo Trabuca.

33 In the San Juan Valley Groundwater Basin, the groundwater is characterized as
34 calcium bicarbonate, bicarbonate-sulfate, calcium-sodium sulfate, and sulfate-
35 chloride with localized areas of high TDS due to sea water intrusion along the
36 Pacific Ocean coast and high fluoride near hot springs near Thermal Canyon
37 (DWR 2004bj).

38 The San Juan Valley Groundwater Basin was designated by the CASGEM
39 program as low priority.

1 **7.3.6.2.2 Groundwater Use and Management**

2 Groundwater is an important water supply throughout the Southern California
3 Region. Many of the groundwater basins in Los Angeles and Orange counties
4 have been adjudicated, as summarized in Table 7.1, and groundwater
5 management agencies have been established to manage, preserve, and regulate
6 groundwater withdrawals and recharge actions.

7 *San Fernando Valley Groundwater Basin*

8 The communities and agricultural users in the San Fernando Valley Groundwater
9 Basin use a combination of surface water and groundwater to meet water demands
10 (GLCIRWMR 2014; ULARAW 2013). The Metropolitan Water District of
11 Southern California provides wholesale surface water supplies to several
12 communities. The cities of Los Angeles, Glendale, Burbank, San Fernando,
13 Crescenta Valley, Bell Canyon, and Hidden Hills provide retail water supplies,
14 including groundwater, to the communities. The groundwater basin has been
15 adjudicated and is managed by the Upper Los Angeles River Area Watermaster.

16 Groundwater is recharged in the San Fernando Valley Groundwater Basin through
17 seepage of precipitation within the groundwater basin, including the recharge of
18 stormwater at spreading grounds between 1968 and 2012; and storage of imported
19 water (ULARAW 2013). The spreading basins for stormwater flows are operated
20 by Los Angeles County and the cities of Los Angeles and Burbank. A portion of
21 the extracted groundwater is exported to areas that overly other groundwater
22 basins.

23 The operations of the San Fernando Valley Groundwater Basin are defined by the
24 Upper Los Angeles River Area January 26, 1979 Final Judgment; the Sylmar
25 Basin Stipulations of August 26, 1983; and subsequent agreements. These
26 agreements, as managed by the Upper Los Angeles River Area Watermaster,
27 provide for the right to extract a percent of surface water, including applied
28 recycled water, that enters within specified subbasins of the San Fernando Valley
29 Groundwater Basin with specific calculations to identify maximum withdrawals
30 for the cities of Burbank, Glendale, Los Angeles, and San Fernando and
31 Crescenta Valley Water District; the right to store and withdraw water within
32 specified subbasins by the cities of Burbank, Glendale, Los Angeles, and San
33 Fernando; and the acknowledgment that the City of Los Angeles has an exclusive
34 Pueblo Water Right for the native safe yield of the San Fernando subbasin within
35 the larger San Fernando Valley Groundwater Basin.

36 *Raymond Groundwater Basin*

37 The communities in the Raymond Groundwater Basin use a combination of
38 surface water and groundwater to meet water demands (GLCIRWMR 2014). The
39 Metropolitan Water District of Southern California and Foothills Municipal Water
40 District provide wholesale surface water supplies to several communities. The
41 cities of Alhambra, Arcadia, Pasadena, San Marino, and Sierra Madre; Upper San
42 Gabriel Municipal Water District; and Valley Water Company and several other
43 private water companies, provide retail water supplies, including groundwater, to
44 the communities to Altadena, Las Crescenta-Montrose, La Cañada Flintridge,

1 Rubio Canyon, and South Pasadena. The City of Alhambra and San Gabriel
2 Valley Municipal Water District; can withdraw groundwater from the Raymond
3 Basin, but currently are not operating wells within this groundwater basin (City of
4 Alhambra 2011).

5 The groundwater basin was the first adjudicated groundwater basin in California
6 and is managed by the Raymond Basin Management Board as the Watermaster
7 (RBMB 2014). The Raymond Basin Management Board limits the amount of
8 groundwater withdrawals in different areas of the basin, and allows for short-term
9 and long-term storage of water in the groundwater basin.

10 Groundwater is recharged in the Raymond Groundwater Basin through seepage of
11 precipitation within the groundwater basin, injection wells, and spreading basins
12 operated by Los Angeles County and the cities of Pasadena and Sierra Madre
13 (MWDC 2007). Water from Metropolitan Water District of Southern California,
14 which is generally a combination of SWP water and Colorado River water, cannot
15 be used for direct recharge if the TDS is greater than 450 milligrams/liter
16 (RBMB 2014). A portion of the extracted groundwater is exported to areas that
17 overly other groundwater basins.

18 *San Gabriel Valley Groundwater Basin*

19 The communities in the San Gabriel Valley Groundwater Basin use a combination
20 of surface water and groundwater to meet water demands (GLCIRWMR 2014;
21 MWDC 2007). The Metropolitan Water District of Southern California, San
22 Gabriel Valley Municipal Water District, Upper San Gabriel Municipal Water
23 District; Three Valleys Municipal Water District, and Covina Irrigating Company
24 provide wholesale surface water and/or groundwater supplies to several
25 communities. The cities of Alhambra, Arcadia, Azusa, Covina, El Monte,
26 Glendora, La Verne, Monrovia, Pomona, San Marino, and Upland; San Gabriel
27 County Water District and Valley County Water District; Golden State Water
28 Company, San Antonio Water Company, San Gabriel Valley Water Company,
29 Suburban Water Systems, Valencia Heights Water Company, and several other
30 private water companies, provide retail water supplies, including groundwater, to
31 users within their communities and to the communities of Baldwin Park,
32 Bradbury, Claremont, Duarte, Hacienda Heights, Irwindale, La Puente,
33 Montebello, Monterey Park, Pico Rivera, Rosemead, San Dimas, San Gabriel,
34 Santa Fe Springs, Sierra Madre, South El Monte, South San Gabriel, Temple City,
35 Valinda, and Whittier (City of Alhambra 2011; City of Arcadia 2011; City of La
36 Verne 2011; City of Pomona 2011; City of Upland 2011; Golden State Water
37 Company 2011c; SGCWD 2011; SGVWC 2011; Suburban Water Systems 2011;
38 SAWCO 2011; TVMWD 2011; USGVMWD 2011).

39 The San Gabriel Valley Groundwater Basin includes several adjudicated basins.
40 A portion of the groundwater basin is managed by the San Gabriel River
41 Watermaster and the Main San Gabriel Basin Watermaster (MWDC 2007;
42 SGVWC 2011). The Watermasters coordinate groundwater elevation and water
43 quality monitoring, coordinate imported water supplies, coordinate recharge
44 operations with imported water and recycled water, manage the amount of
45 groundwater withdrawals in different areas of the basin by balancing the amount

1 of groundwater recharge, and allow for short-term and long-term storage of water
2 in the groundwater basin. Groundwater is recharged through seepage of
3 precipitation within the groundwater basin, injection wells, and spreading basins
4 operated by Los Angeles County and a private water company (MWDSC 2007).
5 Water recharged into the spreading basins from Metropolitan Water District of
6 Southern California and San Gabriel Valley Municipal Water District.

7 The Six Basins portion of the groundwater basin also is adjudicated and managed
8 by the Six Basins Watermaster Board (MWDSC 2007). The Watermaster
9 manages withdrawals and requires replenishment obligation of equal amounts for
10 withdrawals over the operating safe yield of the basin. The Pomona Valley
11 Protective Agency conveys flows from San Antonio Creek and SWP water to the
12 San Antonio Spreading Grounds; and from local waters to the Thompson Creek
13 Spreading Grounds. The City of Pomona conveys flows from local surface
14 waters to the Pomona Spreading Grounds. Los Angeles County Department of
15 Public Works conveys flows from local surface water and SWP water to the Live
16 Oak Spreading Grounds.

17 The cities of Alhambra, Arcadia, La Verne, Monterey Park, San Gabriel Valley
18 Water Company, and other water entities operate groundwater treatment facilities
19 to remove dichloroethane, chloroform, other volatile organic compounds, and/or
20 nitrates (City of Alhambra 2011; City of Arcadia 2011; City of Monterey
21 Park 2012; MWDSC 2007; SGVWC 2011).

22 *Coastal Plain of Los Angeles Groundwater Basin*

23 The Coastal Plain of Los Angeles Groundwater Basin includes four subbasins:
24 Hollywood, Santa Monica, Central and West Coast.

25 *Hollywood Subbasin*

26 The primary user of groundwater in the Hollywood subbasin is the City of
27 Beverly Hills (MWDSC 2007). The basin is not adjudicated. The city manages
28 the groundwater subbasin through limits on withdrawals and discharges to the
29 groundwater. Groundwater is recharged through seepage of precipitation within
30 the groundwater subbasin (City of Beverly Hills 2011). All groundwater
31 withdrawn by the city is treated to reduce salinity.

32 *Santa Monica Subbasin*

33 The primary user of groundwater in the Santa Monica subbasin is the City of
34 Santa Monica (MWDSC 2007). The basin is not adjudicated. Groundwater is
35 recharged through seepage of precipitation within the groundwater subbasin
36 (City of Santa Monica 2011; MWDSC 2007). Groundwater treatment is provided
37 to a portion of the subbasin withdrawals to reduce volatile organic compounds,
38 and methyl tertiary butyl ether.

39 *Central Subbasin*

40 The communities in the Central subbasin use a combination of surface water and
41 groundwater to meet water demands (GLCIRWMR 2014; MWDSC 2007). The
42 Metropolitan Water District of Southern California and Central Basin Municipal
43 Water District provide wholesale surface water supplies to several communities.

1 The cities of Bell, Bell Gardens, Cerritos, Compton, Cudahy, Downey,
2 Huntington Park, Lakewood, Long Beach, Los Angeles, Lynwood, Monterey
3 Park, Norwalk, Paramount, Pico Rivera, Santa Fe Springs, Signal Hill, South
4 Gate, Vernon, and Whittier; Los Angeles County Water District, La Habra
5 Heights County Water District, Orchard Dale Water District, and Paramount
6 Water District; Golden State Water Company, Suburban Water Systems,
7 Bellflower-Somerset Mutual Water Company, Montebello Land & Water
8 Company; Park Water Company, Dominguez Water Corp, California Water
9 Service Company, San Gabriel Valley Water Company, Walnut Park Mutual
10 Water Company, and several other private water companies, provide retail water
11 supplies, including groundwater, to users within their communities and to the
12 communities of Artesia, Commerce, Dominguez, East La Mirada, East Los
13 Angeles, East Rancho, Florence-Graham, Hawaiian Gardens, La Mirada, Los
14 Nieto, Maywood, Montebello, South Whittier, Walnut Park, Westmount, West
15 Whittier, and Willow Brook (CBMWD 2011; BSMWC 2011; City of Compton
16 2011; City of Downey 2012; City of Huntington Park 2011; City of Lakewood
17 2011; City of Long Beach 2011; City of Los Angeles 2011; City of Monterey
18 Park 2012; City of Norwalk 2011; City of Paramount 2011; City of Pico Rivera
19 2011; City of Santa Fe Springs 2011; City of South Gate; City of Vernon 2011;
20 City of Whittier 2011; LHHWC 2012; Golden State Water Company 2011d,
21 2011e, 2011f, 2011g; Suburban Water Systems 2011).

22 The Central subbasin was adjudicated, and is managed by DWR. The
23 adjudication specifies a total amount of allowed annual withdrawals (or
24 Allowable Pumping Allocation) in the Central subbasin (MWDSC 2007; WRD
25 2013a). Approximately 25 percent of the water users of groundwater from the
26 Central subbasin are not located on the land that overlies the subbasin (CBMWD
27 2011). Groundwater from the San Gabriel Valley Groundwater Basin also is used
28 by water users that overlie the Central subbasin.

29 The Water Replenishment District of Southern California has the statutory
30 authority to replenish the groundwater in the Central and West Coast subbasins of
31 the Coastal Plain of Los Angeles Groundwater Basin. The Water Replenishment
32 District of Southern California purchases water for water replenishment facilities
33 operated by Los Angeles County Department of Public Works at the Montebello
34 Forebay near the Rio Hondo and San Gabriel Rivers near the boundaries of the
35 Central and West Coast subbasins (CBMWD 2011; Los Angeles County 2015;
36 WRD 2013a). The Montebello Forebay includes the Rio Hondo Coastal Basin
37 Spreading Grounds along the Rio Hondo Channel; the San Gabriel River Coastal
38 Basin Spreading Grounds; and the unlined reach of the lower San Gabriel River
39 from Whittier Narrows Dam to Florence Avenue (LACDPW 2014, WRD 2013a).

40 The replenishment water is purchased water from two different sources: recycled
41 water from various regional treatment facilities, and imported water (WRD
42 2013a). The recycled water is used for groundwater recharge at the spreading
43 grounds and at the seawater barrier wells. Water Replenishment District of
44 Southern California must blend recycled water with other water sources to meet
45 the groundwater recharge water quality and volumetric requirements established

1 by the State Water Resources Control Board. This blended water is either
2 imported water from the SWP and/or the Colorado River, or untreated surface
3 water flows from the San Gabriel River, Rio Hondo River, and waterways in the
4 San Gabriel Valley (CBMWD 2011). Up to 35 percent of the replenishment
5 water can be provided from recycled water supplies. Several recent projects have
6 been implemented to store stormwater flows for increased replenishment water
7 volumes.

8 In the Central subbasin, the Water Replenishment District of Southern California
9 also purchases imported and recycled water for injection by the Los Angeles
10 County Department of Public Works into the portion of the Alamitos Barrier
11 Project located in Los Angeles County to reduce seawater intrusion
12 (MWDC 2007; WRD 2007). Initially, imported SWP water was used to prevent
13 seawater intrusion. However, over the past 20 years, recycled water has been
14 used for a substantial amount of the groundwater injection program. The Water
15 Replenishment District of Southern California is planning to fully use recycled
16 water at the Alamitos Gap Barrier Project by 2014 (WRD 2013b).

17 The cities of Long Beach, Monterey Park, South Gate, and Whittier operate
18 groundwater treatment facilities in the Central subbasin (City of Long Beach
19 2012; City of Monterey Park 2012; City of South Gate; City of Whittier 2011).

20 *West Coast Subbasin*

21 The communities in the Central subbasin use a combination of surface water and
22 groundwater to meet water demands (GLCIRWMR 2014; MWDC 2007). The
23 Metropolitan Water District of Southern California and West Basin Municipal
24 Water District provide wholesale surface water supplies to several communities.
25 The cities of Inglewood, Lomita, Manhattan Beach, and Torrance; Golden State
26 Water Company, California Water Service Company, and several other private
27 water companies, provide retail water supplies, including groundwater, to users
28 within their communities and to the communities of Athens, Carson, Compton,
29 Del Aire, Gardena, Hawthorne, Hermosa Beach, Inglewood, Lawndale, Lennox,
30 Redondo Beach, Torrance (WBMWD 2011a; City of Inglewood 2011; City of
31 Lomita 2011; City of Manhattan Beach 2011; City of Torrance 2011; Golden
32 State Water 2011h; California Water Service Company 2011b, 2011c, 2011d,
33 2011e). The communities of El Segundo, Long Beach, and Los Angeles overlie
34 the West Coast subbasin; however, no groundwater from this subbasin is used in
35 these communities due to water quality issues and facilities locations.

36 Groundwater use is primarily for emergency uses, including firefighting, in the
37 communities of Hawthorne, Lomita, and Torrance due to high concentrations of
38 minerals (e.g., iron and manganese), sulfides, and/or volatile organic compounds.

39 The West Coast subbasin was adjudicated, and is managed by DWR. The
40 adjudication specifies a total amount of allowed annual withdrawals (or
41 Allowable Pumping Allocation) in the West Coast subbasin (MWDC 2007;
42 WBMWD 2011a; WRD 2013a). Groundwater from the Central subbasin is used
43 by some water users that overlie the West Coast subbasin.

1 The Water Replenishment District of Southern California has the statutory
2 authority to replenish the groundwater in the Central and West Coast subbasins of
3 the Coastal Plain of Los Angeles Groundwater Basin. In the West Coast
4 subbasin, the Water Replenishment District of Southern California purchases
5 imported and recycled water for injection by the Los Angeles County Department
6 of Public Works into the West Coast Barrier Project and the Dominguez Barrier
7 Project (MWDSC 2007; WRD 2007; WRD 2013). Water is purchased by the
8 Water Replenishment District of Southern California for injection at the barrier
9 projects (WRD 2013). Initially, imported SWP water was used to prevent
10 seawater intrusion. However, over the past 20 years, recycled water has been
11 used for a substantial amount of the groundwater injection program. The Water
12 Replenishment District of Southern California is planning to fully use recycled
13 water at the West Coast Barrier Project and the Dominguez Barrier Project by
14 2014 and 2017, respectively (WRD 2013b).

15 California Water Service Company operates groundwater treatment facilities
16 within the community of Hawthorne (California Water Service Company 2011b).
17 The Water Replenishment District of Southern California operates the Robert W.
18 Goldsworthy Desalter near Torrance to reduce salinity for up to 18,000 acre-
19 feet/year of groundwater that is located inland of the West Coast Basin Barrier
20 (WRD 2013a).

21 The West Basin Municipal Water District treats brackish groundwater at the
22 C. Marvin Brewer Desalter Facility for two wells near Torrance that are affected
23 by a saltwater plume in the West Coast subbasin (WBMWD 2011a).

24 *Malibu Valley Groundwater Basin*

25 No groundwater is used by the communities in this groundwater basin, including
26 the Malibu area (Los Angeles County 2011; MWDSC 2007).

27 *Coastal Plain of Orange County Groundwater Basin*

28 The communities in the Coastal Plain of Orange County Groundwater Basin use a
29 combination of surface water and groundwater to meet water demands
30 (MWDSC 2007). The Municipal Water District of Orange County, Orange
31 County Water District, and East Orange County Water District provide wholesale
32 surface water supplies to several communities. The cities of Anaheim, Buena
33 Park, Fountain Valley, Fullerton, Garden Grove, Huntington Beach, La Habra,
34 La Palma, Newport Beach, Orange, Santa Ana, Seal Beach, Tustin, and
35 Westminster; East Orange County Water District, Irvine Ranch Water District,
36 Mesa Consolidated Water District, Rowland Water District, Serrano Water
37 District, Walnut Valley Water District, and Yorba Linda Water District; Golden
38 State Water Company, California Water Service Company, California Domestic
39 Water Company, and several other private water companies, provide retail water
40 supplies, including groundwater, to users within their communities and to the
41 communities of Brea, Costa Mesa, Cypress, Diamond Bar, Garden Grove,
42 Hacienda Heights, Industry, Irvine, La Palma, La Puente, Los Alamitos, Midway
43 City, Newport Beach, Orange, Panorama Heights, Placentia, Pomona, Rowland
44 Heights, Rossmoor, Seal Beach, Stanton, Villa Park, Walnut, West Covina, West

1 Orange, and Yorba Linda (City of Anaheim 2011; City of Brea 2011; City of
2 Buena Park 2011; City of Fountain Valley 2011; City of Fullerton 2011; City of
3 Garden Grove 2011; City of Huntington Beach 2011; City of La Habra 2011; City
4 of La Palma 2011; City of Newport Beach 2011; City of Orange 2011; City of
5 Santa Ana 2011; City of Seal Beach 2011; City of Tustin 2011; City of
6 Westminster 2011; IRWD 2011; MCWD 2011; RWD 2011; SWD 2011; WWD
7 2011; YLWD 2011; Golden State Water Company 2011i, 2011j). Groundwater
8 use is primarily for non-potable water uses in West Covina and for supplemental
9 supplies for users of recycled water in Rowland Heights.

10 The Coastal Plain of Orange County Groundwater Basin is managed by Orange
11 County Water District in accordance with special State legislation to increase
12 supply and provide uniform costs for groundwater (MWDSC 2007). The basin is
13 managed to maintain a water balance over several years using two step pricing
14 levels to incentivize users to obtain alternative water supplies after withdrawing a
15 basin production target. The groundwater basin is managed to provide
16 approximately a three-year drought supply.

17 Orange County Water District manages an extensive groundwater recharge
18 program in the Coastal Plain of Orange County Basin (Orange County Water
19 District 2014). The Orange County Water District manages spreading basins
20 along the Santa Ana River and Santiago Creek for groundwater recharge
21 (MWDSC 2007). Water is supplied to these basins with flows diverted from the
22 Santa Ana River into the recharge basins at inflatable rubber dams, SWP water,
23 and recycled water from the Orange County Water District/Orange County
24 Sanitation District Groundwater Replenishment System Advanced Water
25 Purification Facility (OCWD n.d.).

26 The Orange County Water District also injects water into the Talbert Barrier and
27 the portion of the Alamitos Barrier Project within Orange County. Water supplies
28 for the seawater barriers include water from the Groundwater Replenishment
29 System and SWP water (GWRS n.d.; MWDSC 2007).

30 The Irvine Desalter Project was initiated in 2007 by Orange County Water
31 District, Irvine Ranch Water District, Metropolitan Water District of Orange
32 County, Metropolitan Water District of Southern California, and the U.S. Navy to
33 reduce TDS and salts (IRWD 2011; MWDSC 2007). Several other treatment
34 facilities remove volatile organic compounds. The city of Tustin operates the
35 Tustin Seventeenth Street Desalter to reduce TDS within the Tustin community
36 (MWDSC 2007). The City of Garden Grove and Mesa County Water District
37 operate treatment facilities to reduce nitrates and compounds that change the color
38 of the water, respectively (City of Garden Grove 2011; MCWD 2011).

39 *San Juan Valley Groundwater Basin*

40 The communities in the San Juan Groundwater Basin use a combination of
41 surface water and groundwater to meet water demands (MWDSC 2007). The
42 Municipal Water District of Orange County provides wholesale surface water
43 supplies to several communities. The City of San Juan Capistrano; Moulton
44 Niguel Water District, Santa Margarita Water District, and South Coast Water

1 District provide retail water supplies to users within their communities and to the
 2 communities of Coto de Caza, Dana Point, Laguna Forest, Laguna Woods, Las
 3 Flores, Ladera Ranch, Mission Viejo, Rancho Santa Margarita, South Laguna,
 4 Talega, (City of San Juan Capistrano 2011; MNWD 2011; SCWD 2011;
 5 SMWD 2011). Most of the groundwater use occurs within or near the City of San
 6 Juan Capistrano. Groundwater use is small or does not occur within the Santa
 7 Margarita Water District, South Coast Water District, and Moulton Niguel Water
 8 District service areas.

9 The San Juan Basin Authority manages water resources development in the
 10 San Juan Valley Groundwater Basin and in the surrounding San Juan watershed to
 11 protect water quality and water resources (MWDC 2007; SJBA 2013). In
 12 addition to community uses, groundwater also is used for agricultural and
 13 industrial purposes and golf course irrigation. Overall, groundwater provides less
 14 than 10 percent of the total water supply within the groundwater basin.

15 The City of San Juan Capistrano Groundwater Recovery Plant reduces iron,
 16 manganese, and TDS concentrations. This city is modifying the treatment plant to
 17 reduce recently observed high concentrations of methyl tertiary butyl ether
 18 (MTBE) (City of San Juan Capistrano 2011; MWDC 2007). The South Coast
 19 Water District operates the Capistrano Beach Groundwater Recovery Facility in
 20 Dana Point to reduce iron and manganese concentrations (SCWD 2011;
 21 MWDC 2007).

22 **7.3.6.3 Western San Diego County**

23 The areas within the SWP service area in western San Diego County in the
 24 Southern California Region include the San Mateo Valley Groundwater Basin in
 25 Orange and San Diego counties; and the San Onofre Valley, Santa Margarita
 26 Valley, San Luis Rey Valley, Escondido Valley, San Marcos Area, Batiquitos
 27 Lagoon Valley, San Elijo Valley, San Dieguito Creek, Poway Valley, San Diego
 28 River Valley, El Cajon Valley, Mission Valley, Sweetwater Valley, Otay Valley,
 29 Tijuana Basin groundwater basins in San Diego County, as shown in Figure 7.11.

30 **7.3.6.3.1 Hydrogeology and Groundwater Conditions**

31 In San Diego County, several smaller groundwater basins exist, in the western
 32 portion of the county. The most productive groundwater basins are characterized
 33 by narrow river valleys filled with shallow sand and gravel deposits.
 34 Groundwater occurs farther inland in fractured bedrock and semi consolidated
 35 sedimentary deposits with limited yield and storage (SDCWA et al. 2013).

36 *San Mateo Valley, San Onofre Valley, and Santa Margarita Valley* 37 *Groundwater Basins*

38 The San Mateo Valley Groundwater Basin is located in southern Orange County
 39 and northern San Diego County (DWR 2004bk). The San Onofre Valley and
 40 Santa Margarita Valley groundwater basins are located in northwestern San Diego
 41 County (DWR 2004bl, 2004bm). Groundwater flows towards the Pacific Ocean.
 42 The water bearing formations are mainly gravel, sand, clays, and silt.
 43 Groundwater is recharged naturally from precipitation and stream flows. In the

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1 San Mateo Valley and San Onofre Valley groundwater basins, treated wastewater
2 effluent discharged from the Marine Corps Base Camp Pendleton wastewater
3 treatment plants into local streams also recharges the groundwater. In the San
4 Mateo Valley and Santa Margarita Valley groundwater basins, the groundwater is
5 characterized as calcium-sulfate-chloride. In the San Onofre Valley Groundwater
6 Basin, the groundwater is characterized as calcium-sodium bicarbonate-sulfate.
7 Localized areas with high boron, chloride, magnesium, nitrate, sulfate, and TDS
8 occur in the Santa Margarita Valley Groundwater Basin.

9 Santa Margarita Valley Groundwater Basin was designated by the CASGEM
10 program as medium priority. San Mateo Valley and San Onofre Valley
11 groundwater basins were designated as very low priority.

12 *San Luis Rey Valley Groundwater Basin*

13 The San Luis Rey Valley Groundwater Basin is located in northwestern
14 San Diego County (DWR 2004bn). Groundwater flows towards the Pacific
15 Ocean. The water bearing formations are mainly gravel and sand. Under some
16 portions of the alluvial aquifer, partially consolidated marine terrace deposits of
17 partly consolidated sandstone, mudstone, siltstone, and shale occur. Groundwater
18 is recharged naturally from precipitation and stream flows, and from runoff that
19 flows into the streams from lands irrigated with SWP water. The groundwater is
20 characterized as calcium-sodium bicarbonate-sulfate with localized areas of high
21 magnesium, nitrate, and TDS (MWDC 2007).

22 San Luis Rey Valley Groundwater Basin was designated by the CASGEM
23 program as medium priority.

24 *San Marcos Valley, Escondido Valley, San Pasqual Valley, Pamo Valley, Santa
25 Maria Valley, and Poway Valley Groundwater Basins*

26 The San Marcos Valley, Escondido Valley, San Pasqual Valley, Pamo Valley,
27 Santa Maria Valley, and Poway Valley groundwater basins are located in the
28 foothills within central, western San Diego County. The water bearing formations
29 are mainly alluvium of sand, gravel, clay, and silt; consolidated sandstone; or
30 weathered crystalline basement rock (DWR 2004bo, 2004bp, 2004bq, 2004br,
31 2004bs, 2004bt). The basins area bounded by semi-permeable marine and non-
32 marine deposits and impermeable granitic and metamorphic rocks. Groundwater
33 is recharged naturally from precipitation and stream flows, and from runoff that
34 flows into the streams from irrigated lands. The groundwater is characterized
35 with moderate to high concentrations of salinity. There are localized areas with
36 high sulfate and nitrate concentrations in the Santa Maria Valley Groundwater
37 Basin.

38 San Pasqual Valley Groundwater Basin was designated by the CASGEM program
39 as medium priority. San Marcos Valley, Escondido Valley, Pamo Valley, Santa
40 Maria, and Poway Valley groundwater basins were designated as very low
41 priority.

1 *Batiquitos Lagoon Valley, San Elijo Valley, and San Dieguito Valley*
2 *Groundwater Basins*

3 The Batiquitos Lagoon Valley, San Elijo Valley, and San Dieguito Valley
4 groundwater basins are located along the central San Diego County coast of the
5 Pacific Ocean. The water bearing formations are mainly alluvium of sand, gravel,
6 clay, and silt with areas of consolidated sandstone (DWR 2004bu, 2004bv,
7 2004bw). Some areas of the Batiquitos Lagoon Valley Groundwater Basin are
8 bounded by impermeable crystalline rock. Groundwater is recharged naturally
9 from precipitation and stream flows, and from runoff that flows into the streams
10 from irrigated lands. The groundwater is characterized with moderate to high
11 concentrations of salinity.

12 Batiquitos Valley, San Elijo Valley, and San Dieguito Valley groundwater basins
13 were designated by the CASGEM program as very low priority.

14 *San Diego River Valley, El Cajon, Mission Valley, Sweetwater Valley, Otay*
15 *Valley, and Tijuana Groundwater Basins*

16 The San Diego River Valley, El Cajon, Mission Valley, Sweetwater Valley, Otay
17 Valley, and Tijuana groundwater basins are located in the southwestern portion of
18 San Diego County. The water bearing formations are mainly alluvium of sand,
19 gravel, cobble, clay, and silt; or siltstone and sandstone (DWR 2004bx, 2004by,
20 2004bz, 2004ca, 2004cb, 2004cc). Groundwater is recharged naturally from
21 precipitation and stream flows, and from runoff that flows into the streams from
22 irrigated lands. The groundwater is characterized with moderate to high levels of
23 salinity. A recent study by USGS evaluated the sources and movement of saline
24 groundwater in these groundwater basins (USGS 2013b). The chloride
25 concentrations ranged from 57 to 39,400 mg/L. The sources of salinity were
26 natural geologic sources and sea water intrusion. There are localized areas with
27 high sulfate and magnesium concentrations.

28 San Diego River Valley Groundwater Basin was designated by the CASGEM
29 program as medium priority. El Cajon, Mission Valley, Sweetwater Valley, Otay
30 Valley, and Tijuana groundwater basins were designated as very low priority.

31 **7.3.6.3.2 Groundwater Use and Management**

32 Groundwater production and use in the San Diego region is currently limited due
33 to a lack of aquifer storage capacity, available recharge, and degraded water
34 quality due to high salinity. Groundwater currently represents about 3 percent of
35 the water supply portfolio within the areas of San Diego County that could be
36 served by SWP water (SDCWA et al. 2013).

37 *San Mateo Valley, San Onofre Valley, and Santa Margarita Valley Groundwater*
38 *Basins*

39 The primary user of groundwater in the San Mateo Valley, San Onofre Valley,
40 and Santa Margarita Valley groundwater basins is the Marine Corps Base Camp
41 Pendleton (FPUD 2011; MWDSC 2007; SCWD 2011; SDCWA et al. 2013). The
42 Marine Corps Base Camp Pendleton withdraws approximately 8,500 acre-
43 feet/year from the three groundwater basins and operates spreading basins to

1 recharge the groundwater in the Santa Margarita Valley Groundwater Basin.
2 Portions of the South Coast Water District overlie the northern portions of the San
3 Mateo Valley Groundwater Basin; however, the district does not withdraw water
4 from that basin. Fallbrook Public Utility District overlies northern portions of the
5 Santa Margarita Valley Groundwater Basin; however, the district currently uses a
6 small amount of groundwater to meet their water demand (FPUD 2011).

7 The Santa Margarita Valley Groundwater Basin is within an adjudicated
8 watershed (SMRW 2011). The Santa Margarita River Watermaster manages both
9 surface water and groundwater that contributes direct or indirect flows into the
10 Santa Margarita River in accordance with the Modified Final Judgment and
11 Decrees of 1966 by the U.S. District Court in the *United States v. Fallbrook*
12 *Public Utility et al.* The watershed includes the Santa Margarita Valley
13 Groundwater Basin near the Pacific Ocean and the Temecula Valley groundwater
14 basins in the upper Santa Margarita River Watershed within Riverside County, as
15 discussed in the following subsection. Within San Diego County, the only
16 groundwater user in the Santa Margarita Valley Groundwater Basin is the Marine
17 Corps Base Camp Pendleton.

18 *San Luis Rey Valley Groundwater Basin*

19 The communities in the San Luis Rey Valley Groundwater Basin use a
20 combination of surface water and groundwater to meet water demands (City of
21 Oceanside 2011; MWDC 2007; RMWD 2011; VCMWD 2011; YMWD 2014a,
22 2014b). The San Diego County Water Authority provides wholesale surface
23 water supplies to several communities. The City of Oceanside; Rainbow
24 Municipal Water District, Valley Center Municipal Water District, and Yuima
25 Municipal Water District; and Rancho Pauma Mutual Water Company and
26 several other private water companies provide retail water supplies to users within
27 their communities. Groundwater use is small or does not occur within the
28 Rainbow Municipal Water District or Valley Center Municipal Water District.
29 Groundwater also is used on agricultural lands, especially for orchards in the
30 Pauma area (San Diego County 2010). The Tribal lands also depend upon
31 groundwater including lands within the La Jolla Reservation, Los Coyotes
32 Reservation, Pala Reservation, Pauma & Yuima Reservation, Rincon Reservation,
33 and Santa Ysabel Reservation (SDCWA et al. 2013).

34 There are three municipal water districts that overlie the San Luis Rey Valley
35 Groundwater Basin that manage water rights protection efforts. Groundwater is
36 the only water supply within the Pauma Municipal Water District and the primary
37 water supplies within the Mootamai Municipal Water District and the San Luis
38 Rey Municipal Water District (SDLAFCO 2011; SDCWA et al. 2013). The
39 districts protect groundwater, surface water rights, and water storage; and to
40 coordinate planning studies and legal activities within the San Luis Rey River
41 watershed. Vista Irrigation District withdraws and stores groundwater in Lake
42 Henshaw and withdraws groundwater in a subbasin located upgradient the
43 San Luis Rey Valley Groundwater Basin.

1 *San Marcos, Escondido Valley, San Pasqual Valley, Pamo Valley, Santa Maria*
2 *Valley, and Poway Valley Groundwater Basins*

3 The communities in the San Marcos, Escondido Valley, San Pasqual Valley,
4 Pamo Valley, Santa Maria Valley, and Poway Valley groundwater basins use a
5 combination of surface water and groundwater to meet water demands (City of
6 Escondido 2011; City of Poway 2011; Ramona MWD 2011; RDDMWD 2011;
7 VWD 2011). The San Diego County Water Authority provides wholesale surface
8 water supplies to several communities. The cities of Escondido and Poway;
9 Ramona Municipal Water District, Rincon del Diablo Municipal Water District,
10 Vallecitos Water District, and Vista Irrigation District; and private water
11 companies provide retail water supplies to users within their communities.
12 Groundwater use is small or does not occur within the cities of Escondido and
13 Poway, Ramona Municipal Water District, Rincon del Diablo Municipal Water
14 District, and Vallecitos Water District. Ramona Municipal Water District used to
15 use groundwater until high nitrate concentrations required the district to abandon
16 the wells.

17 *Batiquitos Lagoon Valley, San Elijo Valley, and San Dieguito Valley*
18 *Groundwater Basins*

19 The communities in the Batiquitos Lagoon Valley, San Elijo Valley, and San
20 Dieguito Valley groundwater basins primarily use surface water to meet water
21 demands (CMWD 2011; OMWD 2011; SDLAFCO 2011; SDWD 2011; SFID
22 2011). The San Diego County Water Authority provides wholesale surface water
23 supplies to several communities. Groundwater use is limited to private wells
24 within the Carlsbad Municipal Water District, including the City of Carlsbad;
25 Olivenhain Municipal Water District, including the cities of Encinitas, Carlsbad,
26 San Diego, Solano Beach, and San Marcos, and the communities of Olivenhain,
27 Leucadia, Elfin Forest, Rancho Santa Fe, Fairbanks Ranch, Santa Fe Valley, and
28 4S Ranch; San Dieguito Water District, including the communities of Encinitas,
29 Cardiff-by-the-Sea, New Encinitas, and Old Encinitas; and Santa Fe Irrigation
30 District, including the City of Solana Beach and the communities of Rancho Santa
31 Fe and Fairbanks Ranch. Groundwater was used within the Carlsbad Municipal
32 Water District area until high salinity caused the area to abandon the wells.
33 Questhaven Municipal Water District manages groundwater for a recreation
34 community located to the west of Escondido.

35 *San Diego River Valley, El Cajon, Mission Valley, Sweetwater Valley, Otay*
36 *Valley, and Tijuana Groundwater Basins*

37 The communities in the San Diego River Valley, El Cajon, Mission Valley,
38 Sweetwater Valley, Otay Valley, and Tijuana groundwater basins use a
39 combination of surface water and groundwater to meet water demands (California
40 American Water Company 2012; City of San Diego 2011; HWD 2011; OWD
41 2011; PDMWD 2011; SDCWA et al. 2013; Sweetwater Authority 2011). The San
42 Diego County Water Authority provides wholesale surface water supplies to
43 several communities. The City of San Diego, Helix Water District, and
44 Sweetwater Authority provide retail surface water and/or groundwater supplies to
45 users within cities of La Mesa, Lemon Grove, National City, and San Diego;

1 portions of Chula Vista and El Cajon; and all or portions of the communities of
 2 Bonita, Lakeside, and Spring Valley. The County of San Diego—Campo Water
 3 and Sewer Maintenance District, Cuyamaca Water District, Decanso Community
 4 Services District, Julian Community Services District, Majestic Pines Community
 5 Services District, Wynola Water District, Lake Morena Oak Shores Mutual
 6 Water Company, Pine Hills Mutual Water Company, and Pine Valley Mutual
 7 Water Company rely upon groundwater to meet their water demands.
 8 Groundwater is not used for water supplies within Padre Dam Municipal Water
 9 District which serves the City of Santee and portions of the City of El Cajon; Otay
 10 Water District which serves portions of the cities of Chula Vista, El Cajon, and La
 11 Mesa, and several unincorporated communities; and California American Water
 12 which serves the City of Imperial Beach and portions of the cities of Chula Vista,
 13 Coronado, and San Diego. Sweetwater Authority operates the Desalination
 14 Facility to treat brackish groundwater (San Diego County LAFCO 2011).

15 **7.3.6.4 Western Riverside County and Southwestern San Bernardino** 16 **County**

17 The areas within the SWP service area in western and central Riverside County
 18 and southern San Bernardino County in the Southern California Region include
 19 the Upper Santa Ana Valley Groundwater Basin in Riverside and San Bernardino
 20 counties; the Elsinore, San Jacinto Groundwater Basin in Riverside County; and
 21 the Temecula Valley Groundwater Basin in Riverside and San Diego counties, as
 22 shown in Figure 7.12.

23 **7.3.6.4.1 Hydrogeology and Groundwater Conditions**

24 *Upper Santa Ana Valley Groundwater Basin*

25 The Upper Santa Ana Valley Groundwater Basin consists of the Cucamonga,
 26 Chino, Riverside-Arlington, Temescal, Rialto-Colton, Cajon, Bunker Hill,
 27 Yucaipa, and San Timoteo groundwater subbasins.

28 *Cucamonga Subbasin*

29 The Cucamonga subbasin is located within San Bernardino County in the upper
 30 Santa Ana River watershed (DWR 2004 cd; MWDSC 2007). Groundwater is
 31 contained within the basin by the Red Hill fault. The water bearing formations
 32 are mainly alluvium of gravel, sand, and silt with beds of compacted clay.
 33 Groundwater is recharged naturally from precipitation and stream flows, water
 34 discharged to spreading basins, and runoff that flows into the streams from
 35 irrigated lands, including lands irrigated with SWP water. The groundwater is
 36 characterized as calcium-sodium bicarbonate with moderate to high TDS and
 37 nitrates, and localized areas with high volatile organic compounds, perchlorate,
 38 and dibromochloropropane (DBCP) (MWDSC 2007).

39 The Cucamonga subbasin was designated by the CASGEM program as medium
 40 priority.

1 *Chino Subbasin*

2 The Chino subbasin is located in San Bernardino County. The Chino subbasin is
3 composed of alluvial material. The Rialto-Colton, San Jose, and the Cucamonga
4 faults act as groundwater flow barriers (DWR 2006z). Along the southern
5 boundary of the subbasin, groundwater can rise to the elevation of the Santa Ana
6 River and be discharged into the stream. Groundwater is recharged naturally
7 from precipitation and stream flows along the Santa Ana River and its tributaries,
8 water discharged to spreading basins, and runoff that flows into the streams from
9 irrigated lands, including lands irrigated with SWP water.

10 The Chino subbasin is characterized with high TDS and nitrate concentrations and
11 localized areas of high volatile organic compounds, and perchlorate
12 (MWDSC 2007).

13 The Chino subbasin was designated by the CASGEM program as high priority.

14 *Riverside-Arlington Subbasin*

15 The Riverside-Arlington subbasin is located within the Santa Ana River Valley in
16 southwestern San Bernardino County and northwestern Riverside County
17 (DWR 2004ce). Water bearing formations include alluvial deposits of sand,
18 gravel, silt, and clay. The Rialto-Colton Fault separates this subbasin from the
19 Rialto-Colton subbasin. The Riverside and Arlington portions of the subbasin are
20 also separated. Groundwater flows to the northwest and to the Arlington Gap in
21 the southwest area of the subbasin; and continues into the Temescal subbasin.
22 Groundwater is recharged naturally from precipitation and stream flows in the
23 Santa Ana River, and flow from adjacent subbasins. The groundwater is
24 characterized as calcium-sodium bicarbonate with moderate to high TDS and
25 nitrates, and localized areas with high volatile organic compounds, perchlorate,
26 and DBCP (MWDSC 2007).

27 The Riverside-Arlington subbasin was designated by the CASGEM program as
28 high priority.

29 *Temescal Subbasin*

30 The Temescal subbasin is located within the Santa Ana River Valley in Riverside
31 County. Water bearing formations consist of alluvium bounded by the Elsinore
32 fault zone on the west and the Chino fault zone on the northwest (DWR 2006aa).
33 Groundwater is recharged naturally from precipitation and stream flows in the
34 tributaries of the Santa Ana River. The groundwater is characterized as calcium-
35 sodium bicarbonate with moderate to high TDS and nitrates, and localized areas
36 with high volatile organic compounds, perchlorate, iron, and manganese
37 (MWDSC 2007).

38 The Temescal subbasin was designated by the CASGEM program as medium
39 priority.

40 *Cajon Subbasin*

41 The Cajon subbasin is located within the upper Santa Ana River Valley in San
42 Bernardino County. Water bearing formations consist of alluvium bounded by
43 the San Andreas Fault zone on the south and impermeable rock formations on the

1 east and west (DWR 2004cf). Groundwater is recharged naturally from
2 precipitation, stream flows in the tributaries of the Santa Ana River, and runoff
3 that flows into the streams from irrigated lands, including lands irrigated with
4 SWP water. The groundwater quality is good for the beneficial uses.

5 The Cajon subbasin was designated by the CASGEM program as very low
6 priority.

7 *Rialto-Colton Subbasin*

8 The Rialto-Colton subbasin is located within the upper Santa Ana River Valley in
9 southwestern San Bernardino County and northwestern Riverside County. Water
10 bearing formations consist of alluvium bounded by the Rialto-Colton and San
11 Jacinto fault zones (DWR 2004cg). Groundwater is recharged naturally from
12 precipitation and stream flows. The groundwater quality is good for the
13 beneficial uses with localized areas of high volatile organic compounds.

14 The Rialto-Colton subbasin was designated by the CASGEM program as medium
15 priority.

16 *Bunker Hill Subbasin*

17 The Bunker Hill subbasin is located in San Bernardino County. The water
18 bearing formations include alluvium of sand, gravel, and boulders with deposits
19 of silt and clay bounded by the Rialto-Colton and San Jacinto fault zones
20 (DWR 2004ch). Groundwater is recharged naturally from precipitation, stream
21 flows in the Santa Ana River and its tributaries, water discharged to spreading
22 basins, and runoff that flows into the streams from irrigated lands, including lands
23 irrigated with SWP water. The groundwater quality is good for the beneficial
24 uses. The groundwater is characterized as calcium- bicarbonate with localized
25 areas of high volatile organic compounds and perchlorate within several
26 contamination plumes (*Lockheed Martin Corporation v. United States, Civil*
27 *Action No. 2008-1160*).

28 The Bunker Hill subbasin was designated by the CASGEM program as high
29 priority.

30 *Yucaipa Subbasin*

31 The Yucaipa subbasin is located within the upper Santa Ana River Valley in San
32 Bernardino County. Water bearing formations include alluvial deposits of sand,
33 gravel, boulders, silt, and clay (DWR 2004ci). Several fault zones restrict
34 groundwater movement. The San Timoteo formation along the western boundary
35 of the basin causes the water to rise to the elevation of the San Timoteo Wash, a
36 tributary of the Santa Ana River. Groundwater is recharged naturally from
37 precipitation and stream flows, and water discharged to recharge basins. The
38 groundwater is characterized as calcium-sodium bicarbonate with moderate TDS
39 and high nitrate concentrations, and localized areas with high volatile organic
40 compounds.

41 The Yucaipa subbasin was designated by the CASGEM program as medium
42 priority.

1 *San Timoteo Subbasin*

2 The San Timoteo subbasin is located within the upper Santa Ana River Valley in
3 Riverside County. Water bearing formations include alluvial deposits of gravel,
4 silt, and clay (DWR 2004cj). Several fault zones restrict groundwater movement.
5 Groundwater is recharged naturally from precipitation and stream flows, and
6 water discharged to recharge basins. The groundwater is characterized as
7 calcium-sodium bicarbonate and good quality for the beneficial uses.

8 The San Timoteo subbasin was designated by the CASGEM program as medium
9 priority.

10 *San Jacinto Groundwater Basin*

11 The San Jacinto Groundwater Basin is located in upper Santa Ana River Valley in
12 Riverside County, and underlies the San Jacinto, Perris, Moreno and Menifee
13 valleys and Lake Perris. The water bearing formations are alluvium over
14 crystalline basement rock (DWR 2006ab). Several fault zones restrict
15 groundwater movement. Groundwater is recharged naturally from precipitation
16 and stream flows along the San Jacinto River and its tributaries, percolation from
17 Lake Perris, and water discharged to recharge basins. The groundwater is
18 characterized as calcium-sodium bicarbonate with high TDS and nitrate
19 concentrations and localized areas with high iron, manganese, sulfides, volatile
20 organic compounds, and perchlorate (DWR 2006ac; MWDSC 2007).

21 The San Jacinto Groundwater Basin was designated by the CASGEM program as
22 high priority.

23 *Elsinore Groundwater Basin*

24 The Elsinore Groundwater Basin is located in upper Santa Ana River Valley in
25 Riverside County. The water bearing formations are alluvial fan, floodplain, and
26 lacustrine deposits underlain by alluvium of gravel, sand, silt, and clay
27 (DWR 2006ac). Several fault zones restrict groundwater movement.
28 Groundwater is recharged naturally from precipitation and stream flows along the
29 San Jacinto River, and water discharged to recharge basins. The groundwater is
30 characterized as calcium-sodium bicarbonate with moderate salinity and localized
31 areas with high fluoride, arsenic, nitrate, iron, manganese, volatile organic
32 compounds, and perchlorate (DWR 2006ac; MWDSC 2007).

33 The Elsinore Groundwater Basin was designated by the CASGEM program as
34 high priority.

35 *Temecula Valley Groundwater Basin*

36 The Temecula Valley Groundwater Basin is located in the upper Santa Margarita
37 River watershed within Riverside and San Diego counties. The water bearing
38 formations are alluvium of sand, tuff, and silt underlain by fractured bedrock
39 (DWR 2004ck). Several fault zones restrict groundwater movement.
40 Groundwater is recharged naturally from precipitation and stream flows. The
41 groundwater is characterized as calcium-sodium bicarbonate with high TDS,
42 fluoride, nitrate, volatile organic compounds, and perchlorate (DWR 2006ac;
43 MWDSC 2007).

1 The Temecula Valley Groundwater Basin was designated by the CASGEM
2 program as high priority.

3 **7.3.6.4.2 Groundwater Use and Management**

4 *Upper Santa Ana Valley Groundwater Basin*

5 The Upper Santa Ana Valley Groundwater Basin consists of the Cucamonga,
6 Chino, Riverside-Arlington, Temescal, Rialto-Colton, Cajon, Bunker Hill,
7 Yucaipa, and San Timoteo groundwater subbasins.

8 *Cucamonga and Chino Subbasins*

9 The communities in the Cucamonga and Chino subbasins use a combination of
10 surface water and groundwater to meet water demands (City of Chino 2011; City
11 of Ontario 2011; City of Pomona 2011; City of Upland 2011; Cucamonga Valley
12 WD 2011; FWC 2011; JCSO 2011; MWDSC 2007; MVWD 2011; SAWC 2011;
13 WMWD 2011). The cities of Chino, Ontario, Pomona, and Upland; Cucamonga
14 Valley Water District, Jurupa Community Services District, Monte Vista Water
15 District, and Western Municipal Water District; San Antonio Water Company,
16 Fontana Water Company, Santa Ana River Water Company, and Marygold
17 Mutual Water Company, and Golden State Water Company provide wholesale
18 and/or retail water supplies, including groundwater, to users within their
19 communities and to portions of the City of Rialto, Montclair, Rancho Cucamonga,
20 and San Antonio Heights.

21 The Cucamonga subbasin was adjudicated in 1958 to allocate groundwater rights
22 in the basin and surface water rights to Cucamonga Creek (City of Chino 2011;
23 Cucamonga Valley WD 2011; MWDSC 2007). The water supplies are allocated
24 to the Cucamonga Valley Water District, San Antonio Water Company, and the
25 West End Consolidated Water Company. The City of Upland has agreements
26 with San Antonio Water Company and the West End Consolidated Water
27 Company to divert from the subbasin.

28 The Chino subbasin was adjudicated in 1978 through the Chino Basin Judgment
29 which established the Chino Basin Watermaster to manage the subbasin and
30 enforce the provisions of the judgment (City of Chino 2011; Cucamonga Valley
31 WD 2011; MWDSC 2007). The judgment and subsequent agreements allocated
32 the available safe yield to three categories, or pools: Overlying Agricultural Pool,
33 including dairies, farms, and the State of California; Overlying Non-Agricultural
34 Pool for industrial users; and the Appropriative Pool Committee, including local
35 cities, public water agencies, and private water companies. The judgment and
36 subsequent agreements included provisions for reallocation of water rights,
37 groundwater replenishment if the subbasin is operated in a controlled overdraft
38 condition, and development of a groundwater management plan. Through “Peace
39 Agreements” adopted in 2000 and amended in 2004, included provisions to allow:
40 members of the Overlying Non-Agricultural Pool to transfer their water within
41 their pool or to the Watermaster, appropriators to provide water service to
42 overlying lands, and the Watermaster to allocate unallocated safe yield. The
43 Peace Agreement also addressed use of local storage facilities, management of the
44 subbasin under the Dry Year Yield program when imported water, including SWP

1 water, is not fully available. Groundwater replenishment is allowed through
2 spreading basins, percolation, groundwater injection, and in-lieu use of other
3 water supplies, including SWP water. The Chino Basin Watermaster also was
4 required to develop an Optimum Basin Management Plan, adopted in 1998, to
5 address approaches that would enhance basin water supplies, protect and enhance
6 water quality, enhance management of the basin, and equitably finance
7 implementation of programs identified in the plan. The Peace II Agreement was
8 adopted in 2007 addressed procedures related to basin reoperation under
9 controlled overdraft conditions using the Chino Desalters to meet the
10 replenishment obligation and to maintain hydraulic control in the subbasin, and
11 transfers. The Groundwater Recharge Master Plan update was prepared by the
12 Watermaster in 2010.

13 The Santa Ana Regional Water Quality Control Board adopted a Water Quality
14 Control Plan in 2004 for the entire Santa Ana River Basin which included a
15 Maximum Benefit Basin Plan, recommended by the Chino Basin Watermaster
16 and the Inland Empire Utilities Agency. The plan established water quality
17 objectives in groundwater quality objectives for TDS and Total Inorganic
18 Nitrogen and wasteload allocations to allow use of recycled water for
19 groundwater recharge. The Maximum Benefit Basin Plan includes commitments
20 for surface water and groundwater monitoring programs; implementation of up to
21 40 million gallons/day of treated groundwater at desalters; implementation of
22 recharge facilities, conjunctive use programs, and recycled water quality
23 management programs; and groundwater management to provide hydraulic
24 controls to protect the Santa Ana River water quality.

25 Operations of the Chino Basin portion of the upper Santa Ana River are also
26 affected by surface water right judgments administered by the Santa Ana River
27 Watermaster.

28 A large portion of the natural runoff in the upper Santa Ana River watershed is
29 captured and used to recharge the groundwater aquifers. Flood control channels
30 and percolation basins are operated by San Bernardino County Flood Control
31 District to allow for flood control and groundwater recharge (MWDSC 2007).
32 Groundwater recharge also occurs in spreading basins operated by the City of
33 Upland, San Antonio Water Company, and San Antonio Water Company. The
34 Chino Basin Water Conservation District operates percolation ponds and
35 spreading basins to facilitate groundwater recharge (IEUA 2011).

36 The Inland Empire Utilities Agency manages production and treatment of
37 recycled water supplies that are used in groundwater recharge operations and as
38 part of conjunctive use programs in the cities of Chino, Chino Hills, Ontario, and
39 Upland; and in the service areas of the Cucamonga Valley Water District, Monte
40 Vista Water District, Fontana Water Company, and San Antonio Water Company
41 (IEUA 2011). The district is a member of the Chino Basin Watermaster Board of
42 Directors. The Inland Empire Utilities Agency operates several recharge facilities
43 in the Chino subbasin. Recharge water comes from three sources: recycled water,
44 stormwater, and imported SWP water. The Inland Empire Utilities Agency
45 operates the Chino Desalter Authority's Chino I and Chino II Desalters that treat

1 water from 22 wells. The Chino Desalter Authority is a joint powers authority
2 that includes the cities of Chino, Chino Hills, Norco, and Ontario; and the Jurupa
3 Community Services District, Santa Ana River Water Company, Western
4 Municipal Water District, and Inland Empire Utilities Agency. The treated water
5 from the desalters is used for potable water supplies, groundwater recharge with
6 water with reduced salts and nitrates, and improved water quality of the Santa
7 Ana River.

8 *Riverside-Arlington and Temescal Subbasins*

9 The communities in the Riverside-Arlington and Temescal subbasins use a
10 combination of surface water and groundwater to meet water demands (City of
11 Corona 2011; City of Norco 2014; City of Rialto 2011; City of Riverside 2011;
12 JCSD 2011; MWDC 2007; RCWD 2011; SBVMWD 2011; WMWD 2011).
13 The San Bernardino Valley Municipal Water District and Western Municipal
14 Water District provide wholesale and retail water supplies, including
15 groundwater, in the areas that overlay the Riverside-Arlington and Temescal
16 subbasins. The cities of Colton, Corona, Norco, Rialto, and Riverside; Elsinore
17 Valley Municipal Water District; Jurupa Community Services District, Lee Lake
18 Water District; Rubidoux Community Services District, San Bernardino Valley
19 Municipal Water District, Western Municipal Water District, and West Valley
20 Water District; and Box Springs Mutual Water Company, Riverside Highland
21 Mutual Water Company, and Terrace Water Company provide retail water
22 supplies, including groundwater, to users within their communities. The Jurupa
23 Community Services District uses wells within the Riverside-Arlington subbasin
24 for non-potable uses (JCSD 2011).

25 The Riverside portion of the Riverside-Arlington subbasin was adjudicated in
26 1969 through the stipulated judgment for the *Western Municipal Water District of*
27 *Riverside County et al. versus East San Bernardino County Water District, et al.*
28 The judgment provided average annual extraction volumes and replenishment
29 schedules for the separate sections of the subbasin as defined by the San
30 Bernardino County and Riverside County boundary (Riverside North and
31 Riverside South portions of the subbasin) (City of Riverside 2011; MWDC
32 2007). Within the Riverside North portion, the judgment affects only withdrawals
33 that are to be used in Riverside County because withdrawals for use of water in
34 San Bernardino County are not limited. The Western-San Bernardino
35 Watermaster manages the monitoring and reporting of groundwater conditions of
36 the Riverside portion of the subbasin.

37 The northern portion of the Riverside portion of the subbasin also was part of the
38 1969 judgment in the *Orange County Water District v. City of Chino et al.* This
39 judgment primarily includes the Bunker Hill subbasin and small portions of the
40 northern Riverside, Rialto-Colton, and Yucaipa subbasins; and requires minimum
41 downstream flows into the lower Santa Ana River (SBVMWD 2011). To meet
42 the flow obligations, the San Bernardino Valley Municipal Water District is
43 responsible to manage groundwater and surface waters within the San Bernardino
44 Basin Area, as defined in the judgment. The district manages the groundwater by

1 allocation of groundwater withdrawal amounts and requiring replenishment when
2 additional groundwater is withdrawn.

3 The Arlington portion of the Riverside-Arlington subbasin and the Temescal
4 subbasins are not adjudicated (City of Corona 2011; MWDSC 2007). In 2008, an
5 agreement was adopted between Elsinore Valley Municipal Water District and the
6 City of Corona for use of water from the southern portion of the Temescal
7 subbasin.

8 The City of Riverside operates two water treatment plants as part of the North
9 Riverside Water Project to remove volatile organic compounds. The City of
10 Corona operates the Temescal Basin Desalter Treatment Plant/Facility and the
11 Western Municipal Water District operates the Arlington Desalter (City of Corona
12 2011; WMWD 2011) to reduce TDS. The City of Norco operates a groundwater
13 treatment plant to reduce iron, manganese, and hydrogen sulfide (City of
14 Norco 2014).

15 *Cajon, Rialto-Colton, Bunker Hill, Yucaipa, and San Timoteo Subbasins*

16 The communities in the Cajon, Rialto-Colton, Bunker Hill, Yucaipa, and San
17 Timoteo subbasins use a combination of surface water and groundwater to meet
18 water demands (City of Rialto 2011; City of Riverside 2011; MWDSC 2007;
19 SBVMWD 2011; YVWD 2011; WMWD 2011; West Valley WD 2014a). The
20 San Bernardino Valley Municipal Water District and Western Municipal Water
21 District provide wholesale and retail water supplies, including groundwater, in the
22 areas that overlay the Cajon, Rialto-Colton, Bunker Hill, Yucaipa, and San
23 Timoteo subbasins. The cities of Colton, Loma Linda, Redlands, Rialto,
24 Riverside, and San Bernardino; Beaumont-Cherry Valley Water District, East
25 Valley Water District, South Mesa Water District, West Valley Water District,
26 Western Municipal Water District, West Valley Water District, and Yucaipa
27 Valley Water District; and several private water companies provide retail water
28 supplies, including groundwater, to users within their communities and to portions
29 of the cities of Beaumont, Calimesa, and Yucaipa; the communities of Cherry
30 Valley, Mission Grove, Orange Crest, and Woodcrest; and numerous private
31 water companies.

32 Groundwater adjudication in these subbasins have occurred over the past 90
33 years. A portion of the Bunker Hill subbasin underlays the Lytle Creek watershed
34 (City of Rialto 2011). The remaining portion of the Lytle Creek watershed
35 overlays the Lytle Creek groundwater basin that is not included in the DWR
36 Bulletin 118. The entire Lytle Creek groundwater basin, including the portion in
37 the Bunker Hill subbasin, is a major groundwater recharge source to the Bunker
38 Hill and Rialto-Colton subbasins; and was adjudicated in 1924. The stipulation of
39 the judgment allocated groundwater withdrawal right to the City of Rialto,
40 Citizens Land and Water Company, Lytle Creek Water and Improvement
41 Company, Rancheria Water Company, and Mutual Water Company.

42 The Rialto-Colton subbasin was adjudicated in 1961 under the *Lytle Creek Water*
43 *& Improvement Company vs. Fontana Ranchos Water Company et al* (City of
44 Rialto 2011). The adjudication allocated groundwater withdrawals between the

1 cities of Rialto and Colton, West Valley Water District, and Fontana Union Water
2 Company based upon spring groundwater levels at three index wells between
3 March and May of each water year. The groundwater subbasin is managed by the
4 Rialto Basin Management Association. The stipulation of the judgment allocated
5 groundwater withdrawal right to the City of Rialto, Citizens Land and Water
6 Company, Lytle Creek Water and Improvement Company, and private well users.
7 Use of this aquifer has been limited due to contamination with volatile organic
8 compounds which are currently being treated. The City of Rialto also has
9 agreements with San Bernardino Municipal Water District to store SWP water in
10 the Rialto subbasin. The city can withdraw the stored water without affecting the
11 water allowed to be withdrawn under the 1961 decree.

12 As described above under the Riverside-Arlington and Temescal Subbasins
13 section, in 1969 the stipulated judgment for the *Western Municipal Water District*
14 *of Riverside County et al. versus East San Bernardino County Water District, et*
15 *al.* to preserve the safe yield of the San Bernardino Basin Area through
16 entitlements to groundwater withdrawals to protect the safe yield and
17 establishment of replenishment schedules when the safe yield is exceeded (City of
18 Rialto 2011; SBVMWD 2011). The San Bernardino Basin Area includes the
19 Bunker Hill subbasin and portions of the Rialto-Colton and Yucaipa subbasins;
20 and portions of the Mill Creek, Lytle Creek, and upper Santa Ana River
21 watersheds. The Western-San Bernardino Watermaster, which includes Western
22 Municipal Water District and San Bernardino Municipal Water District, manages
23 the monitoring and reporting of groundwater conditions. The primary users of the
24 groundwater under this decree include the cities of Colton, Loma Linda,
25 Redlands, and Rialto; East Valley Water District, San Bernardino Municipal
26 Water District, West Valley Water District, and Yucaipa Valley Water District;
27 Riverside-Highland Water Company and 13 private water companies.

28 In 2002, the City of Beaumont, Beaumont-Cherry Valley Water District, South
29 Mesa Water Company, and Yucaipa Valley Water District formed the San
30 Timoteo Watershed Management Authority to enhance water supplies and water
31 quality, manage groundwater in the Beaumont Basin (part of the San Timoteo
32 subbasin), protect riparian habitat in San Timoteo Creek, and allocate benefits and
33 costs of these programs (Beaumont Basin Watermaster 2013; SBVMWD 2011).
34 One of the issues that the authority initiated was negotiations related to
35 groundwater withdrawals by the City of Banning. A Stipulated Agreement was
36 adopted in 2004 in accordance with the judgment for the *San Timoteo Watershed*
37 *Management Authority, vs. City of Banning et al.* The judgment established a
38 Watermaster committee of the cities of Banning and Beaumont, Beaumont-Cherry
39 Valley Water District, South Mesa Water Company, and Yucaipa Valley Water
40 District. The judgment allocated groundwater supplies in a manner that allows
41 for storage of groundwater recharge from spreading basins or in-lieu programs.

42 The Seven Oaks Accord, a settlement agreement, was signed by the City of
43 Redlands; East Valley Water District, San Bernardino Valley Municipal Water
44 District, and Western Municipal Water District; and Bear Valley Mutual Water
45 Company, Lugonia Water Company, North Fork Water Company, and Redlands

1 Water Company to recognize prior rights of water users of a portion of the natural
2 flow of the Santa Ana River (SBVMWD 2011). The Seven Oaks Accord requires
3 that San Bernardino Valley Municipal Water District, and Western Municipal
4 Water District develop a groundwater spreading program to recharge the
5 groundwater in cooperation with other parties to the accord to maintain relatively
6 constant groundwater levels.

7 In 2005, the San Bernardino Valley Municipal Water District entered into an
8 agreement with the San Bernardino Valley Water Conservation District to work
9 cooperatively to develop and implement a groundwater management plan which
10 includes groundwater banking programs (SBVMWD 2011).

11 The City of Rialto, San Bernardino Valley Municipal Water District, West Valley
12 Water District, and Riverside Highland Water District have jointly constructed the
13 Baseline Feeder to convey groundwater from the Bunker Hill subbasin to the
14 Rialto area and West Valley Water District to be used in an in-lieu program that
15 would reduce reliance on SWP water supplies (City of Rialto 2011; West Valley
16 WD 2014c, 2014d).

17 West Valley Water District implemented a bioremediation wellhead treatment
18 system (West Valley Water District 2014b).

19 *San Jacinto Groundwater Basin*

20 The communities in the San Jacinto Groundwater Basin use a combination of
21 surface water and groundwater to meet water demands (City of Hemet 2011; City
22 of San Jacinto 2011; EMWD 2011; LHMWD 2011; MWDSC 2007; RCWD
23 2011). The Eastern Municipal Water District provides wholesale and retail water
24 supplies, including groundwater, in the areas that overlay the San Jacinto
25 Groundwater Basin. The cities of Hemet and San Jacinto; and Eastern Municipal
26 Water District and Rancho California provide retail water supplies, including
27 groundwater, to users within their communities and to portions of the cities of
28 Menifee, Moreno Valley, Murrieta, and Temecula; Lake Hemet Municipal Water
29 District; Nuevo Water Company and numerous private water companies; and the
30 communities of Edgemont, Homeland, Juniper Flats, Lakeview, Mead Valley,
31 North Perris Water System, Romoland, Sunnymead, Valle Vista, and Winchester.
32 The City of Perris overlays a portion of the San Jacinto Groundwater Basin;
33 however, the city does not use groundwater. A substantial portion of the
34 groundwater supplies within the San Jacinto Groundwater Basin are used by
35 agricultural water users.

36 The 1954 Fruitvale Judgment allows for Eastern Municipal Water District to
37 withdraw water from the San Jacinto Groundwater Basin if the groundwater
38 elevation is greater than a specified elevation (EMWD 2009, 2011, 2014). The
39 judgment includes a maximum withdrawal volume for use outside of the
40 groundwater basin. There are further restrictions within the Canyon Basin
41 subbasin of the San Jacinto Groundwater Basin. DWR worked with the cities of
42 Hemet and San Jacinto, Lake Hemet Municipal Water District, Eastern Municipal
43 Water District, and private groundwater companies to file a stipulated judgment in
44 2007 to form a Watermaster to develop and implement the Hemet/San Jacinto

1 Water Management Plan, including the Hemet/San Jacinto Integrated Recharge
2 and Recovery Program, Recycled Water In-Lieu Project, and Hemet Filtration
3 Plant. The stipulated judgment also limited groundwater withdrawals to protect
4 the groundwater basin, provide for recharge programs, expand water production,
5 and protect water quality. The program uses SWP water and San Jacinto River
6 runoff to recharge the San Jacinto-Upper Pressure Groundwater Management
7 Zone. In 2013, the judgment was filed with the court to adopt the Hemet/San
8 Jacinto Water Management Plan and create the Watermaster Board.

9 The stipulated judgment also addressed methods to fulfil the Soboaba Band of
10 Luiseño Indians water rights in accordance with the findings of the Court for the
11 *Soboba Band of Luiseño Indians Water Settlement Agreement* in 2006. In 2008,
12 the Soboba Settlement Act was signed by the President of the United States to
13 provide an annual water supply and provide funds for economic development.
14 The legislation also provides funds to construct recharge facilities and provisions
15 for the Soboba Tribe to participate in restoration efforts.

16 The Eastern Municipal Water District adopted the West San Jacinto Groundwater
17 Basin Management Plan in 1995. The management plan includes the Nuevo
18 Water Company, City of Moreno Valley, City of Perris, and McCanna Ranch
19 Water Company (MWDSC 2007).

20 Eastern Municipal Water District operates two desalination plants to treat
21 brackish water within the San Jacinto Groundwater Basin as part of the
22 Groundwater Salinity Management Program (EMWD 2011). Other wells within
23 the Eastern Municipal Water District also include treatment facilities to reduce
24 hydrogen sulfide, iron, and/or manganese.

25 *Elsinore Groundwater Basin*

26 The communities in the Elsinore Groundwater Basin use a combination of surface
27 water and groundwater to meet water demands (EVMWD 2011; MWDSC 2007).
28 The Elsinore Valley Municipal Water District provides wholesale and retail water
29 supplies, including groundwater, in the areas that overlay the Elsinore
30 Groundwater Basin. The cities of Lake Elsinore, Canyon Lake, and Wildomar;
31 Elsinore Valley Municipal Water District and Elsinore Water District; and Farm
32 Mutual Water Company provide retail water supplies, including groundwater, to
33 users within their communities and to portions of Cleveland Ranch, Farm,
34 Horsethief Canyon, Lakeland Village, Meadowbrook, Rancho Capistrano –
35 El Cariso Village, and Temescal Canyon.

36 The Elsinore Groundwater Basin is not adjudicated. The Elsinore Valley
37 Municipal Water District was responsible for over 90 percent of the groundwater
38 withdrawals in mid-2000s (EVMWD 2011). The Elsinore Basin Groundwater
39 Management Plan, adopted by Elsinore Valley Municipal Water District in 2005,
40 identifies conjunctive use projects, including direct recharge projects. The direct
41 recharge projects use imported water, including SWP water.

1 *Temecula Valley Groundwater Basin*

2 The communities in the Temecula Valley Groundwater Basin use a combination
3 of surface water and groundwater to meet water demands (MWDSC 2007;
4 RCSD 2011; WMWD 2011). The Rancho California Water District and Western
5 Municipal Water District (including Murrieta County Water District) provide
6 wholesale and retail water supplies, including groundwater, in the areas that
7 overlay the Temecula Valley Groundwater Basin, including the cities of Murrieta
8 and Temecula. The Pechanga Indian Reservation operates groundwater wells
9 within the Temecula Valley Groundwater Basin (MWDSC 2007).

10 The Temecula Valley Groundwater Basin is located within the Santa Margarita
11 River watershed. As described above for the San Mateo Valley, San Onofre
12 Valley, and Santa Margarita Valley Groundwater Basins, the groundwater basins
13 that contribute direct or indirect flows into the Santa Margarita River have been
14 adjudicated and are managed by the Santa Margarita River Watermaster in
15 accordance with the 1940 Stipulated Judgment, the 1966 Modified Final
16 Judgment and Decree, and subsequent court orders (MWDSC 2007;
17 RCWD 2011; SMRW 2011; WMWD 2011). The court-appointed steering
18 committee for the Watermaster includes Eastern Municipal Water District,
19 Fallbrook Public Utility District, Metropolitan Water District of Southern
20 California, Pechanga Band of Luiseno Mission Indians of the Pechanga
21 Reservation, Rancho California Water District, Western Municipal Water District,
22 and Marine Corps Base Camp Pendleton. In accordance with the judgment, the
23 Rancho California Water District prepares the annual Groundwater Audit and
24 Recommended Groundwater Production Report that allocates groundwater
25 withdrawals based upon rainfall, recharge area, and pumping capacity. The
26 subsequent orders adopted following 1966 included the Cooperative Water
27 Resource Management Agreement between Rancho California Water District and
28 the Marine Corps Base Camp Pendleton to manage groundwater levels and
29 surface water flows; water rights to Vail Lake on Temecula Creek; and an
30 agreement between the Rancho California Water District and the Pechanga Band
31 of Luiseno Mission Indians of the Pechanga Reservation.

32 Rancho California Water District provides imported water, including SWP water,
33 and natural runoff released from Vail Lake to the Valle de Los Caballos Recharge
34 Basins (RCWD 2011). The district also has implemented the Vail Lake
35 Stabilization and Conjunctive Use Project to store imported water in Vail Lake for
36 subsequent groundwater recharge (RCWD et al. 2014).

37 **7.3.6.5 Central Riverside County**

38 The areas within the SWP service area which receive Colorado River water in-
39 lieu of SWP water deliveries are located within the Coachella Valley
40 Groundwater Basin. The Coachella Valley Groundwater Basin includes the
41 Desert Hot Springs, Indio, Mission Creek, and San Geronio Pass subbasins, as
42 shown in Figure 7.12.

1 **7.3.6.5.1 Hydrogeology and Groundwater Conditions**

2 The Coachella Valley Groundwater Basin underlies the entire floor of the
3 Coachella Valley. Primary water-bearing materials in the Coachella Valley
4 Groundwater Basin are unconsolidated alluvial deposits along the valley floor
5 which consist of older alluvium and a thick sequence of poorly bedded coarse
6 sand and gravel; terrace deposits under the surrounding foothills in the Mission
7 Creek subbasin; and partly consolidated fine to coarse sandstone in the
8 surrounding mountains in the San Gorgonio Pass subbasin (DWR 2004cm,
9 2004cn, 2004co, 2004cp). The movement of groundwater is locally influenced by
10 features such as faults, structural depressions, and constrictions; however,
11 groundwater generally flows to the southeast towards the Salton Sea.
12 Groundwater recharge occurs along stream beds and from groundwater inflows
13 from adjacent subbasins. Within the Indio subbasin, groundwater also is
14 recharged from spreading basins and injection wells.

15 The groundwater quality is characterized as calcium-sodium bicarbonate.
16 Groundwater quality is adequate for community and agricultural water uses
17 within the San Gorgonio Pass, Mission Creek, and Indio subbasins. There are
18 localized areas with high fluoride near the Banning and San Andreas fault zones.
19 Groundwater quality in the Desert Hot Springs subbasin due to the geothermal
20 activity which results in high sodium sulfate, TDS, and chlorides. The hot springs
21 water is only used by a resort for bathing.

22 Desert Hot Springs Groundwater Basin was designated by the CASGEM program
23 as low priority. Indio, Mission Creek, and San Gorgonio Pass groundwater basins
24 were designated as medium priority.

25 **7.3.6.5.2 Groundwater Use and Management**

26 *Coachella Valley Groundwater Basin*

27 The Coachella Valley Groundwater Basin includes the San Gorgonio Pass,
28 Mission Creek, Desert Hot Springs, and Indio subbasins.

29 *San Gorgonio Pass Subbasin*

30 The communities in the San Gorgonio Pass subbasin use a combination of surface
31 water and groundwater to meet water demands (BCVWD 2013; City of Banning
32 2011; SGPWA 2010). The City of Banning, Beaumont-Cherry Valley Water
33 District, Cabazon Water District, and High Valley Water District provide retail
34 water supplies, including groundwater, in the areas that overlay the San Gorgonio
35 Pass subbasin, including the City of Banning and the eastern portion of the City of
36 Beaumont; Banning Heights Mutual Water Company; and the community of
37 Cabazon. The Morongo Band of Mission Indians operates groundwater wells
38 within the San Gorgonio Pass subbasin.

39 The western portion of the San Gorgonio Pass subbasin is located within the
40 Beaumont Basin (USGS 1974). As described above, the City of Beaumont,
41 Beaumont-Cherry Valley Water District, South Mesa Water Company, and
42 Yucaipa Valley Water District formed the San Timoteo Watershed Management
43 Authority to enhance water supplies and water quality, manage groundwater,

1 protect riparian habitat in San Timoteo Creek, and allocate benefits and costs of
2 these programs (Beaumont Basin Watermaster 2013). One of the issues that the
3 authority initiated was negotiations related to groundwater withdrawals by the
4 City of Banning. A Stipulated Agreement was adopted in 2004 in accordance
5 with the judgment for the *San Timoteo Watershed Management Authority, vs. City*
6 *of Banning et al.* The judgment established a Watermaster committee of the cities
7 of Banning and Beaumont, Beaumont-Cherry Valley Water District, South Mesa
8 Water Company, and Yucaipa Valley Water District. The judgment allocated
9 groundwater supplies in a manner that allows for storage of groundwater recharge
10 from spreading basins or in-lieu programs.

11 *Mission Creek, Desert Hot Springs, and Indio Subbasins*

12 The communities in the Mission Creek, Desert Hot Springs, and Indio subbasins
13 use a combination of surface water and groundwater to meet water demands (City
14 of Coachella 2011; CVWD 2011, 2012; DWA 2011; IWA 2010; MSWD 2011).
15 The City of Coachella, Coachella Valley Water District, Desert Water Agency,
16 Indio Water Authority, and Mission Springs Water District provide retail water
17 supplies, including groundwater, in the areas that overlay the Mission Creek,
18 Desert Hot Springs, and Indio subbasins, including the cities of Cathedral City,
19 Coachella, Desert Hot Springs, Indian Wells, Indio, La Quinta, Palm Desert, Palm
20 Springs, and Rancho Mirage; and the communities of Barton Canyon, Bermuda
21 Dunes, Bombay Beach, Desert Crest, Desert Edge, Indio Hills, Mecca, Mecca
22 Hills, Palm Springs Crest, Salton City, Thermal, and West Palm Springs Village.
23 The Cabazon Band of Mission Indians and the Torres-Martinez Desert Cahuilla
24 Indians operate groundwater wells within the subbasins.

25 The Coachella Valley Water District, Desert Water Agency, and Mission Springs
26 Water District all participate in groundwater management programs within the
27 subbasins (CVWD 2011, 2012; DWA 2011; MSWD 2011). These programs
28 include purchasing imported Colorado River water for groundwater recharge and
29 in-lieu programs, conjunctive use programs, and conservation programs.
30 Coachella Valley Water District and Desert Water Agency are SWP water
31 contractors. However, because no conveyance facilities exist to deliver the SWP
32 water, these districts have agreements with the Metropolitan Water District of
33 Southern California to exchange SWP water for Colorado River water
34 (CVWD 2012). Since 1973, these agencies have recharged more than 2.6 million
35 acre-feet of water in the groundwater basin with delivery of Colorado River water
36 to the Whitewater River Recharge Facility. The Metropolitan Water District of
37 Southern California also has an agreement with Coachella Valley Water District
38 and Desert Water Agency to store water in the Coachella Valley Groundwater
39 Basin. The Coachella Valley Water District also operates the Thomas E. Levy
40 Groundwater Replenishment Facility and the Martinez Canyon Pilot Recharge
41 Facility. Coachella Valley Water District and Desert Water Agency also provide
42 recycled water for in-lieu programs. The Coachella Valley Water District has
43 agreed to operate groundwater recharge facilities to store Colorado River water
44 for Imperial Irrigation District (CVWD 2011).

1 These groundwater recharge programs and broader groundwater management
2 programs for the Indio subbasin have been developed in accordance with the
3 Whitewater Basin Water Management Plan developed by Coachella Valley Water
4 District and Desert Water Agency, and the Coachella Valley Water Management
5 Plan developed by Coachella Valley Water District (CVWD 2011, 2012;
6 DWA 2011).

7 The Coachella Valley Water District, Desert Water Agency, and Mission Springs
8 Water District jointly manage the Mission Creek subbasin in accordance with the
9 2004 Mission Creek Settlement Agreement (DWA 2011; MSWD 2011). The
10 Coachella Valley Water District and Desert Water Agency also manage portions
11 of the subbasin in accordance with the 2003 Mission Creek Groundwater
12 Replenishment Agreement. These agreements provide for the allocation of
13 available Colorado River water under the SWP water exchange agreement with
14 the Metropolitan Water District of Southern California between the Mission
15 Creek and Indio (also known as the Whitewater) subbasins.

16 **7.3.6.6 Antelope Valley and Mojave Valley**

17 The areas within the SWP service area in the Antelope Valley and Mojave Valley
18 include Salt Wells Valley, Cuddeback Valley, Pilot Knob Valley, Grass Valley,
19 Superior Valley, El Mirage Valley, Upper Mojave River Valley, Middle Mojave
20 River Valley, Lower Mojave River Valley, Caves Canyon Valley, Langford
21 Valley, Cronise Valley, Coyote Lake Valley, Kane Wash Area, Iron Ridge Area,
22 Bessemer Valley, Lucerne Valley, Johnson Valley, Means Valley, Deadman
23 Valley, Twentynine Palms Valley, Joshua Tree, Ames Valley, Copper Mountain
24 Valley, Warren Valley, and Morongo Valley groundwater basins in San
25 Bernardino County; Harper Valley and Fremont Valley groundwater basins in
26 San Bernardino Kern counties; Lost Horse Valley in Riverside and San
27 Bernardino counties; Antelope Valley Groundwater Basin in San Bernardino,
28 Kern, and Los Angeles counties; and Indian Wells and Searles Valley
29 groundwater basin in San Bernardino, Inyo, and Kern counties, as shown in
30 Figure 7.13.

31 **7.3.6.6.1 Hydrogeology and Groundwater Conditions**

32 *Indian Wells Valley Groundwater Basin*

33 Indian Wells Valley Groundwater Basin is located in Inyo, Kern, and San
34 Bernardino Counties. Water bearing formations consist of unconsolidated
35 lakebed, stream, and alluvial fan deposits with upper and lower aquifers
36 (DWR 2004cn). The lower aquifer is more productive and has a saturated
37 thickness of approximately 1000 feet. The upper aquifer provides low yield and
38 has low quality. The lower aquifer is considered unconfined in most of the valley.
39 There is indication that some faults within the valley could obstruct groundwater
40 flow. Groundwater is recharged from runoff on the southwest to northeast sides
41 of the valley. Groundwater levels have been declining since 1945. Groundwater
42 quality varies throughout the groundwater basin from appropriate for beneficial
43 uses to areas with poor water quality due to wastewater disposal practices. Areas

1 near geothermal activity are characterized by high chloride, boron, and arsenic
2 concentrations.

3 Indian Wells Valley Groundwater Basin was designated by the CASGEM
4 program as medium priority.

5 *Salt Wells Valley Groundwater Basin*

6 Salt Wells Valley Groundwater Basin is located in San Bernardino County.
7 Water bearing formations consist of unconsolidated to poorly consolidated
8 alluvium (DWR 2004co). Groundwater is recharged from the Indian Wells
9 Groundwater Basin and percolation of rainfall on the valley floor. The regional
10 groundwater flow direction is towards the east into the Searles Valley
11 Groundwater Basin. The groundwater has extremely high salinity, TDS, and
12 boron.

13 Salt Wells Valley Groundwater Basin was designated by the CASGEM program
14 as very low priority.

15 *Searles Valley Groundwater Basin*

16 Searles Valley Groundwater Basin is located in San Bernardino, Inyo, and Kern
17 Counties. Water bearing formations consist of alluvium with unconsolidated to
18 semi-consolidated deposits (DWR 2004cp). The Garlock fault may be a barrier to
19 groundwater flow in the southern part of the basin. Groundwater is recharged
20 from percolation of mountain runoff through the alluvial fan deposits and
21 subsurface inflow from Salt Wells Valley and Pilot Knob Valley groundwater
22 basins. Groundwater flows towards Searles Lake except in the northern portion
23 of the basin where pumping by industrial water users has altered the groundwater
24 flow. Groundwater levels near Searles Lake are close to the lake bed elevations.
25 Groundwater quality is generally appropriate for beneficial uses with localized
26 areas with high levels of fluoride and nitrate. In the vicinity of Searles Lake, the
27 groundwater quality is poor with high levels of fluoride, boron, sodium, chloride,
28 sulfate, and TDS.

29 Searles Valley Groundwater Basin was designated by the CASGEM program as
30 very low priority.

31 *Cuddeback Valley, Pilot Knob Valley, Grass Valley, and Superior Valley,*
32 *Groundwater Basins*

33 Cuddeback Valley, Pilot Knob Valley, Grass Valley, and Superior Valley
34 Groundwater basins are located in northern San Bernardino County. Water
35 bearing formations consist of unconsolidated to poorly consolidated alluvium
36 (DWR 2004cq, 2004cr, 2004cs, 2004ct). Several fault zones restrict groundwater
37 movement. Groundwater is recharged in the Cuddeback Valley, Pilot Knob
38 Valley, Grass Valley, and Superior Valley groundwater basins primarily through
39 groundwater inflow into the basins and percolation of precipitation at the valley
40 margins. Groundwater within Cuddeback Valley, Grass Valley, and Superior
41 Valley groundwater basins flows towards the Harper Valley Groundwater Basin.
42 Groundwater in the Cuddeback Valley Groundwater Basin also flows towards
43 Cuddeback Lake. Groundwater in Pilot Knob Valley Groundwater Basin flows

1 towards the Searles Valley and Brown Mountain Valley groundwater basins.
2 Groundwater quality is characterized as sodium chloride-bicarbonate with high
3 salinity and TDS in the Cuddeback Valley Groundwater Basin and high
4 concentrations of sodium and fluoride in the Superior Valley Groundwater Basin.
5 Cuddeback Valley, Pilot Knob Valley, Grass Valley, and Superior Valley
6 groundwater basins were designated by the CASGEM program as very low
7 priority.

8 *Harper Valley Groundwater Basin*

9 Harper Valley Groundwater Basin is located in western San Bernardino County
10 and eastern Kern County. Water bearing formations consist of lacustrine deposits
11 and unconsolidated to semi-consolidated alluvial deposits (DWR 2004cu). The
12 alluvial deposits at the center of the basin is generally more interbedded with
13 lacustrine silty clay. Faults in the Harper Valley Groundwater Basin cause at least
14 partial barriers to groundwater flow. Groundwater is recharged from percolation
15 of rainfall and runoff through alluvial fan material at the valley edges and
16 underflow from Cuddeback Valley, Grass Valley, Superior Valley, and Middle
17 Mojave River Valley groundwater basins. Regional groundwater flows toward
18 the south and Harper Lake. Groundwater quality is characterized as sodium
19 chloride-bicarbonate with high concentrations of boron, fluoride, and sodium.
20 Harper Valley Groundwater Basin was designated by the CASGEM program as
21 low priority.

22 *Fremont Valley Groundwater Basin*

23 The Fremont Valley Groundwater Basin is located in eastern Kern County and in
24 northwestern San Bernardino County. Water bearing formations consist of
25 alluvial and lacustrine deposits (DWR 2004cv). The alluvial deposits are
26 generally unconfined and the lacustrine deposits may exhibit locally confined
27 conditions. Fault zones, including the Garlock and El Paso fault zones, are
28 barriers to groundwater flow. Groundwater is recharged along streambeds in the
29 Sierra Nevada Mountains. Groundwater flow is generally toward the center of the
30 valley and Koehn Lake. Groundwater is characterized as sodium bicarbonate
31 with high concentrations of calcium, chloride, fluoride, and sodium.

32 Fremont Valley Groundwater Basin was designated by the CASGEM program as
33 low priority.

34 *Antelope Valley Groundwater Basin*

35 The Antelope Valley Groundwater Basin is located in Kern, Los Angeles, and San
36 Bernardino counties. Water bearing formations consist of unconsolidated alluvial
37 and lacustrine deposits consisting of compact gravels, sand, silt, and clay (DWR
38 2004cw). Several fault zones restrict groundwater movement. Groundwater is
39 recharged along streams from the surrounding mountains, including Big Rock
40 Creek and Little Rock Creek. The regional groundwater flow direction
41 historically was towards the dry lakebeds of Rosamond, Rogers, and Buckhorn
42 Lakes. However, extensive groundwater pumping has caused subsidence and
43 reduced the groundwater storage and flow direction. The groundwater is

1 characterized as sodium bicarbonate with localized areas of high nitrate and
2 boron.

3 Antelope Valley Groundwater Basin was designated by the CASGEM program as
4 high priority.

5 *El Mirage Valley Groundwater Basin*

6 The El Mirage Valley Groundwater Basin is located in San Bernardino County.
7 Water bearing formations consist of unconsolidated to semi-consolidated
8 alluvium (DWR 2003c). Several fault zones restrict groundwater movement.
9 Groundwater is recharged in alluvial deposits at the mouth of Sheep Creek. The
10 regional groundwater flow directions is generally north toward El Mirage Lake.
11 The groundwater is characterized as sodium bicarbonate with localized areas of
12 high levels of fluoride, sulfate, sodium, and TDS.

13 El Mirage Valley Groundwater Basin was designated by the CASGEM program
14 as medium priority.

15 *Upper Mojave River Valley, Middle Mojave River Valley, Lower Mojave River*
16 *Valley, and Caves Canyon Valley Groundwater Basins*

17 The Upper Mojave River Valley, Middle Mojave River Valley, Lower Mojave
18 River Valley, and Caves Canyon Valley groundwater basins are located along the
19 Mojave River in southwestern and central San Bernardino County. The water
20 bearing formations consist of alluvial fan deposits overlain by river channel,
21 floodplain, or lake deposits (DWR 2004cx, 2004cy, 2003d, 2003e). The general
22 groundwater flow direction follows the Mojave River north through the Upper
23 Mojave River Valley Groundwater Basin, and east through the Middle Mojave
24 River Valley, Lower Mojave River Valley, and Caves Canyon Valley
25 groundwater basins. Several fault zones restrict groundwater movement.
26 Groundwater is recharged from precipitation on the valley floor, underflow from
27 the Mojave River, streamflow, and flow between the basins. Treated wastewater
28 and irrigation return flows also provide a source of groundwater recharge in these
29 basins. Groundwater quality in the Upper Mojave River Valley, Middle Mojave
30 River Valley, Lower Mojave River Valley, and Caves Canyon Valley
31 groundwater basins varies throughout the basins due to geological formations and
32 includes areas dominated by calcium bicarbonate, calcium-sodium bicarbonate,
33 calcium-sodium sulfate, sodium-calcium sulfate, and sodium sulfate-chloride.
34 There are localized areas of high nitrate, iron, and manganese in the Upper
35 Mojave River Valley Groundwater Basin; and areas with high nitrates, fluoride,
36 and boron in the Middle Mojave River Valley and Lower Mojave River Valley
37 groundwater basins. Localized areas with high volatile organic compounds occur
38 in the Upper Mojave River Valley and Lower Mojave River Valley groundwater
39 basins.

40 Upper Mojave River Valley Groundwater Basin was designated by the CASGEM
41 program as high priority. Lower Mojave River Valley Groundwater Basin was
42 designated as medium priority. Middle Mojave River Valley Groundwater Basin
43 was designated as low priority. Caves Canyon Valley Groundwater Basin was
44 designated as very low priority.

1 *Langford Valley Groundwater–Langford Well Lake Subbasin, and Cronise Valley*
2 *and Coyote Lake Valley Groundwater Basins*

3 The Langford Well Lake subbasin and the Cronise Valley and Coyote Lake
4 Valley groundwater basins are located in central San Bernardino County. Water
5 bearing formations consist of unconsolidated to semi-consolidated alluvium
6 (DWR 2004cz, 2004da, 2004db). Groundwater is recharged from precipitation,
7 stream flows into alluvial deposits along the mountains at the basin boundaries,
8 and subsurface inflow from other groundwater basins including the Superior
9 Valley Groundwater Basin. Groundwater quality is poor due to high
10 concentrations of fluoride, boron, and TDS, and localized areas with high iron in
11 the Langford Well Lake subbasin.

12 Langford Well Lake subbasin and the Cronise Valley and Coyote Lake Valley
13 groundwater basins were designated by the CASGEM program as very low
14 priority.

15 *Kane Wash Area Groundwater Basin*

16 The Kane Wash Area Groundwater Basin is located in San Bernardino County.
17 Water bearing formations consist of unconsolidated to semi-consolidated
18 alluvium with undissected coarse gravel to sand in the younger deposits and
19 dissected gravel sand and silt in the older deposits (DWR 2004dc). Groundwater
20 is recharged from precipitation and stream flows. The groundwater is
21 characterized as sodium sulfate-bicarbonate with moderate TDS concentrations.

22 Kane Wash Area Groundwater Basin was designated by the CASGEM program
23 as very low priority.

24 *Iron Ridge Area Groundwater Basin*

25 The Iron Ridge Area Groundwater Basin is located in southern San Bernardino
26 County. Water bearing formations consist of unconsolidated to semi-consolidated
27 alluvium (DWR 2004dd). Several fault zones restrict groundwater movement.
28 Groundwater is recharged from precipitation and stream flows from the nearby
29 mountains.

30 Iron Ridge Area Groundwater Basin was designated by the CASGEM program as
31 very low priority.

32 *Bessemer Valley Groundwater Basin*

33 The Bessemer Valley Groundwater Basin is located in eastern San Bernardino
34 County. Water bearing formations consist of unconsolidated to semi-consolidated
35 alluvial deposits, fanglomerate, and playa lake deposits (DWR 2004de). More
36 recent deposits consist of unconsolidated, undissected coarse gravel to sand.
37 Older deposits consist of gravel, sand, and silt from dissected alluvial fans.
38 Several fault zones restrict groundwater movement. Groundwater is recharged
39 from precipitation and stream flows at the valley margins.

40 Bessemer Valley Groundwater Basin was designated by the CASGEM program
41 as very low priority.

1 *Lucerne Valley Groundwater Basin*

2 The Lucerne Valley Groundwater basin is located in San Bernardino County.
3 Water bearing formations consist of unconsolidated or semi-consolidated alluvial
4 deposits and dune sand deposits composed of gravel, sand, silt, clay, and
5 occasional boulders (DWR 2004df). Several fault zones restrict groundwater
6 movement. Groundwater is recharged from precipitation and stream flows.
7 Groundwater levels have declined throughout the basin and caused subsidence.
8 The groundwater is characterized as calcium-magnesium bicarbonate or
9 magnesium-sodium sulfate with TDS and nitrates.

10 Lucerne Valley Groundwater Basin was designated by the CASGEM program
11 low priority.

12 *Johnson Valley Groundwater Basin*

13 The Johnson Valley Groundwater Basin is located in San Bernardino County and
14 includes the Soggy Lake and Upper Johnson Valley subbasins. Water bearing
15 formations in both subbasins consist of alluvial deposits with mainly sand and
16 gravel in the Soggy Lake subbasin and silt, clay, sand, and gravel in the Upper
17 Johnson Valley subbasin (DWR 2004dg, 2004dh). Springs occur throughout the
18 Soggy Lake subbasin. Groundwater flows from Soggy Lake subbasin into the
19 Upper Johnson Valley subbasin. Several fault zones restrict groundwater
20 movement. The groundwater is characterized with moderate to high TDS and
21 localized areas with high fluoride.

22 Johnson Valley Groundwater Basin was designated by the CASGEM program as
23 very low priority.

24 *Means Valley Groundwater Basin*

25 The Means Valley Groundwater Basin is located in south central part of San
26 Bernardino County. Water bearing formations consist of alluvial and lacustrine
27 deposits with unconsolidated fine to coarse grained sand, pebbles, and boulders;
28 and varying silt and clay deposits throughout the basin (DWR 2004di). Several
29 fault zones restrict groundwater movement. Groundwater is recharged from
30 precipitation and subsurface inflow from the Johnson Valley Groundwater Basin.
31 The groundwater is characterized as sodium-chloride bicarbonate with high TDS,
32 fluoride, and nitrates.

33 Means Valley Groundwater Basin was designated by the CASGEM program as
34 very low priority.

35 *Deadman Valley Groundwater Basin*

36 The Deadman Valley Groundwater Basin is located in San Bernardino County.
37 The Deadman Valley Groundwater Basin includes the Deadman Lake and
38 Surprise Spring subbasins. Water bearing formations consist of unconsolidated to
39 partly consolidated continental deposits including interbedded gravels,
40 conglomerates, clays, and silts in alluvial fan units (DWR 2004dj, 2004dk).
41 Several fault zones restrict groundwater movement. Groundwater is recharged
42 from precipitation and stream flows. Groundwater flows from the Surprise Spring
43 subbasin into the Deadman Lake subbasin, and from Deadman Lake subbasin to

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1 the dry Mesquite Lake. Groundwater also flows from the Ames Valley
2 Groundwater Basin into the Surprise Spring subbasin. The groundwater is
3 characterized as sodium bicarbonate with moderate to high TDS and localized
4 areas of high fluoride.

5 Deadman Valley Groundwater Basin was designated by the CASGEM program as
6 very low priority.

7 *Twentynine Palms Valley, Joshua Tree, Ames Valley, Copper Mountain Valley,*
8 *and Warren Valley Groundwater Basins*

9 The Twentynine Palms Valley, Ames Valley, and Copper Mountain Valley
10 groundwater basins are located in southern San Bernardino County. The Joshua
11 Tree and Warren Valley groundwater basins are located in southern San
12 Bernardino County and northern Riverside County. Water bearing formations
13 consist of unconfined, unconsolidated to partly consolidated continental deposits
14 with interbedded gravels, conglomerates, lake playa, silts, clays, and sandy-clay
15 deposits (DWR 2004di, 2004dj, 2004dk, 2004dl, 2004dm). Several fault zones
16 restrict groundwater movement. Groundwater is recharged from precipitation,
17 stream flows, and wastewater effluent disposal. Groundwater flows from the
18 Joshua Tree Groundwater Basin into the Copper Mountain Valley Groundwater
19 Basin. Groundwater recharge in the Warren Valley Groundwater Basin also
20 occurs at spreading grounds. The groundwater is characterized as calcium-
21 sodium bicarbonate or sodium sulfate with moderate to high TDS in all of the
22 basins except the Copper Mountain Valley Groundwater Basin; and localized
23 areas with high fluoride, nitrate, sulfate, and chloride.

24 Warren Valley Groundwater Basin was designated by the CASGEM program as
25 medium priority. Twentynine Palms Valley was designated as low priority.
26 Joshua Tree, Ames, and Copper Mountain Valley groundwater basins were
27 designated as very low priority.

28 *Morongo Valley Groundwater Basin*

29 The Morongo Valley Groundwater basin is located in southern San Bernardino
30 County. Water bearing formations consist of alluvial deposits composed of sand,
31 gravel, silt, and clay (DWR 2003f). Several fault zones restrict groundwater
32 movement. Groundwater is recharged from precipitation and stream flows in the
33 Big Morongo and Little Morongo creeks. The groundwater is characterized as
34 calcium-sodium bicarbonate with moderate TDS.

35 Morongo Valley Groundwater Basin was designated by the CASGEM program as
36 very low priority.

37 *Lost Horse Valley Groundwater Basin*

38 The Lost Horse Valley Groundwater Basin is located on the border between
39 southeastern San Bernardino County and northeastern Riverside County. Water
40 bearing formations consist of unconsolidated to semi-consolidated alluvial
41 deposits (DWR 2004dn). Groundwater is recharged from precipitation and
42 stream flows.

1 Lost Horse Valley Groundwater Basin was designated by the CASGEM program
2 as very low priority.

3 **7.3.6.6.2 Groundwater Use and Management**

4 Within the Antelope Valley and Mojave Valley, groundwater management is
5 facilitated by the Antelope Valley-East Kern Water Agency and Mojave Water
6 Agency. These agencies purchase SWP water and other water supplies to be used
7 for groundwater recharge or in-lieu uses to protect groundwater within the
8 Antelope and Mojave valleys.

9 *Antelope Valley*

10 The Antelope Valley-East Kern Water Agency (AVEK) provides SWP water to
11 areas that overlay portions of the Antelope Valley, Fremont Valley, and Indian
12 Wells Valley groundwater basins. To maintain groundwater aquifers in the area,
13 the AVEK provides treated SWP water to users through the Domestic-
14 Agricultural Water Network and untreated SWP water to some agricultural users
15 (AVEK 2011a). The AVEK participates in groundwater banking programs.
16 Communities within the AVEK service area also use groundwater, including the
17 cities of California City, Lancaster, and Palmdale; Edwards Air Force Base;
18 County of Los Angeles Waterworks District No. 40; Boron Community Services
19 District, Desert Lake Community Services District, Indian Wells Water District
20 (including the City of Ridgecrest), Mojave Public Utilities District, Palmdale
21 Water District, Palm Ranch Irrigation District, Quartz Hill Water District, and
22 Rosamond Community Services District; and California Water Service Company
23 (Antelope Valley, Lake Hughes, areas outside of the City of Lancaster, and Leona
24 Valley), Edgemont Crest Municipal Water Company, El Dorado Mutual Water
25 Company, Lake Elizabeth Mutual Water Company, Shadow Acres Mutual Water
26 Company, Sunnyside Farm Mutual Water Company, Westside Park Mutual Water
27 Company, and White Fence Farms Mutual Water Company provide retail
28 groundwater supplies (AVEK 2011a; AVRWC 2011; California Water Service
29 Company 2011f; City of California City 2013; IWVWD 2011; Los Angeles
30 County et al. 2011; PWD 2011; Rosamond CSD 2011).

31 In 2004, the County of Los Angeles Waterworks District No. 40 and Palmdale
32 Water District filed for the adjudication of the Antelope Valley Groundwater
33 Basin (DWR 2014a; Los Angeles County et al. 2011; PWD 2011). The request of
34 the filing is to allocate groundwater rights within the basin to these districts, other
35 municipal and industrial water users, and Overlying Landowners and provide for
36 a program to replace groundwater withdrawals in excess of a specified yield in
37 order to stabilize or reverse groundwater declines.

38 *Mojave Valley*

39 Within the Mojave Water Agency service area, most of the water supply is from
40 groundwater (AVRWC 2011; City of Adelanto 2011; Golden State Water
41 Company 2011k; HDWD 2011; Hesperia Water District 2011; JBWD 2011;
42 MWA 2011; PPHCSD 2011; San Bernardino County 2012; TPWD 2014;
43 Victorville Water District 2011). The Mojave Water Agency uses natural surface
44 water flows, recycled water imported from outside of the agency's service area,

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1 SWP water, and return flows from water users of groundwater within the service
2 area to recharge groundwater. These water supplies are provided as wholesale
3 water supplies to retail groundwater users to maintain groundwater levels in the
4 area. The Mojave Water Agency overlays all or portions of all of the
5 groundwater basins described in this subsection. The City of Adelanto; Hesperia
6 Water District, Hi-Desert Water District, Joshua Water District, Twentynine
7 Palms Water District, Victorville Water District, Apple Foothill County Water
8 District, Apple Heights County Water District, Juniper Riviera County Water
9 District, Thunderbird County Water District, Daggett Community Services
10 District, Helendale Community Services District, Phelan Piñon Hills Community
11 Services District, Yermo Community Services District, Bighorn-Desert View
12 Water Agency, and San Bernardino County Service Areas numbers 64 and 70;
13 and Golden State Water Company, Apple Valley Ranchos Water Company,
14 Jubilee Water Company, and Rancharitos Mutual Water Company provide retail
15 groundwater supplies. These entities provide water to the cities of Adelanto,
16 Barstow, Hesperia, Twentynine Palms, Victorville; towns of Apple Valley and
17 Yucca; Joshua Tree National Park; Twentynine Palms Marine Corps Base; and
18 the communities of Apple Heights, Apple Valley, Daggett, Flamingo Heights,
19 Helendale, Johnson Valley, Landers, Lucerne Valley, Newberry Springs, Oak
20 Hills, Spring Valley Lake, Yermo, and users between these communities. The
21 Morongo Band of Mission Indians also rely upon groundwater from this area.

22 The Mojave Water Agency has implemented 13 groundwater recharge facilities
23 (MWA 2011). The SWP water is delivered to the recharge facilities throughout
24 the Mojave Water Agency service area.

25 The area known as the Mojave Basin Area has been adjudicated. This area
26 includes all or portions of Cuddeback Valley, Superior Valley, Harper Valley,
27 Antelope Valley, El Mirage Valley, Upper Mojave River Valley, Middle Mojave
28 River Valley, Lower Mojave River Valley, Caves Canyon Valley, Langford
29 Valley, Cronise Valley, Coyote Lake Valley, Kane Wash Area, Iron Ridge Area,
30 Lucerne Valley, and Johnson Valley groundwater basins (Golden State Water
31 Company 2011k; MWA 2011). The Mojave Basin Judgment allocated
32 groundwater withdrawals in the area and required groundwater users that
33 withdraw more than the allocated amount to purchase replenishment SWP water
34 from the Watermaster or from another entity within the judgment. The judgment
35 considers local surface water sources, including groundwater recharge near
36 Hesperia with treated wastewater effluent from Lake Arrowhead Community
37 Services District (LACSD 2011). The judgment also provides for carry over
38 storage between water years. The Mojave Water Agency has been appointed as
39 the Watermaster.

40 The Warren Valley Groundwater Basin was adjudicated in 1977 (MWA 2011).
41 The Hi-Desert Water District was appointed as the Watermaster to manage
42 groundwater withdrawals and groundwater quality; to provide SWP water,
43 captured stormwater, and recycled water; and to encourage conservation.

1 In 1991, the Bighorn-Desert Water Agency and the Hi-Desert Water District
2 agreed to the court approved Ames Valley Basin Water Management Agreement.
3 In accordance with this agreement, the Hi-Desert Water District implemented the
4 Mainstream Wells and expansion to conveyance and monitoring approaches.

5 **7.4 Impact Analysis**

6 This section describes the potential mechanisms and analytical methods for
7 change in groundwater resources, results of the impact analysis, potential
8 mitigation measures, and cumulative effects.

9 **7.4.1 Potential Mechanisms for Change and Analytical Methods**

10 As described in Chapter 4, Approach to Environmental Analysis, the impact
11 analysis considers changes in groundwater conditions related to changes in CVP
12 and SWP operations under the alternatives as compared to the No Action
13 Alternative and Second Basis of Comparison.

14 **7.4.1.1 Changes in Groundwater Use and Groundwater Levels**

15 Changes in availability of CVP and SWP water supplies could result in changes in
16 groundwater use. For example, if CVP and SWP water supplies are decreased,
17 water users may increase the amount of groundwater withdrawals in response.

18 As previously described in Section 7.2.3, Sustainable Groundwater Management
19 Act, most groundwater users in California must develop Groundwater
20 Sustainability Plans (GSPs) by 2020 or 2022, and meet the sustainable goal within
21 20 years after adoption of the plan. This EIS analysis assumes that groundwater
22 users have developed the GSPs by 2030, and have begun to plan, design, and
23 possibly construct alternative water supply facilities or implement water
24 conservation measures to achieve full compliance by 2042. However, this EIS
25 analysis assumes that the new facilities or conservation measures are not
26 implemented by 2030. Therefore, reductions in groundwater use in accordance
27 with the SGMA are not anticipated until after 2030 and are analyzed under the
28 Cumulative Effects analysis.

29 Changes in groundwater use by users of or providers to CVP and SWP water
30 supplies could result in changes in groundwater storage and groundwater levels.
31 For example, if CVP and SWP water supplies are decreased and water users
32 increase the amount of groundwater withdrawals, groundwater levels could
33 decline. Changes in groundwater levels resulting in levels declining could result
34 in a decrease in well yields. Changes in groundwater levels also could result in
35 different groundwater pumping costs, as analyzed in Chapter 12, Agricultural
36 Resources, and Chapter 14, Socioeconomics, for agricultural and municipal water
37 users of CVP and SWP water supplies, respectively

1 **7.4.1.1.1 Use of Central Valley Hydrologic Model**

2 There are many groundwater models that have been developed for portions of the
3 Central Valley. However, most of these models were not developed in a manner
4 that would allow for analysis of groundwater changes throughout the Central
5 Valley which includes the majority of CVP and SWP agricultural water users. As
6 described in Appendix 7A, Groundwater Model Documentation, changes in
7 groundwater use, and levels in the Central Valley have been evaluated using the
8 Central Valley Hydrologic Model (CVHM) because this model is readily
9 available and covers the entire Central Valley. CVHM is a regional-scale
10 calibrated historical finite-difference, block-centered saturated groundwater flow
11 model application developed by the USGS and uses the MODFLOW-2000
12 computer code (USGS 2000b). The CVHM model spans a 42-year simulation
13 period between water years 1962 and 2003.

14 CVHM is used to estimate the changes in groundwater levels and groundwater
15 withdrawals under the alternatives as compared to the No Action Alternative and
16 Second Basis of Comparison. CVHM model output is also used as input files of
17 the State Wide Agricultural Production (SWAP) model to simulate agricultural
18 production changes based on groundwater pumping costs, as described in
19 Chapter 12, Agricultural Resources.

20 The CVHM domain is subdivided into 21 WBSs, as summarized in Figure 7.14
21 (USGS 2009). Applied water requirements for each WBS are computed based on
22 crop type and available water from precipitation, shallow groundwater uptake,
23 and surface water, as limited by surface water rights and CVP and SWP water
24 supply deliveries.

25 CVHM simulates primarily subsurface and limited surface hydrologic processes
26 over the entire Central Valley at a uniform grid-cell spacing of 1 mile. Boundary
27 conditions were modified to reflect anticipated changes in surface water
28 availability, including the effects of climate change.

29 Surface water inflows from the CalSim II model were used to define boundary
30 conditions for CVHM for each alternative and the Second Basis of Comparison.
31 The CalSim II model simulates the operation of the major SWP and CVP
32 facilities in the Central Valley by calculating river flows; and CVP and SWP
33 reservoir storage, exports, and deliveries (see Appendix 5A for more details on
34 CalSim II). The CalSim II outputs are included in the CVHM input files.

35 Changes in agricultural groundwater pumping under the alternatives are compared
36 to groundwater pumping under the No Action Alternative and Second Basis of
37 Comparison. The data for these results were processed from the FMP output
38 files, which include the amount of water used from each available source by the
39 farm, based on the computed crop water demand for each WBS.

40 For the analyses presented in this chapter, changes in groundwater use, elevation,
41 and pumping volumes between the alternatives, No Action Alternative, and
42 Second Basis of Comparison are described for agricultural water users only in the
43 Central Valley Region.

1 **7.4.1.1.2 Analysis of Changes in Municipal and Industrial**
2 **Groundwater Use**

3 Due to the regional scale of the CVHM model, municipal and industrial
4 groundwater use is a very small portion of total groundwater use due to the
5 predominance of agricultural groundwater use. Therefore, in the CVHM model,
6 municipal and industrial groundwater use in the Central Valley was assumed to
7 continue at the 2003 calibrated volume throughout the predictive simulations.

8 For municipal and industrial groundwater use in the Central Valley, the CWEST
9 model is a more appropriate model than CVHM. The CWEST model evaluates
10 total water use by municipal and industrial water users in the Central Valley, San
11 Francisco Bay Area, Central Coast, and Southern California regions based upon
12 economic decisions.

13 It is recognized that municipal and industrial pumping in urban areas in the
14 Central Valley could cause localized impacts to groundwater levels from
15 increased drawdown. The increased withdrawals could also impact groundwater
16 quality due to the migration of existing plumes, as described in the Affected
17 Environment section.

18 **7.4.1.1.3 Analysis of Changes in Agricultural Groundwater Use Outside of**
19 **the Central Valley Region**

20 Agricultural groundwater use by CVP and SWP water users located outside of the
21 Central Valley primarily occurs in Santa Clara and San Benito counties in the San
22 Francisco Bay Area Region; San Luis Obispo and Santa Barbara counties in the
23 Central Coast Region; and Ventura, Orange, San Bernardino, and Riverside
24 counties in the Southern California Region. Groundwater management plans or
25 basin adjudication programs in many portions of these counties will minimize
26 changes in groundwater use and levels as a result of changes in CVP and SWP
27 water supplies. There are no regional models that uniformly analyze groundwater
28 use and elevation in these areas in a similar manner as CVHM in the Central
29 Valley. Therefore, changes in groundwater use and related changes in
30 groundwater levels are assumed to be related to availability of CVP and SWP
31 water supplies. However, due to the implementation of groundwater management
32 plans or adjudicated basin requirements in many groundwater basins, increase in
33 CVP and SWP water supplies could result in a decrease in groundwater use.
34 Similarly, a decrease in CVP and SWP water supplies could result in a short-term
35 increase in groundwater use; however, due to groundwater use restrictions in the
36 groundwater management plans or adjudicated basin requirements, long-term
37 groundwater use is assumed to not increase. Therefore, agricultural production
38 could decrease if CVP and SWP water supplies decrease.

39 **7.4.1.2 Changes in Land Subsidence**

40 Extensive groundwater withdrawals from confined and unconfined aquifers
41 increases the potential for land subsidence. In aquifers with clay and silt lenses,
42 decreased groundwater levels can result in compaction of fine-grained deposits
43 which could lead to irreversible land subsidence. Subsidence could result in
44 structural damage to roads, railroad tracks, pipelines and associated structures,

1 drainage, buildings, and wells. Subsidence can also result in the permanent loss
2 of groundwater storage potential within an aquifer system.

3 Subsidence is related to changes in groundwater levels; and a review of simulated
4 changes in groundwater elevation output from the CVHM model as compared
5 between alternatives is used to provide an indication of the potential occurrence of
6 subsidence.

7 CVHM includes a module known as the SUB package that computes the
8 cumulative compaction of each model layer during the model simulation. The
9 cumulative layer compactations at the end of the simulation are summed into a total
10 subsidence. However, this version of the SUB package does not consider the
11 potential reduction in the rate of subsidence that would occur as the magnitude of
12 compaction approaches the physical thickness of the affected fine-grained
13 interbeds. Thus, subsidence forecasts from the predictive versions of CVHM
14 were judged to be overly conservative. Therefore, a qualitative approach was
15 used for the estimation of the potential for increased land subsidence in areas of
16 the Central Valley that have historically experienced inelastic subsidence due to
17 the compaction of fine-grained interbeds.

18 Potential changes in subsidence due to changes in municipal and industrial
19 groundwater use were qualitatively analyzed for regions with historic or existing
20 subsidence issues, such as in Santa Clara County in the San Francisco Bay Area
21 Region.

22 **7.4.1.3 Changes in Groundwater Quality**

23 Changes in groundwater quality could occur in several ways under
24 implementation of the alternatives as compared to the No Action Alternative and
25 Second Basis of Comparison. Reductions in groundwater levels could change
26 groundwater flow directions, potentially causing poorer quality groundwater to
27 migrate into areas with higher quality groundwater, or cause intrusion of poor
28 water quality (e.g. from aquitards) as water levels decline.

29 Groundwater quality also could change due to changes in availability of CVP
30 and/or SWP water supplies used by agricultural water users. For example, if
31 reductions in CVP and/or SWP water supplies result in increased use of
32 groundwater with higher salinity than CVP and/or SWP supplies, shallow
33 groundwater could become more saline and soil salinity could increase, as
34 described in Chapter 11, Geology and Soils.

35 Changes in groundwater quality due to changes in CVP and SWP water supply
36 availability could occur under the following mechanisms:

- 37 • Migration of reduced quality groundwater towards areas of groundwater
38 withdrawals, including seawater intrusion and migration of contaminant
39 plumes
- 40 • Depletion of the freshwater aquifer that overlays poorer quality groundwater,
41 and the upwelling of the poorer quality groundwater into the upper aquifers

- 1 • Percolation of applied water with poorer water quality than underlying
2 groundwater
- 3 Within the Central Valley, changes in groundwater use and groundwater flow
4 direction are analyzed using the CVHM. The model does not directly simulate
5 changes in groundwater quality. However, in regions with existing poorer quality
6 groundwater, changes in groundwater levels or flow directions can be used to
7 evaluate potential impacts to groundwater quality. For example, declines in
8 groundwater levels that result in seawater intrusion, or the migration of good
9 quality groundwater into areas with poor quality can result in groundwater quality
10 degradation. Further, reduction in groundwater quality could also occur due to
11 migration or upwelling of poorer quality groundwater into areas with good quality
12 groundwater.
- 13 Long-term use of poorer quality groundwater due to changes in CVP and SWP
14 water supplies could also result in a reduction in shallow aquifer groundwater
15 quality. Application of poorer quality groundwater also could increase soil
16 salinity, as described in Chapter 11, Geology and Soils Resources.

17 **7.4.1.4 Effects Related to Water Transfers**

- 18 Historically water transfer programs have been developed on an annual basis.
- 19 The demand for water transfers is dependent upon the availability of water
20 supplies to meet water demands. Water transfer transactions have increased over
21 time as CVP and SWP water supply availability has decreased, especially during
22 drier water years.
- 23 Parties seeking water transfers generally acquire water from sellers who have
24 available surface water who can make the water available through releasing
25 previously stored water, pump groundwater instead of using surface water
26 (groundwater substitution); idle crops; or substitute crops that uses less water in
27 order to reduce normal consumptive use of surface water.
- 28 Water transfers using CVP and SWP Delta pumping plants and south of Delta
29 canals generally occur when there is unused capacity in these facilities. These
30 conditions generally occur drier water year types when the flows from upstream
31 reservoirs plus unregulated flows are adequate to meet the Sacramento Valley
32 water demands and the CVP and SWP export allocations. In non-wet years, the
33 CVP and SWP water allocations would be less than full contract amounts;
34 therefore, capacity may be available in the CVP and SWP conveyance facilities to
35 move water from other sources.
- 36 Projecting future groundwater conditions related to water transfer activities is
37 difficult because specific water transfer actions required to make the water
38 available, convey the water, and/or use the water would change each year due to
39 changing hydrological conditions, CVP and SWP water availability, specific local
40 agency operations, and local cropping patterns. Reclamation recently prepared a
41 long-term regional water transfer environmental document which evaluated
42 potential changes in surface water conditions related to water transfer actions
43 (Reclamation 2014c). Results from this analysis were used to inform the impact

1 assessment of potential effects of water transfers under the alternatives as
2 compared to the No Action Alternative and the Second Basis of Comparison.

3 **7.4.2 Conditions in Year 2030 without implementation of** 4 **Alternatives 1 through 5**

5 The impact analysis in this EIS is based upon the comparison of the alternatives to
6 the No Action Alternative and the Second Basis of Comparison in the Year 2030.
7 Changes that would occur over the next 15 years without implementation of the
8 alternatives are not analyzed in this EIS. However, the changes that are assumed
9 to occur by 2030 under the No Action Alternative and the Second Basis of
10 Comparison are summarized in this section. Many of the changed conditions
11 would occur in the same manner under both the No Action Alternative and the
12 Second Basis of Comparison.

13 This section of Chapter 7 provides qualitative projections of the No Action
14 Alternative as compared to existing conditions described under the Affected
15 Environment; and qualitative projections of the Second Basis of Comparison as
16 compared to “recent historical conditions.” Recent historical conditions are not
17 the same as existing conditions which include implementation of the
18 2008 U.S. Fish and Wildlife Service (USFWS) biological opinion (BO) and 2009
19 National Marine Fisheries Service (NMFS) BO; and consider changes that would
20 have occurred without implementation of the 2008 USFWS BO and the 2009
21 NMFS BO.

22 **7.4.2.1 Common Changes in Conditions under the No Action** 23 **Alternative and Second Basis of Comparison**

24 Conditions in 2030 would be different than existing conditions due to:

- 25 • Climate change and sea-level rise
- 26 • General plan development throughout California, including increased water
27 demands in portions of Sacramento Valley
- 28 • Implementation of reasonable and foreseeable water resources management
29 projects to provide water supplies

30 These changes would result in a decline of the long-term average CVP and SWP
31 water supply deliveries by 2030 as compared to recent historical long-term
32 average deliveries, as described in Chapter 5, Surface Water Resources and Water
33 Supplies.

34 **7.4.2.1.1 Changes in Conditions due to Climate Change and Sea-Level Rise**

35 It is anticipated that climate change would result in more short-duration high-
36 rainfall events and less snowpack in the winter and early spring months. The
37 reservoirs would be full more frequently by the end of April or May by 2030 than
38 in recent historical conditions. However, as the water is released in the spring,
39 there would be less snowpack to refill the reservoirs. This condition would
40 reduce reservoir storage and available water supplies to downstream uses in the
41 summer. The reduced end of September storage also would reduce the ability to

1 release stored water to downstream regional reservoirs. These conditions would
2 occur for all reservoirs in the California foothills and mountains, including
3 non-CVP and SWP reservoirs.

4 Climate change also would reduce groundwater supplies due to reduced
5 groundwater recharge potential and increased groundwater overdraft potential as
6 surface water supplies decline. However, in some locations, sustainable
7 groundwater supplies could remain similar to recent historical conditions or rise
8 due to implementation of groundwater management plans to reduce groundwater
9 overdraft, including the completion of ongoing groundwater recharge and
10 recovery programs.

11 **7.4.2.1.2 General Plan Development in California**

12 Counties and cities throughout California have adopted general plans which
13 identify land use classifications including those for municipal and industrial uses
14 and those for agricultural uses. Preparation of general plans includes an
15 environmental evaluation under the California Environmental Quality Act to
16 identify adverse impacts to the physical environment and to provide mitigation
17 measures to reduce those impacts to a level of less than significance. Most of the
18 counties where CVP and SWP water supplies are delivered have adopted general
19 plans following the environmental review of the plans and appropriate
20 alternatives. Population projections from those general plan evaluations are
21 provided to the State Department of Finance and are used to project future water
22 needs and the potential for conversion of existing undeveloped lands and
23 agricultural lands. Many of the existing general plans for counties with municipal
24 areas recently have been modified to include land use and population projections
25 through 2030. The No Action Alternative and the Second Basis of Comparison
26 assume that land uses will develop through 2030 in accordance with existing
27 general plans.

28 The assumptions related to 2030 municipal water demands are based upon a
29 review of the 2010 Urban Water Management Plans (UWMPs) prepared by CVP
30 and SWP water users. The No Action Alternative and the Second Basis of
31 Comparison assumptions related to future water supplies presented in the
32 UWMPs were evaluated to determine if the projects were reasonable and certain
33 to occur by 2030. Projects that had undergone environmental review, were under
34 design, or under construction were included in the future water supply
35 assumptions for 2030 in the No Action Alternative and the Second Basis of
36 Comparison. Projects described in the UWMPs that currently were under
37 evaluation were included in the Cumulative Effects analysis for future water
38 supplies.

39 Under the No Action Alternative and Second Basis of Comparison, it is assumed
40 that water demands would be met on a long-term basis and in dry and critical dry
41 years using a combination of conservation, CVP and SWP water supplies, other
42 imported water supplies, groundwater, recycled water, infrastructure
43 improvements, desalination water treatment, and water transfers and exchanges.
44 It is anticipated that individual communities or users could be in a situation that

1 would not allow for affordable water supply options, and that water demands
2 could not be fully met. However, on a regional scale, it is anticipated that water
3 demands would be met.

4 **7.4.2.1.3 Reasonable and Foreseeable Water Resources Management** 5 **Projects**

6 The No Action Alternative and the Second Basis of Comparison assumes
7 completion of water resources management and environmental restoration
8 projects that would have occurred without implementation of the 2008 USFWS
9 BO and 2009 NMFS BO by 2030, as described in Chapter 3, Description of
10 Alternatives. Many of these future actions could affect groundwater conditions
11 and use of groundwater.

12 The No Action Alternative and the Second Basis of Comparison assume that
13 groundwater would continue to be used even if groundwater overdraft conditions
14 continue or become worse. It is recognized that SGMA was enacted in September
15 2014. The SGMA requires the formation of GSPs in groundwater basins or
16 subbasins that DWR designates as medium or high priority based upon
17 groundwater conditions identified using the CASGEM results by 2022.
18 Sustainable groundwater operations must be achieved within 20 years following
19 completion of the GSPs. In some areas with adjudicated groundwater basins,
20 sustainable groundwater management could be achieved and/or maintained by
21 2030. However, to achieve sustainable conditions in many areas, measures could
22 require several years to design and construct water supply facilities to replace
23 groundwater, such as seawater desalination. Therefore, it does not appear to be
24 reasonable and foreseeable that sustainable groundwater management would be
25 achieved by 2030; and it is assumed that groundwater pumping will continue to
26 be used to meet water demands not fulfilled with surface water supplies or other
27 alternative water supplies in 2030.

28 **7.4.2.1.4 Potential Future Groundwater Conditions in 2030 due to** 29 **Common Changes**

30 *Groundwater Conditions*

31 In the Central Valley Region, the combination of increased groundwater
32 withdrawals due to reductions in CVP and SWP water deliveries as compared to
33 recent historical long-term deliveries and reduced groundwater recharge due to
34 climate change could result in continued reductions in groundwater levels in the
35 same manner as recent declines of up to 10 feet in the Sacramento Valley and
36 more than 20 feet in the San Joaquin Valley, as described in Section 7.3.4, Central
37 Valley Region. Under the No Action Alternative and Second Basis of
38 Comparison, groundwater banks and other management programs would continue
39 to be implemented, and possibly expanded, including ongoing groundwater
40 recharge efforts in the Eastern San Joaquin, Kings, Kaweah, and Kern subbasins
41 in the San Joaquin Valley Groundwater Basin. These programs could result in
42 groundwater levels that are similar or higher as compared to recent groundwater
43 conditions. If local agencies fully implement GSPs in accordance with the state

1 SGMA prior to the regulatory deadline, groundwater levels could remain similar
2 to recent conditions or increase.

3 Localized groundwater levels in portions of the Central Valley Region could
4 increase due to seepage in lands adjacent to the ecosystem restoration areas in the
5 Yolo Bypass, Cache Slough, and Suisun Marsh areas depending upon local
6 geological and soil conditions.

7 In the Southern California Region, several SWP water users have purchased
8 transferred water, expanded groundwater storage within their service areas,
9 implemented wastewater recycling and stormwater recycling programs to provide
10 water supplies for groundwater recharge, and participated in groundwater banks
11 outside of their service areas as part of ongoing sustainable groundwater
12 management programs. Under the No Action Alternative and the Second Basis of
13 Comparison, groundwater banks and other management programs would continue
14 to be implemented, and possibly expanded. Several of the programs include
15 expansion of groundwater storage by Kern County and Antelope Valley-East
16 Kern Water Agency; groundwater recharge programs using recycled stormwater
17 by the Los Angeles Department of Water and Power; groundwater recharge
18 programs using recycled wastewater by the Water Replenishment District; and
19 groundwater treatment by City of Oxnard and Western Municipal Water District
20 (AVEK 2011b; City of Los Angeles 2011; City of Oxnard 2013; Reclamation
21 2010b; WMWD 2012; WRD 2015). Expansion of these programs could result in
22 maintenance of groundwater levels in accordance with objectives in the current
23 groundwater management plans even with reduced SWP water supplies under the
24 No Action Alternative and Second Basis of Comparison.

25 *Potential Land Subsidence*

26 Land subsidence due to groundwater withdrawals historically occurred in the
27 Yolo subbasin of the Sacramento Valley Groundwater Basin and Delta-Mendota
28 and Westside subbasins of the San Joaquin Valley Groundwater Basin in the
29 Central Valley Region; Santa Clara Valley Groundwater Basin in the San
30 Francisco Bay Area Region; and the Antelope Valley and Lucerne Valley
31 groundwater basins in the Southern California Region. Under the No Action
32 Alternative, it is anticipated that increased groundwater withdrawals due to
33 reductions in CVP and SWP water supplies and reduced groundwater recharge
34 due to climate change could result in increased irreversible land subsidence in
35 these areas.

36 *Groundwater Quality*

37 *Central Valley Region*

38 As described in Section 7.3, Affected Environment, in the Central Valley, there
39 are localized areas of high salinity related to natural geologic formations and/or
40 historic land uses; high naturally occurring arsenic, calcium, iron, and/or
41 manganese; and high levels of boron, and/or phosphates related to historic land
42 use practices. High concentrations of nitrates due to current anthropogenic
43 sources and legacy sources occur in many locations in the San Joaquin Valley
44 Groundwater Basin, especially in the Eastern San Joaquin, Modesto, Merced,

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1 Kings, Kaweah, Tule, and Tulare Lake subbasins. Under the No Action
2 Alternative, it is anticipated that these conditions would continue to occur; and
3 that groundwater quality could be further degraded due to reduction of
4 groundwater elevation that can cause adjacent poorer quality water to flow
5 towards the groundwater withdrawals.

6 Groundwater quality in the Grasslands Drainage Area and near Mud Slough and
7 the San Joaquin River is anticipated to improve as compared with historic
8 conditions due to the implementation of the Grasslands Bypass project. This
9 program would reduce seepage from unlined canals and capture, treat, and/or
10 reuse drainage flows (Reclamation 2009).

11 In the Tulare Lake Area of the San Joaquin Valley Groundwater Basin (in the
12 Westside, Tulare Lake, Kings, Kaweah, and Tule subbasins within Fresno, Kern,
13 Kings, and Tulare counties) high salinity groundwater occurs in the shallow
14 aquifers due to agricultural drainage issues and naturally occurring high saline
15 soils. Salts are imported into the Tulare Lake Area through the use of CVP and
16 SWP irrigation water supplies and introduced into groundwater from dissolution
17 of salts in the local soil from agricultural land use. Groundwater salinity increases
18 because the Tulare Lake Area is a closed basin.

19 The CV-SALTS program is preparing a Salinity and Nitrate Management Plan for
20 publication in 2016 (CVRWQCB 2015). The plan will include sustainable salt
21 management alternatives, including treatment and salt recovery technologies, such
22 as, reverse osmosis; and related brine disposal/storage options that could range
23 from deep well injection to dedicated disposal locations to conveyance of brine to
24 locations outside of the San Joaquin Valley. This plan also will address current
25 and legacy sources of nitrates; assimilative capacity of the groundwater subbasins
26 and aquifers; drinking water protection measures, including waste discharge
27 requirements from irrigated lands and dairies; and measurable and enforceable
28 milestones that do not disproportionately impact disadvantaged communities; and
29 measures that minimize costs and maximize benefits to the community and water
30 users. The 2015 CV-SALTS work plan projects completion of Central Valley
31 Basin Plan amendments and Water Quality Control Plans for the Sacramento
32 Valley and San Joaquin Valley updates to incorporate recommendations of
33 CV-SALTS by 2018, including source control strategies and real time
34 management strategies (CVRWQCB 2015; SWRCB 2015). The *2015 CV-SALTS*
35 *Annual Report* indicated that structural best management practices would not be
36 fully selected until 2018 and may not be implemented until after 2030
37 (SWRCB 2015). Under the No Action Alternative and Second Basis of
38 Comparison it is assumed that non-structural measures would be implemented by
39 2030 to reduce salinity and nitrate loadings; however, structural improvements
40 that would reduce total groundwater salinity and nitrate concentrations generally
41 would not be implemented. Therefore, water quality under the No Action
42 Alternative and the Second Basis of Comparison is anticipated to be poorer in
43 some portions of the Central Valley than under recent groundwater quality
44 conditions.

1 Poor groundwater quality occurs near urban areas in the Central Valley due to
2 contamination from municipal and industrial land use practices. In many of these
3 areas, groundwater quality improvement programs have been implemented, as
4 described above. However, in many areas, groundwater quality is managed by
5 reducing groundwater drawdown near contaminant plumes to avoid transporting
6 the contaminants into other portions of the aquifer. Under the No Action
7 Alternative and the Second Basis of Comparison, it is assumed that these
8 programs would continue. However, as CVP and SWP water supplies become
9 less available in 2030 as compared to recent conditions, increased reliance on
10 groundwater could cause groundwater contamination of portions of the aquifers
11 near existing wells.

12 *San Francisco Bay Area Region*

13 In the San Francisco Bay Area Region, there are localized areas of moderate to
14 high salinity due to natural geologic formations and/or seawater intrusion near
15 San Francisco Bay. High levels of boron due to natural geologic formations and
16 nitrates related to historic land use practices occur in the Livermore Valley and
17 the Gilroy-Hollister- Valley groundwater basins. Under the No Action
18 Alternative and the Second Basis of Comparison, it is anticipated that these
19 conditions would continue to occur; and that groundwater quality could be further
20 degraded due to reduction of groundwater elevation that can cause adjacent
21 poorer quality water to flow towards the groundwater withdrawals, especially in
22 locations with seawater intrusion near the coast.

23 *Central Coast Region*

24 In the Central Coast Region, there are localized areas of moderate to high salinity
25 due to seawater intrusion near the coast. High levels of iron and manganese due
26 to natural geologic formations and nitrates related to historic land use practices
27 occur in local areas of the Central Coast Region. Under the No Action
28 Alternative and Second Basis of Comparison, it is anticipated that these
29 conditions would continue to occur. Seawater intrusion could increase and further
30 degrade groundwater quality in groundwater adjacent to the coast if groundwater
31 levels decline in the future.

32 *Southern California Region*

33 In the Southern California Region, there are localized areas of moderate to high
34 salinity due to natural geologic formations, percolation of high salinity applied
35 water supplies, and/or seawater intrusion near the coast. High levels of calcium,
36 sulfate, magnesium, iron, manganese, and fluoride due to natural geologic
37 formations, and nitrates and organic compounds related to historic land use
38 practices. Under the No Action Alternative and the Second Basis of Comparison,
39 it is anticipated that these conditions would continue to occur; and that
40 groundwater quality could be further degraded due to reduction of groundwater
41 elevation that can cause adjacent poorer quality water or seawater to flow towards
42 the groundwater withdrawals.

1 **7.4.2.2 Changes in Conditions under the No Action Alternative**

2 Due to the climate change and sea-level rise and increased water demands in the
3 Sacramento Valley, CVP and SWP water deliveries would be less in 2030 than
4 under recent historical conditions. It is anticipated that these reductions in CVP
5 and SWP water availability would result in a greater reliance on groundwater,
6 especially during dry and critical dry year.

7 **7.4.2.3 Changes in Conditions under the Second Basis of Comparison**

8 Due to the climate change and sea-level rise and increased water demands in the
9 Sacramento Valley, CVP and SWP water deliveries would be less in 2030 than
10 under recent historical conditions. It is anticipated that these reductions in CVP
11 and SWP water availability would result in a greater reliance on groundwater,
12 especially during dry and critical dry year. However, as described in Chapter 5,
13 Surface Water Resources and Water Supplies, the availability of CVP and SWP
14 water supplies would be greater under the Second Basis of Comparison as
15 compared to the No Action Alternative because CVP and SWP water operations
16 would not include requirements of the 2008 USFWS BO and 2009 NMFS BO.
17 However, reliance on groundwater in 2030 under the Second Basis of Comparison
18 is anticipated to increase as compared to recent historical conditions due to the
19 climate change and sea-level rise and increased water demands in the
20 Sacramento Valley.

21 **7.4.3 Evaluation of Alternatives**

22 As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1
23 through 5 have been compared to the No Action Alternative; and the No Action
24 Alternative and Alternatives 1 through 5 have been compared to the Second Basis
25 of Comparison.

26 During review of the numerical modeling analyses used in this EIS, an error was
27 determined in the CalSim II model assumptions related to the Stanislaus River
28 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4
29 model runs. Appendix 5C includes a comparison of the CalSim II model run
30 results presented in this chapter and CalSim II model run results with the error
31 corrected. Appendix 5C also includes a discussion of changes in the comparison
32 of groundwater conditions for the following alternative analyses.

- 33 • No Action Alternative compared to the Second Basis of Comparison
- 34 • Alternative 1 compared to the No Action Alternative
- 35 • Alternative 3 compared to the Second Basis of Comparison
- 36 • Alternative 5 compared to the Second Basis of Comparison.

37 **7.4.3.1 No Action Alternative**

38 The No Action Alternative is compared to the Second Basis of Comparison.

39 **7.4.3.1.1 Trinity River Region**

40 Groundwater conditions in the Trinity River Region are not directly related to
41 CVP and SWP water supplies or operations. Therefore, groundwater use, related
42 groundwater levels, potential for land subsidence, and groundwater quality under

1 the No Action Alternative would be the same as under the Second Basis of
2 Comparison.

3 **7.4.3.1.2 Central Valley Region**

4 *Groundwater Use and Elevation*

5 In areas of the Central Valley Region that do not use CVP and SWP water
6 supplies, areas that use CVP water under Sacramento River Exchange Settlement
7 Contracts, and areas that use San Joaquin River Exchange Contracts under the No
8 Action Alternative water supplies would be the same as under the Second Basis of
9 Comparison. Therefore, in these areas of the Central Valley Region, groundwater
10 use and groundwater levels under the No Action Alternative would be the same as
11 under the Second Basis of Comparison.

12 In areas of the Central Valley Region that use CVP water service contract and
13 SWP entitlement contract water supplies, the CVP and SWP water supplies would
14 be less under the No Action Alternative as compared to the Second Basis of
15 Comparison. The differences would result in increased groundwater use and
16 decreased groundwater levels in the San Joaquin Valley Groundwater Basin under
17 the No Action Alternative as compared to the Second Basis of Comparison.
18 Results of CVHM simulations indicate that groundwater levels would be similar
19 in the Redding and Sacramento Valley Groundwater Basins and the northern
20 portion of the San Joaquin Valley Groundwater Basin, as shown in Figures 7.15
21 through 7.19.

22 Groundwater levels decline under the No Action Alternative in the central and
23 southern San Joaquin Valley Groundwater Basin as compared to the Second Basis
24 of Comparison with greater reductions occurring in wet years than in critical dry
25 years. Figures 7.20 and 7.21 present the simulated changes in groundwater levels
26 over the 42-year CVHM study period. Simulated average July agricultural
27 groundwater pumping under the No Action Alternative as compared to the
28 Second Basis of Comparison is presented in Figures 7.22 and 7.23.

29 Overall, under the No Action Alternative as compared to the Second Basis of
30 Comparison, July average groundwater levels decrease approximately 2 to 10 feet
31 in most of the central and southern San Joaquin Valley Groundwater Basin in all
32 water year types. July average groundwater levels decline 10 to 50 feet in the
33 Delta-Mendota, Tulare Lake, and Kern County subbasins; and 100 to over
34 200 feet in the Westside subbasin in all water year types. In critical dry years,
35 groundwater levels decline by up to 200 feet in the Westside subbasin.
36 Groundwater level changes in the Sacramento Valley are forecast to be less than
37 2 feet. The groundwater level change hydrographs show that in the central and
38 southern San Joaquin Valley, groundwater levels can fluctuate up to 200 feet in
39 some areas due to climatic variations under the No Action Alternative compared
40 to the Second Basis of Comparison.

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1 The change in groundwater pumping in the Sacramento Valley would result in
2 similar conditions (less than 5 percent change). Therefore, groundwater pumping
3 in the Sacramento Valley is similar under the No Action Alternative compared to
4 the Second Basis of Comparison.

5 Groundwater pumping in the San Joaquin and Tulare Basins would increase by
6 approximately 8 percent under the No Action Alternative as compared to the
7 Second Basis of Comparison. Figure 7.23 shows that the biggest change in
8 groundwater pumping under the No Action Alternative as compared to the
9 Second Basis of Comparison occurs in the Westside subbasin, with an average
10 July increase close to 40 thousand acre-feet (TAF).

11 *Land Subsidence*

12 Land subsidence due to groundwater withdrawals historically occurred in the
13 Yolo subbasin of the Sacramento Valley Groundwater Basin. CVP and SWP
14 water supplies are not used extensively in this area. The conditions under the No
15 Action Alternative would be similar as conditions under the Second Basis of
16 Comparison.

17 Under the No Action Alternative, potential for land subsidence due to
18 groundwater withdrawals in the Delta-Mendota and Westside subbasins of the
19 San Joaquin Valley Groundwater Basin would increase as compared to the
20 Second Basis of Comparison due to the increased groundwater withdrawals.

21 Groundwater level-induced land subsidence has the highest potential to occur in
22 the San Joaquin Groundwater Basin, based on historical data, if groundwater
23 pumping substantially increases. Under the No Action Alternative, CVP and
24 SWP water supplies are expected to decrease in the San Joaquin Valley as
25 compared to the Second Basis of Comparison. Decreased surface water deliveries
26 could result in an increase in groundwater pumping. The increased groundwater
27 pumping would result in lower groundwater levels, and therefore, the potential for
28 groundwater level-induced land subsidence is increased under the No Action
29 Alternative as compared to the Second Basis of Comparison.

30 *Groundwater Quality*

31 Under the No Action Alternative, groundwater conditions, including groundwater
32 quality, in areas that do not use CVP and SWP water supplies would be the same
33 as under the Second Basis of Comparison.

34 In areas that use CVP and SWP water supplies, groundwater quality under the No
35 Action Alternative could be reduced as compared to the Second Basis of
36 Comparison in the central and southern San Joaquin Valley Groundwater Basin
37 due to increased groundwater withdrawals and resulting potential changes in
38 groundwater flow patterns. As described above, it is assumed that measures
39 implemented in accordance with the CV-SALTS program or future sustainable
40 groundwater management plans implemented in accordance with SGMA would
41 not be fully implemented by 2030. Therefore, groundwater quality could decline
42 under the No Action Alternative as compared to the Second Basis of Comparison.

1 *Effects Related to Cross Delta Water Transfers*

2 Potential effects to groundwater resources could be similar to those identified in a
3 recent environmental analysis conducted by Reclamation for long-term water
4 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c).
5 Potential effects to groundwater were identified as reduced groundwater levels
6 and potentially subsidence in areas that sold water using groundwater substitution
7 practices. The water transfer programs would Because all water transfers would
8 be required to avoid adverse impacts to other water users and biological resources
9 (see Section 3.A.6.3, Transfers), including impacts to other groundwater users, the
10 analysis indicated that water transfers would not result in substantial changes in
11 groundwater because mitigation and monitoring plans would be required. The
12 mitigation measures would require reductions in providing water from
13 groundwater substitutions if the monitoring results indicated substantial declines
14 in groundwater levels. For the purposes of this EIS, it is anticipated that similar
15 conditions would occur during implementation of cross Delta water transfers
16 under the No Action Alternative and the Second Basis of Comparison.

17 Groundwater use in areas that purchase the transferred water could be reduced if
18 additional surface water is provided. However, if the transferred water is used to
19 meet water demands that would not have been met (e.g., crops that had been
20 idled), groundwater conditions would be similar with or without water transfers.

21 Under the No Action Alternative, the timing of cross Delta water transfers would
22 be limited to July through September and include annual volumetric limits, in
23 accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second
24 Basis of Comparison, water could be transferred throughout the year without an
25 annual volumetric limit. Overall, the potential for cross Delta water transfers
26 would be less under the No Action Alternative than under the Second Basis of
27 Comparison.

28 **7.4.3.1.3 San Francisco Bay Area, Central Coast, and Southern** 29 **California Regions**

30 *Groundwater Use and Elevation*

31 Under the No Action Alternative, it is anticipated that CVP and SWP water
32 supplies in the San Francisco Bay Area, Central Coast, and Southern California
33 regions would be reduced as compared to CVP and SWP water supplies under the
34 Second Basis of Comparison, as discussed in Chapter 5, Surface Water Resources
35 and Water Supplies. The reduction in surface water supplies could result in
36 increased groundwater withdrawals, decreased groundwater recharge, and
37 decreased groundwater levels in areas with CVP and SWP water users. It may be
38 legally impossible to extract additional groundwater in adjudicated basins without
39 gaining the permission of watermasters and accounting for groundwater pumping
40 entitlements and various parties under their adjudicated rights.

1 *Land Subsidence*

2 Increased use of groundwater and reductions in groundwater levels would result
3 in an increased potential for additional land subsidence under the No Action
4 Alternative as compared to the Second Basis of Comparison in the Santa Clara
5 Valley Groundwater Basin in the San Francisco Bay Area Region, and the
6 Antelope Valley and Lucerne Valley groundwater basins in the Southern
7 California Region.

8 *Groundwater Quality*

9 As described in Section 7.3, Affected Environment, there are localized areas of
10 moderate to high salinity due to natural geologic formations and/or seawater
11 intrusion in the San Francisco Bay Area, Central Coast, and Southern California
12 regions. Under the No Action Alternative as compared to the Second Basis of
13 Comparison, it is anticipated that the increased groundwater withdrawals would
14 cause poorer quality groundwater to flow towards the groundwater withdrawals,
15 especially near the coast. This would result in poorer quality groundwater in
16 some areas under the No Action Alternative as compared to the Second Basis of
17 Comparison.

18 **7.4.3.2 Alternative 1**

19 Alternative 1 is identical to the Second Basis of Comparison. As described in
20 Chapter 4, Approach to Environmental Analysis, Alternative 1 is compared to the
21 No Action Alternative and the Second Basis of Comparison. However, because
22 groundwater conditions under Alternative 1 are identical to groundwater
23 conditions under the Second Basis of Comparison; Alternative 1 is only compared
24 to the No Action Alternative.

25 **7.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

26 *Trinity River Region*

27 Groundwater conditions in the Trinity River Region are not directly related to
28 CVP and SWP water supplies or operations. Therefore, groundwater use, related
29 groundwater levels, potential for land use subsidence, and groundwater quality
30 degradation under Alternative 1 would be the same as under the No Action
31 Alternative.

32 *Central Valley Region*

33 *Groundwater Use and Elevation*

34 In areas of the Central Valley Region that do not use CVP and SWP water
35 supplies, areas that use CVP water under Sacramento River Exchange Settlement
36 Contracts, and areas that use San Joaquin River Exchange Contracts under
37 Alternative 1 water supplies would be the same as under the No Action
38 Alternative. Therefore, in these areas of the Central Valley Region, groundwater
39 use and groundwater levels under Alternative 1 would be the same as under the
40 No Action Alternative.

1 In areas of the Central Valley Region that use CVP water service contract and
2 SWP entitlement contract water supplies, the CVP and SWP water supplies would
3 be greater under Alternative 1 as compared to the No Action Alternative. The
4 differences would result in decreased groundwater use and increased groundwater
5 levels in the San Joaquin Valley Groundwater Basin under Alternative 1 as
6 compared to the No Action Alternative. Results of CVHM simulation indicate
7 that groundwater levels would be similar in the Redding and Sacramento Valley
8 groundwater basins and the northern portion of the San Joaquin Valley
9 Groundwater Basin, as shown in Figures 7.24 through 7.28.

10 Groundwater levels increase under Alternative 1 in the central and southern San
11 Joaquin Valley Groundwater Basin as compared to the No Action
12 Alternative with greater increases occurring in wet years than in critical dry years
13 (up to 500 feet). Figures 7.29 and 7.30 present the simulated changes in
14 groundwater levels over the 42-year CVHM study period. Simulated average July
15 agricultural groundwater pumping under Alternative 1 as compared to the No
16 Action Alternative is presented in Figures 7.31 and 7.32.

17 Overall, under Alternative 1 as compared to the No Action Alternative, July
18 average groundwater levels increase approximately 2 to 10 feet in most of the
19 central and southern San Joaquin Valley Groundwater Basin in all water year
20 types. July average groundwater levels rise 10 to 50 feet in the Delta-Mendota,
21 Tulare Lake, and Kern County subbasins; and 100 to 500 feet in Westside
22 subbasin. In critical dry years, groundwater levels increase by up to 200 feet in
23 the Westside subbasin. The groundwater level change hydrographs show that in
24 the central and southern San Joaquin Valley subbasins, groundwater levels can
25 fluctuate up to 200 feet in some areas due to climatic variations under
26 Alternative 1 compared to the No Action Alternative.

27 The change in groundwater pumping in the Sacramento Valley is less than
28 5 percent. Therefore, groundwater pumping in the Sacramento Valley is similar
29 under Alternative 1 as compared to the No Action Alternative.

30 Groundwater pumping in the San Joaquin and Tulare Basins would decrease by
31 approximately 8 percent under Alternative 1 as compared to the No Action
32 Alternative. Figure 7.32 shows that the biggest change in groundwater pumping
33 under the Alternative 1 compared to the No Action Alternative occurs in the
34 Westside subbasin with an average July decrease close to 40 TAF.

35 *Land Subsidence*

36 Land subsidence due to groundwater withdrawals historically occurred in the
37 Yolo subbasin of the Sacramento Valley Groundwater Basin. CVP and SWP
38 water supplies are not used extensively in this area. The conditions under
39 Alternative 1 would be similar as conditions under the No Action Alternative.

40 Under Alternative 1, potential for land subsidence due to groundwater
41 withdrawals in the Delta-Mendota and Westside subbasins of the San Joaquin
42 Valley Groundwater Basin would decrease under Alternative 1 as compared to the
43 No Action Alternative due to the decreased groundwater withdrawals.

1 Groundwater level-induced land subsidence has the highest potential to occur in
2 the San Joaquin Valley Groundwater Basin, based on historical data, if
3 groundwater pumping substantially increases. Under Alternative 1 CVP and
4 SWP water supplies are expected to increase in the San Joaquin Valley as
5 compared to the No Action Alternative. Increased surface water deliveries could
6 result in a decrease in groundwater pumping. The decreased groundwater
7 pumping would result in higher groundwater levels, and therefore, the potential
8 for groundwater level-induced land subsidence is reduced under Alternative 1 as
9 compared to the No Action Alternative.

10 *Groundwater Quality*

11 Under Alternative 1, groundwater conditions, including groundwater quality, in
12 areas that do not use CVP and SWP water supplies would be the same as under
13 the No Action Alternative.

14 In areas that use CVP and SWP water supplies, groundwater quality under
15 Alternative 1 could be improved as compared to the No Action Alternative in the
16 central and southern San Joaquin Valley Groundwater Basin due to decreased
17 groundwater withdrawals. As described above, it is assumed that measures
18 implemented in accordance with the CV-SALTS program or future sustainable
19 groundwater management plans implemented in accordance with SGMA would
20 not be fully implemented by 2030. However, due to the increased availability of
21 CVP and SWP water supplies and related reduction in groundwater use, the
22 groundwater quality would be improved under Alternative 1 as compared to the
23 No Action Alternative.

24 *Effects Related to Water Transfers*

25 Potential effects to groundwater resources could be similar to those identified in a
26 recent environmental analysis conducted by Reclamation for long-term water
27 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as
28 described above under the No Action Alternative compared to the Second Basis
29 of Comparison. For the purposes of this EIS, it is anticipated that similar
30 conditions would occur during implementation of cross Delta water transfers
31 under Alternative 1 and the No Action Alternative, and that groundwater impacts
32 would not be substantial in the seller's service area due implementation
33 requirements of the transfer programs.

34 Groundwater use in areas that purchase the transferred water could be reduced if
35 additional surface water is provided. However, if the transferred water is used to
36 meet water demands that would not have been met (e.g., crops that had been
37 idled), groundwater conditions would be similar with or without water transfers.

38 Under Alternative 1, water could be transferred throughout the year without an
39 annual volumetric limit. Under the No Action Alternative, the timing of cross
40 Delta water transfers would be limited to July through September and include
41 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009
42 NMFS BO. Overall, the potential for cross Delta water transfers would be greater
43 under Alternative 1 as compared to the No Action Alternative.

1 *San Francisco Bay Area, Central Coast, and Southern California Regions*
2 *Groundwater Use and Elevation*

3 Under Alternative 1, it is anticipated that CVP and SWP water supplies in the San
4 Francisco Bay Area, Central Coast, and Southern California regions would be
5 increased as compared to CVP and SWP water supplies under the No Action
6 Alternative, as discussed in Chapter 5, Surface Water Resources and Water
7 Supplies. The increase in surface water supplies could result in decreased
8 groundwater withdrawals by CVP and SWP water users, resulting in increased
9 groundwater recharge, and increased groundwater levels in areas with CVP and
10 SWP water users.

11 *Land Subsidence*

12 Decreased use of groundwater and higher groundwater levels would result in a
13 decreased potential for additional land subsidence under Alternative 1 as
14 compared to the No Action Alternative in the Santa Clara Valley Groundwater
15 Basin in the San Francisco Bay Area Region, and the Antelope Valley and
16 Lucerne Valley groundwater basins in the Southern California Region.

17 *Groundwater Quality*

18 As described in Section 7.3, Affected Environment, there are localized areas of
19 moderate to high salinity due to natural geologic formations and/or seawater
20 intrusion in the San Francisco Bay Area, Central Coast, and Southern California
21 regions. Under Alternative 1 as compared to the No Action Alternative, it is
22 anticipated that the decreased groundwater withdrawals would cause improved
23 groundwater quality, especially near the coast.

24 **7.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

25 Alternative 1 is identical to the Second Basis of Comparison.

26 **7.4.3.3 Alternative 2**

27 The CVP and SWP operations under Alternative 2 are identical to the CVP and
28 SWP operations under the No Action Alternative; therefore, the groundwater
29 conditions under Alternative 2 is only compared to the Second Basis of
30 Comparison.

31 **7.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

32 Changes to groundwater resources under Alternatives 2 as compared to the
33 Second Basis of Comparison would be the same as the impacts described in
34 Section 7.4.3.1, No Action Alternative.

35 **7.4.3.4 Alternative 3**

36 As described in Chapter 3, Description of Alternatives, CVP and SWP operations
37 under Alternative 3 are similar to the Second Basis of Comparison and
38 Alternative 1 with modified Old and Middle River flow criteria. Alternative 3 is
39 compared to the No Action Alternative and the Second Basis of Comparison.

1 **7.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

2 *Trinity River Region*

3 Groundwater conditions in the Trinity River Region are not directly related to
4 CVP and SWP water supplies or operations. Therefore, groundwater use, related
5 groundwater levels, potential for land use subsidence, and groundwater quality
6 under Alternative 3 would be the same as under the No Action Alternative.

7 *Central Valley Region*

8 *Groundwater Use and Elevation*

9 In areas of the Central Valley Region that do not use CVP and SWP water
10 supplies, areas that use CVP water under Sacramento River Exchange Settlement
11 Contracts, and areas that use San Joaquin River Exchange Contracts under
12 Alternative 3 water supplies would be the same as under the No Action
13 Alternative. Therefore, in these areas of the Central Valley Region, groundwater
14 use and groundwater levels under Alternative 3 would be the same as under the
15 No Action Alternative.

16 In areas of the Central Valley Region that use CVP water service contract and
17 SWP entitlement contract water supplies, the CVP and SWP water supplies would
18 be greater under Alternative 3 as compared to the No Action Alternative. The
19 differences would result in decreased groundwater use and increased groundwater
20 levels in the San Joaquin Valley Groundwater Basin under Alternative 3 as
21 compared to the No Action Alternative. Results of CVHM simulation indicate
22 that groundwater levels would be similar in the Redding and Sacramento Valley
23 groundwater basins and the northern portion of the San Joaquin Valley
24 Groundwater Basin (changes would plus/minus 2 feet), as shown in Figures 7.33
25 through 7.37.

26 Groundwater levels increase under Alternative 3 in the central and southern San
27 Joaquin Valley Groundwater Basin as compared to the No Action
28 Alternative with greater increases occurring in wet years than in critical dry years.
29 Figures 7.38 and 7.39 present the simulated changes in groundwater levels over
30 the 42-year CVHM model study period. Simulated average July agricultural
31 groundwater pumping under Alternative 3 as compared to the No Action
32 Alternative is presented in Figures 7.31 and 7.32.

33 Overall, under Alternative 3 as compared to the No Action Alternative, July
34 average groundwater levels increase approximately 2 to 10 feet in most of the
35 central and southern San Joaquin Valley Groundwater Basin in all water year
36 types. July average groundwater levels increase 10 to 50 feet in the
37 Delta-Mendota, Tulare Lake, and Kern County subbasins; and 100 to 500 feet in
38 the Westside subbasin in most year types. In critical dry years, groundwater
39 levels increase by up to 200 feet in the Westside subbasin. The groundwater level
40 change hydrographs show that in the central and southern San Joaquin Valley,
41 groundwater levels can fluctuate up to 200 feet in some areas due to climatic
42 variations under Alternative 3 compared to the No Action Alternative.

1 The change in groundwater pumping in the Sacramento Valley is less than
2 5 percent. Therefore, groundwater pumping in the Sacramento Valley is similar
3 under Alternative 3 compared to the No Action Alternative.

4 Groundwater pumping in the San Joaquin and Tulare Basins decreases by
5 approximately 6 percent under Alternative 3 as compared to the No Action
6 Alternative. Figure 7.32 shows that the largest change in groundwater pumping
7 under Alternative 3 as compared to the No Action Alternative occurs in the
8 Westside subbasin with an average July decrease of approximately 35 TAF.

9 *Land Subsidence*

10 Land subsidence due to groundwater withdrawals historically occurred in the
11 Yolo subbasin of the Sacramento Valley Groundwater Basin. CVP and SWP
12 water supplies are not used extensively in this area. The conditions under
13 Alternative 3 would be similar as conditions under the No Action Alternative.

14 Under Alternative 3, potential for land subsidence due to groundwater
15 withdrawals in the Delta-Mendota and Westside subbasins of the San Joaquin
16 Valley Groundwater Basin would decrease under Alternative 3 as compared to the
17 No Action Alternative due to the decreased groundwater withdrawals.

18 Groundwater level-induced land subsidence has the highest potential to occur in
19 the San Joaquin Valley Groundwater Basin, based on historical data, if
20 groundwater pumping substantially increases. Under Alternative 3 CVP and
21 SWP water supplies are expected to increase in the San Joaquin Valley as
22 compared to the No Action Alternative. Increased surface water deliveries could
23 result in a decrease in groundwater pumping. The decreased groundwater
24 pumping would result in higher groundwater levels, and therefore, the potential
25 for groundwater level-induced land subsidence is reduced under Alternative 3 as
26 compared to the No Action Alternative.

27 *Groundwater Quality*

28 Under Alternative 3, groundwater conditions, including groundwater quality, in
29 areas that do not use CVP and SWP water supplies would be the same as under
30 the No Action Alternative.

31 In areas that use CVP and SWP water supplies, groundwater quality under
32 Alternative 3 could be improved as compared to the No Action Alternative in the
33 central and southern San Joaquin Valley Groundwater Basin due to decreased
34 groundwater withdrawals. As described above, it is assumed that measures
35 implemented in accordance with the CV-SALTS program or future sustainable
36 groundwater management plans implemented in accordance with SGMA would
37 not be fully implemented by 2030. However, due to the increased availability of
38 CVP and SWP water supplies and related reduction in groundwater use, the
39 groundwater quality would be improved under Alternative 3 as compared to the
40 No Action Alternative.

1 *Effects Related to Water Transfers*

2 Potential effects to groundwater resources could be similar to those identified in a
3 recent environmental analysis conducted by Reclamation for long-term water
4 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as
5 described above under the No Action Alternative compared to the Second Basis
6 of Comparison. For the purposes of this EIS, it is anticipated that similar
7 conditions would occur during implementation of cross Delta water transfers
8 under Alternative 3 and the No Action Alternative, and that groundwater impacts
9 would not be substantial in the seller's service area due implementation
10 requirements of the transfer programs.

11 Groundwater use in areas that purchase the transferred water could be reduced if
12 additional surface water is provided. However, if the transferred water is used to
13 meet water demands that would not have been met (e.g., crops that had been
14 idled), groundwater conditions would be similar with or without water transfers.

15 Under Alternative 3, water could be transferred throughout the year without an
16 annual volumetric limit. Under the No Action Alternative, the timing of cross
17 Delta water transfers would be limited to July through September and include
18 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009
19 NMFS BO. Overall, the potential for cross Delta water transfers would be greater
20 under Alternative 3 as compared to the No Action Alternative.

21 *San Francisco Bay Area, Central Coast, and Southern California Regions*
22 *Groundwater Use and Elevation*

23 Under Alternative 3, it is anticipated that CVP and SWP water supplies in the San
24 Francisco Bay Area, Central Coast, and Southern California regions would be
25 increased as compared to CVP and SWP water supplies under the No Action
26 Alternative, as discussed in Chapter 5, Surface Water Resources and Water
27 Supplies. The increase in surface water supplies could result in decreased
28 groundwater withdrawals by CVP and SWP water users, resulting in increased
29 groundwater recharge, and increased groundwater levels. It may be legally
30 impossible to extract additional groundwater in adjudicated basins without
31 gaining the permission of watermasters and accounting for groundwater pumping
32 entitlements and various parties under their adjudicated rights.

33 *Land Subsidence*

34 Decreased use of groundwater and higher groundwater levels would result in a
35 decreased potential for additional land subsidence under Alternative 3 as
36 compared to the No Action Alternative in the Santa Clara Valley Groundwater
37 Basin in the San Francisco Bay Area Region, and the Antelope Valley and
38 Lucerne Valley groundwater basins in the Southern California Region.

39 *Groundwater Quality*

40 As described in Section 7.3, Affected Environment, there are localized areas of
41 moderate to high salinity due to natural geologic formations and/or seawater
42 intrusion in the San Francisco Bay Area, Central Coast, and Southern California
43 regions. Under Alternative 3 as compared to the No Action Alternative, it is

1 anticipated that the decreased groundwater withdrawals would cause improved
2 groundwater quality, especially near the coast.

3 **7.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

4 *Trinity River Region*

5 Groundwater conditions in the Trinity River Region are not directly related to
6 CVP and SWP water supplies or operations. Therefore, groundwater use, related
7 groundwater levels, potential for land use subsidence, and groundwater quality
8 under Alternative 3 would be the same as under the Second Basis of Comparison.

9 *Central Valley Region*

10 *Groundwater Use and Elevation*

11 In areas of the Central Valley Region that do not use CVP and SWP water
12 supplies, areas that use CVP water under Sacramento River Exchange Settlement
13 Contracts, and areas that use San Joaquin River Exchange Contracts under
14 Alternative 3 water supplies would be the same as under the Second Basis of
15 Comparison. Therefore, in these areas of the Central Valley Region, groundwater
16 use and groundwater levels under Alternative 3 would be the same as under the
17 Second Basis of Comparison.

18 In areas of the Central Valley Region that use CVP water service contract and
19 SWP entitlement contract water supplies, the CVP and SWP water supplies would
20 be less under Alternative 3 as compared to the Second Basis of Comparison. The
21 differences would result in increased groundwater use and decreased groundwater
22 levels in the San Joaquin Valley Groundwater Basin under Alternative 3 as
23 compared to the Second Basis of Comparison. Results of CVHM simulation
24 indicate that groundwater levels would be similar in the Redding and Sacramento
25 Valley groundwater basins and the northern portion of the San Joaquin Valley
26 Groundwater Basin, as shown in Figures 7.40 through 7.44.

27 Groundwater levels generally decrease under Alternative 3 in the central and
28 southern San Joaquin Valley Groundwater Basin as compared to the Second Basis
29 of Comparison. Figures 7.45 and 7.46 present the simulated change in
30 groundwater levels over the 42-year CVHM study period. Simulated average July
31 agricultural groundwater pumping under Alternative 3 as compared to the Second
32 Basis of Comparison is presented in Figures 7.22 and 7.23.

33 Overall, under Alternative 3 as compared to the Second Basis of Comparison,
34 July average groundwater levels decrease approximately 2 to 10 feet in most of
35 the central and southern San Joaquin Valley Groundwater Basin in all water year
36 types. July average groundwater levels decline 10 to 50 feet in the Delta-
37 Mendota, Tulare Lake, and Kern County subbasins; and decline up to 100 feet in
38 Westside subbasin, in most water year types. However, groundwater levels in the
39 Westside subbasin increase by up to 25 feet in wet years, due to increased CVP
40 water deliveries to this region in wet years. Groundwater level changes in the
41 Sacramento Valley are forecast to be less than 2 feet. The groundwater level
42 change hydrographs show that in the central and southern San Joaquin Valley,

1 groundwater levels can fluctuate up to 200 feet in some areas due to climatic
2 variations under Alternative 3 compared to the Second Basis of Comparison.

3 The change in groundwater pumping in the Sacramento Valley is less than
4 5 percent. Therefore, groundwater pumping in the Sacramento Valley is similar
5 under Alternative 3 compared to the Second Basis of Comparison.

6 Groundwater pumping in the San Joaquin and Tulare Basins changes by less than
7 5 percent under Alternative 3 as compared to the Second Basis of Comparison,
8 and is therefore considered similar. Figure 7.23 shows that the biggest change in
9 groundwater pumping under Alternative 3 compared to the Second Basis of
10 Comparison occurs in WBS 18, with an average July increase close to 10 TAF.

11 *Land Subsidence*

12 Groundwater pumping would be similar in the Sacramento and San Joaquin
13 valleys, therefore, the potential for groundwater level-induced land subsidence
14 would be similar under Alternative 3 as compared to the Second Basis of
15 Comparison.

16 *Groundwater Quality*

17 Groundwater pumping would be similar in the Sacramento and San Joaquin
18 valleys, therefore, groundwater quality would be similar under Alternative 3 as
19 compared to the Second Basis of Comparison.

20 *Effects Related to Water Transfers*

21 Potential effects to groundwater resources could be similar to those identified in a
22 recent environmental analysis conducted by Reclamation for long-term water
23 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as
24 described above under the No Action Alternative compared to the Second Basis
25 of Comparison. For the purposes of this EIS, it is anticipated that similar
26 conditions would occur during implementation of cross Delta water transfers
27 under Alternative 3 and the Second Basis of Comparison, and that groundwater
28 impacts would not be substantial in the seller's service area due implementation
29 requirements of the transfer programs.

30 Groundwater use in areas that purchase the transferred water could be reduced if
31 additional surface water is provided. However, if the transferred water is used to
32 meet water demands that would not have been met (e.g., crops that had been
33 idled), groundwater conditions would be similar with or without water transfers.

34 Under Alternative 3 and the Second Basis of Comparison, water could be
35 transferred throughout the year without an annual volumetric limit. Therefore, the
36 potential for cross Delta water transfers would be similar under Alternative 3 and
37 the Second Basis of Comparison.

38 *San Francisco Bay Area, Central Coast, and Southern California Regions* 39 *Groundwater Use and Elevation*

40 Under Alternative 3, it is anticipated that CVP and SWP water supplies in the San
41 Francisco Bay Area, Central Coast, and Southern California regions would be
42 decreased as compared to CVP and SWP water supplies under the Second Basis

1 of Comparison, as discussed in Chapter 5, Surface Water Resources and Water
2 Supplies. The decrease in surface water supplies could result in increased
3 groundwater withdrawals by CVP and SWP water users, resulting in decreased
4 groundwater recharge, and decreased groundwater levels in areas with CVP and
5 SWP water users.

6 *Land Subsidence*

7 Increased use of groundwater and lower groundwater levels would result in a
8 decreased potential for additional land subsidence under Alternative 3 as
9 compared to the Second Basis of Comparison in the Santa Clara Valley
10 Groundwater Basin in the San Francisco Bay Area Region, and the Antelope
11 Valley and Lucerne Valley groundwater basins in the Southern California Region.

12 *Groundwater Quality*

13 As described in Section 7.3, Affected Environment, there are localized areas of
14 moderate to high salinity due to natural geologic formations and/or seawater
15 intrusion in the San Francisco Bay Area, Central Coast, and Southern California
16 regions. Under Alternative 3 as compared to the Second Basis of Comparison, it
17 is anticipated that the increased groundwater withdrawals would cause poorer
18 groundwater quality, especially near the coast.

19 **7.4.3.5 Alternative 4**

20 Groundwater conditions under Alternative 4 would be identical to groundwater
21 conditions under the Second Basis of Comparison; therefore, Alternative 4 is only
22 compared to the No Action Alternative.

23 **7.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

24 Changes in groundwater conditions under Alternative 4 as compared to the No
25 Action Alternative would be the same as the impacts described in
26 Section 7.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

27 **7.4.3.6 Alternative 5**

28 CVP and SWP operations under Alternative 5 are similar to the No Action
29 Alternative with modified Old and Middle River flow criteria and New Melones
30 Reservoir operations. As described in Chapter 4, Approach to Environmental
31 Analysis, Alternative 5 is compared to the No Action Alternative and the Second
32 Basis of Comparison.

33 **7.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

34 *Trinity River Region*

35 Groundwater conditions in the Trinity River Region are not directly related to
36 CVP and SWP water supplies or operations. Therefore, groundwater use, related
37 groundwater levels, potential for land use subsidence, and groundwater quality
38 under Alternative 5 would be the same as under the No Action Alternative.

1 *Central Valley Region*

2 *Groundwater Use and Elevation*

3 In areas of the Central Valley Region that do not use CVP and SWP water
4 supplies, areas that use CVP water under Sacramento River Exchange Settlement
5 Contracts, and areas that use San Joaquin River Exchange Contracts under
6 Alternative 5 water supplies would be the same as under the No Action
7 Alternative. Therefore, in these areas of the Central Valley Region, groundwater
8 use and groundwater levels under Alternative 5 would be the same as under the
9 No Action Alternative.

10 In areas of the Central Valley Region that use CVP water service contract and
11 SWP entitlement contract water supplies, the CVP and SWP water supplies would
12 be slightly lower under Alternative 5 as compared to the No Action Alternative.
13 The differences would result in increased groundwater use and decreased
14 groundwater levels in the San Joaquin Valley Groundwater Basin under
15 Alternative 5 as compared to the No Action Alternative. Results of CVHM
16 simulations indicate that groundwater levels would be similar in the Redding and
17 Sacramento Valley groundwater basins and the northern portion of the San
18 Joaquin Valley Groundwater Basin, as shown in Figures 7.47 through 7.51.

19 Groundwater levels decrease under Alternative 5 in the central and southern San
20 Joaquin Valley Groundwater Basin as compared to the No Action
21 Alternative with the greatest decreases occurring in above normal years.
22 Figures 7.52 and 7.53 present the simulated change in groundwater levels over the
23 42-year CVHM study period. Simulated average July agricultural groundwater
24 pumping under Alternative 5 as compared to the No Action Alternative is
25 presented in Figures 7.31 and 7.32.

26 Overall, under Alternative 5 as compared to the No Action Alternative, July
27 average groundwater levels decrease approximately 2 to 10 feet in the Westside
28 subbasin and the northern portion of the Kern County subbasin in critical dry and
29 wet water years, and decrease approximately by up to 25 feet in dry and below
30 normal water years in the Westside subbasin, with a maximum decrease of 50 feet
31 in above normal water years. The groundwater level change hydrographs show
32 that in the central and southern San Joaquin Valley, groundwater levels usually
33 fluctuate approximately 50 feet in some areas due to seasonal and climatic
34 variations under Alternative 5 compared to the No Action Alternative.

35 The change in groundwater pumping in the Sacramento Valley is less than
36 5 percent. Therefore, groundwater pumping in the Sacramento Valley is similar
37 under Alternative 5 compared to the No Action Alternative.

38 Groundwater pumping in the San Joaquin and Tulare Basins changes by less than
39 5 percent under Alternative 5 as compared to the No Action Alternative, and is
40 therefore considered similar. Figure 7.32 shows that the biggest change in
41 groundwater pumping under Alternative 5 compared to the No Action
42 Alternative occurs in the Western San Joaquin Valley.

1 *Land Subsidence*

2 Groundwater pumping would be similar in the Sacramento and San Joaquin
3 valleys, therefore, the potential for groundwater level-induced land subsidence
4 would be similar under Alternative 5 as compared to the No Action Alternative.

5 *Groundwater Quality*

6 Groundwater pumping would be similar in the Sacramento and San Joaquin
7 valleys, therefore, groundwater quality would be similar under Alternative 5 as
8 compared to the No Action Alternative.

9 *Effects Related to Water Transfers*

10 Potential effects to groundwater resources could be similar to those identified in a
11 recent environmental analysis conducted by Reclamation for long-term water
12 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as
13 described above under the No Action Alternative compared to the Second Basis
14 of Comparison. For the purposes of this EIS, it is anticipated that similar
15 conditions would occur during implementation of cross Delta water transfers
16 under Alternative 5 and the No Action Alternative, and that groundwater impacts
17 would not be substantial in the seller's service area due implementation
18 requirements of the transfer programs.

19 Groundwater use in areas that purchase the transferred water could be reduced if
20 additional surface water is provided. However, if the transferred water is used to
21 meet water demands that would not have been met (e.g., crops that had been
22 idled), groundwater conditions would be similar with or without water transfers.

23 Under Alternative 5 and the No Action Alternative, the timing of cross Delta
24 water transfers would be limited to July through September and include annual
25 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.
26 Overall, the potential for cross Delta water transfers would be similar under
27 Alternative 5 as compared to the No Action Alternative.

28 *San Francisco Bay Area, Central Coast, and Southern California Regions*
29 *Groundwater Use and Elevation*

30 Under Alternative 5, it is anticipated that CVP and SWP water supplies in the San
31 Francisco Bay Area, Central Coast, and Southern California regions would be
32 similar to CVP and SWP water supplies under the No Action Alternative, as
33 discussed in Chapter 5, Surface Water Resources and Water Supplies. Therefore,
34 groundwater pumping would be similar.

35 *Land Subsidence*

36 Because the groundwater pumping would be similar under Alternative 5 as
37 compared to the No Action Alternative; therefore, the potential for additional land
38 subsidence would be similar.

39 *Groundwater Quality*

40 Because the groundwater pumping would be similar under Alternative 5 as
41 compared to the No Action Alternative; therefore, groundwater quality would be
42 similar.

1 **7.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

2 *Trinity River Region*

3 Groundwater conditions in the Trinity River Region are not directly related to
4 CVP and SWP water supplies or operations. Therefore, groundwater use, related
5 groundwater levels, potential for land use subsidence, and groundwater quality
6 under Alternative 5 would be the same as under the Second Basis of Comparison.

7 *Central Valley Region*

8 *Groundwater Use and Elevation*

9 In areas of the Central Valley Region that do not use CVP and SWP water
10 supplies, areas that use CVP water under Sacramento River Exchange Settlement
11 Contracts, and areas that use San Joaquin River Exchange Contracts under
12 Alternative 5 water supplies would be the same as under the Second Basis of
13 Comparison. Therefore, in these areas of the Central Valley Region, groundwater
14 use and groundwater levels under Alternative 5 would be the same as under the
15 Second Basis of Comparison.

16 In areas of the Central Valley Region that use CVP water service contract and
17 SWP entitlement contract water supplies, the CVP and SWP water supplies would
18 be lower under Alternative 5 as compared to the Second Basis of Comparison.
19 The differences would result in increased groundwater use and decreased
20 groundwater levels in the San Joaquin Valley Groundwater Basin under
21 Alternative 5 as compared to the Second Basis of Comparison. Results of CVHM
22 simulations indicate that groundwater levels would be similar in the Redding and
23 Sacramento Valley groundwater basins and the northern portion of the San
24 Joaquin Valley Groundwater Basin, as shown in Figures 7.54 through 7.58.

25 Groundwater levels generally decrease under Alternative 5 in the central and
26 southern San Joaquin Valley Groundwater Basin as compared to the Second Basis
27 of Comparison. Figures 7.59 and 7.60 present the simulated change in
28 groundwater levels over the 42-year CVHM study period. Simulated average July
29 agricultural groundwater pumping under Alternative 5 as compared to the Second
30 Basis of Comparison is presented in Figures 7.22 and 7.23.

31 Overall, under Alternative 5 as compared to the Second Basis of Comparison,
32 July average groundwater levels decrease approximately 2 to 10 feet in most of
33 the central and southern San Joaquin Valley Groundwater Basin in all water year
34 types. July average groundwater levels decline 10 to 100 feet in the Delta-
35 Mendota and Tulare Lake subbasins, and up to 200 feet in the Kern County
36 subbasin; and can decline more than 500 feet in the Westside subbasin, in most
37 water year types (except in critical dry years, when the difference in groundwater
38 levels is closer to 200 feet). Groundwater level changes in the Sacramento Valley
39 are forecast to be less than 2 feet. The groundwater level change hydrographs
40 show that in the central and southern San Joaquin Valley, groundwater levels can
41 fluctuate up to 200 feet in some areas due to seasonal and climatic variations
42 under Alternative 5 compared to the Second Basis of Comparison.

1 The change in groundwater pumping in the Sacramento Valley is less than
2 5 percent. Therefore, groundwater pumping in the Sacramento Valley is similar
3 under Alternative 5 compared to the Second Basis of Comparison.

4 Groundwater pumping in the San Joaquin and Tulare Basins increases by
5 approximately 8 percent under the Alternative 5 as compared to the Second Basis
6 of Comparison. Figure 7.23 shows that the biggest change in groundwater
7 pumping under Alternative 5 compared to the Second Basis of Comparison occurs
8 in WBS 14, with an average July increase of almost 40 TAF.

9 *Land Subsidence*

10 Land subsidence due to groundwater withdrawals historically occurred in the
11 Yolo subbasin of the Sacramento Valley Groundwater Basin. CVP and SWP
12 water supplies are not used extensively in this area. The conditions under
13 Alternative 5 would be similar as conditions under the Second Basis of
14 Comparison.

15 Under Alternative 5, potential for land subsidence due to groundwater
16 withdrawals in the Delta-Mendota and Westside subbasins of the San Joaquin
17 Valley Groundwater Basin would increase under Alternative 5 as compared to the
18 Second Basis of Comparison due to the increased groundwater withdrawals.

19 Groundwater level-induced land subsidence has the highest potential to occur in
20 the San Joaquin Groundwater Basin, based on historical data, if groundwater
21 pumping substantially increases. Under Alternative 5, CVP and SWP water
22 supplies are expected to decrease in the San Joaquin Valley as compared to the
23 Second Basis of Comparison. Decreased surface water deliveries could result in
24 an increase in groundwater pumping. The increased groundwater pumping would
25 result in lower groundwater levels, and therefore, the potential for groundwater
26 level-induced land subsidence is increased under Alternative 5 as compared to the
27 Second Basis of Comparison.

28 *Groundwater Quality*

29 Under Alternative 5, groundwater conditions, including groundwater quality, in
30 areas that do not use CVP and SWP water supplies would be the same as under
31 the Second Basis of Comparison.

32 In areas that use CVP and SWP water supplies, groundwater quality under
33 Alternative 5 could be reduced as compared to the Second Basis of Comparison in
34 the central and southern San Joaquin Valley Groundwater Basin due to increased
35 groundwater withdrawals and resulting potential changes in groundwater flow
36 patterns. As described above, it is assumed that measures implemented in
37 accordance with the CV-SALTS program or future sustainable groundwater
38 management plans implemented in accordance with SGMA would not be fully
39 implemented by 2030. Therefore, groundwater quality may be affected under
40 Alternative 5 as compared to the Second Basis of Comparison.

1 *Effects Related to Water Transfers*

2 Potential effects to groundwater resources could be similar to those identified in a
3 recent environmental analysis conducted by Reclamation for long-term water
4 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as
5 described above under the No Action Alternative compared to the Second Basis
6 of Comparison. For the purposes of this EIS, it is anticipated that similar
7 conditions would occur during implementation of cross Delta water transfers
8 under Alternative 5 and the Second Basis of Comparison, and that groundwater
9 impacts would not be substantial in the seller's service area due implementation
10 requirements of the transfer programs.

11 Groundwater use in areas that purchase the transferred water could be reduced if
12 additional surface water is provided. However, if the transferred water is used to
13 meet water demands that would not have been met (e.g., crops that had been
14 idled), groundwater conditions would be similar with or without water transfers.

15 Under Alternative 5 and the Second Basis of Comparison, water could be
16 transferred throughout the year without an annual volumetric limit. Therefore, the
17 potential for cross Delta water transfers would be similar under Alternative 5 and
18 the Second Basis of Comparison.

19 *San Francisco Bay Area, Central Coast, and Southern California Regions*
20 *Groundwater Use and Elevation*

21 Under Alternative 5, it is anticipated that CVP and SWP water supplies in the San
22 Francisco Bay Area, Central Coast, and Southern California regions would be
23 decreased as compared to CVP and SWP water supplies under the Second Basis
24 of Comparison, as discussed in Chapter 5, Surface Water Resources and Water
25 Supplies. The decrease in surface water supplies could result in increased
26 groundwater withdrawals by CVP and SWP water users, resulting in decreased
27 groundwater recharge, and decreased groundwater levels in areas with CVP and
28 SWP water users. It may be legally impossible to extract additional groundwater
29 in adjudicated basins without gaining the permission of watermasters and
30 accounting for groundwater pumping entitlements and various parties under their
31 adjudicated rights.

32 *Land Subsidence*

33 Increased use of groundwater and lower groundwater levels would result in a
34 decreased potential for additional land subsidence would increase under
35 Alternative 5 as compared to the Second Basis of Comparison in the Santa Clara
36 Valley Groundwater Basin in the San Francisco Bay Area Region, and the
37 Antelope Valley and Lucerne Valley groundwater basins in the Southern
38 California Region.

39 *Groundwater Quality*

40 As described in Section 7.3, Affected Environment, there are localized areas of
41 moderate to high salinity due to natural geologic formations and/or seawater
42 intrusion in the San Francisco Bay Area, Central Coast, and Southern California
43 regions. Under Alternative 5 as compared to the Second Basis of Comparison, it

1 is anticipated that the increased groundwater withdrawals would cause poorer
2 groundwater quality, especially near the coast.

3 **7.4.3.7 Summary of Impact Analysis**

4 The results of the impact analysis of implementation of Alternatives 1 through 5
5 as compared to the No Action Alternative and the Second Basis of Comparison
6 are presented in Tables 7.3 and 7.4.

7 **Table 7.3 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	<p>Trinity River Region Groundwater conditions would be similar.</p> <p>Central Valley Region Groundwater pumping and levels in the Sacramento Valley would be similar. Groundwater pumping in the San Joaquin Valley would decrease by approximately 8 percent. July groundwater levels in all water year types would be higher by approximately 2 to 10 feet in the in most of the central and southern San Joaquin Valley; 10 to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and 100 to over 500 feet in the Westside subbasin. The higher groundwater levels would reduce the potential for land subsidence. Groundwater quality in the San Joaquin Valley Groundwater Basin could decline.</p> <p>San Francisco Bay Area, Central Coast, and Southern California Regions Increases in CVP and SWP water supplies, could decrease groundwater pumping and decrease the potential for land subsidence.</p>	None needed
Alternative 2	No effects on groundwater resources or water supplies.	None needed
Alternative 3	<p>Trinity River Region Groundwater conditions would be similar.</p> <p>Central Valley Region Groundwater pumping and levels in the Sacramento Valley would be similar. Groundwater pumping in the San Joaquin Valley would decrease by approximately 6 percent. July groundwater levels in all water year types would be higher by approximately 2 to 10 feet in the in most of the central and southern San Joaquin Valley; 10 to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and 100 to over 500 feet in the Westside subbasin. The higher groundwater levels would reduce the potential for land subsidence. Groundwater quality in the San Joaquin Valley Groundwater Basin could decline.</p> <p>San Francisco Bay Area, Central Coast, and Southern California Regions Increases in CVP and SWP water supplies, could decrease groundwater pumping and decrease the potential for land subsidence.</p>	None needed
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed

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Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 5	<p>Trinity River Region Groundwater conditions would be similar.</p> <p>Central Valley Regions Groundwater pumping and levels in the Sacramento Valley would be similar.</p> <p>Groundwater pumping, levels, and quality in the San Joaquin Valley would be similar. July groundwater levels in all water year types would decline approximately 2 to 10 feet in the in most of the central and southern San Joaquin Valley; and 25 to 50 feet in the Westside subbasin.</p> <p>San Francisco Bay Area, Central Coast, and Southern California Regions Because the CVP and SWP water deliveries would be similar; groundwater pumping would be similar the potential for land subsidence would be similar.</p>	None needed

1 **Table 7.4 Comparison of No Action Alternative and Alternatives 1 through 5 to**
2 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	<p>Trinity River Region Groundwater conditions would be similar.</p> <p>Central Valley Regions Groundwater pumping and levels in the Sacramento Valley would be similar.</p> <p>Groundwater pumping in the San Joaquin Valley would increase by approximately 8 percent. July groundwater levels in all water year types would decline approximately 2 to 10 feet in the in most of the central and southern San Joaquin Valley; 10 to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and 100 to over 200 feet in the Westside subbasin. The reduction in groundwater levels could cause additional land subsidence.</p> <p>Groundwater quality in the San Joaquin Valley Groundwater Basin could decline.</p> <p>San Francisco Bay Area, Central Coast, and Southern California Regions Reductions in CVP and SWP water supplies, could increase groundwater pumping and increase the potential for land subsidence.</p>	Not considered for this comparison.
Alternative 1	No effects on groundwater resources or water supplies.	None needed.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 3	<p>Trinity River Region Groundwater conditions would be similar.</p> <p>Central Valley Regions Groundwater pumping and levels in the Sacramento Valley would be similar.</p> <p>Groundwater pumping, levels, and quality in the San Joaquin Valley would be similar. July groundwater levels in all water year types would decline approximately 2 to 10 feet in the in most of the central and southern San Joaquin Valley; 10 to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and up to 100 feet in the Westside subbasin.</p> <p>San Francisco Bay Area, Central Coast, and Southern California Regions Reductions in CVP and SWP water supplies, could increase groundwater pumping and increase the potential for land subsidence.</p>	Not considered for this comparison.
Alternative 4	No effects on groundwater resources or water supplies.	None needed
Alternative 5	<p>Trinity River Region Groundwater conditions would be similar.</p> <p>Central Valley Regions Groundwater pumping and levels in the Sacramento Valley would be similar.</p> <p>Groundwater pumping in the San Joaquin Valley would increase by approximately 8 percent. July groundwater levels in all water year types would decline approximately 2 to 10 feet in the in most of the central and southern San Joaquin Valley; 10 to 100 feet in the Delta-Mendota and Tulare Lake subbasins; up to 200 feet in the Kern County subbasins; and up to 500 feet in the Westside subbasin. The reduction in groundwater levels could cause additional land subsidence.</p> <p>Groundwater quality in the San Joaquin Valley Groundwater Basin could decline.</p> <p>San Francisco Bay Area, Central Coast, and Southern California Regions Reductions in CVP and SWP water supplies, could increase groundwater pumping and increase the potential for land subsidence.</p>	Not considered for this comparison.

1 **7.4.3.8 Potential Mitigation Measures**

2 As described above and summarized in Table 7.3, implementation of
3 Alternatives 1 through 5 as compared to the No Action Alternative would result in
4 either similar or less groundwater pumping and potential for land subsidence; and
5 similar groundwater quality conditions. Therefore, there would be no adverse
6 impacts to groundwater; and no mitigation measures are needed.

7 **7.4.3.9 Cumulative Effects Analysis**

8 As described in Chapter 3, the cumulative effects analysis considers projects,
9 programs, and policies that are not speculative; and are based upon known or
10 reasonably foreseeable long-range plans, regulations, operating agreements, or
11 other information that establishes them as reasonably foreseeable.

1 The No Action Alternative, Alternatives 1 through 5, and Second Basis of
2 Comparison include climate change and sea-level rise, implementation of general
3 plans, and completion of ongoing projects and programs (see Chapter 3,
4 Description of Alternatives). The effects of these items were analyzed
5 quantitatively and qualitatively, as described in the Impact Analysis of this
6 chapter. The discussion below focuses on the qualitative effects of the
7 alternatives and other past, present, and reasonably foreseeable future projects
8 identified for consideration of cumulative effects (see Chapter 3, Description of
9 Alternatives).

10 **7.4.3.9.1 No Action Alternative and Alternatives 1 through 5**

11 Continued coordinated long-term operation of the CVP and SWP under the No
12 Action Alternative would result in reduced CVP and SWP water supply
13 availability as compared to recent conditions due to climate change and sea-level
14 rise by 2030. These conditions are included in the analysis presented above.

15 Future groundwater management projects considered in cumulative effects
16 analysis (see Chapter 3, Description of Alternatives), could improve groundwater
17 conditions, including development or expansion of groundwater banks (City of
18 Roseville 2012; MORE 2015; NSJCGBA 2007; SEWD 2012; MWDSC 2010;
19 KRCD 2012b; BVWSD 2015; City of Los Angeles 2010, 2013; Los Angeles
20 County 2013; City of San Diego 2009a, 2009b; RCWD 2011, 2012; Reclamation
21 2011b; EMWD 2014a; JCSD et al. 2010).

22 Implementation of SGMA, will have a beneficial effect on groundwater resources,
23 as most areas will develop plans to manage groundwater extractions to not
24 exacerbate further groundwater level declines. The implementation of the SGMA
25 in high and medium groundwater basins would reduce the impacts on
26 groundwater levels, storage and groundwater supply by implementing sustainable
27 groundwater management plans and actions at the local level.

28 As part of the SGMA actions and implementation, there will be several measures
29 available to CVP and SWP water users, even with reduced surface water supply
30 reliability. The CVP and SWP water contractors receive variable water supplies
31 due to variations in hydrology and regulatory constraints and are accustomed to
32 responding accordingly. As a result of this variability, many water users have
33 developed or are developing complex water management strategies that include
34 numerous options. It is recognized that in some basins and subbasins, SGMA
35 actions could be implemented early, and sustainable groundwater management
36 might be fully underway by 2030. This would result in beneficial impacts on
37 groundwater resources in these areas.

38 There would be no adverse impacts associated with implementation of the
39 alternatives as compared to the No Action Alternative. Therefore, Alternatives 1
40 through 5 would not contribute cumulative impacts to groundwater as compared
41 to the No Action Alternative. However, implementation of No Action
42 Alternative and Alternative 5 (in the Central Valley, San Francisco Bay Area,
43 Central Coast, and Southern California regions) and Alternative 3 (in the San
44 Francisco Bay Area, Central Coast, and Southern California regions) as compared

1 to the Second Basis of Comparison would result in increased groundwater
2 pumping and associated potential for land subsidence and poorer groundwater
3 quality; and could contribute to cumulative impacts related to groundwater
4 conditions as compared to the Second Basis of Comparison conditions.

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