11. Groundwater Quality

11.1 Introduction

This chapter describes the groundwater quality setting for the Extended, Secondary, and Primary study areas. Descriptions and maps of these three study areas are provided in Chapter 1 Introduction. Groundwater quality can be affected by both natural and human-caused activities. In natural systems, the quality of groundwater results from geochemical reactions between the water and rock as the water flows from areas of recharge. Typically, the longer that groundwater remains in contact with soluble materials, the greater the concentrations of dissolved materials in the water (in addition to the effects of temperature, pressure, and solubility). The quality of groundwater can also change as a result of the mixing of waters from different aquifers. Human-caused effects on groundwater quality can occur directly by the infiltration of compounds, or indirectly by alteration of flow or geochemical conditions. Groundwater chemistry may be influenced by irrigation water, wastewater from human activities, and by-products from industrial activities. The regulatory setting for groundwater resources is presented in Appendix 4A Environmental Compliance.

This chapter focuses primarily on the Primary Study Area. Potential impacts in the Secondary and Extended study areas were evaluated and discussed qualitatively. Potential local and regional impacts from constructing, operating, and maintaining the alternatives were described and compared to applicable significance thresholds. Mitigation measures are provided for identified potentially significant impacts, where appropriate.

11.2 Environmental Setting/Affected Environment

11.2.1 Extended Study Area

11.2.1.1 Methodology

For the Extended Study Area, the existing groundwater quality conditions were evaluated using hydrologic regions as boundaries. There are 10 hydrologic regions in California; they consider varying climates, geography, and hydrology (See Figure 6-2 in Chapter 6 Surface Water Resources). These regions correspond to the state’s major water drainage basins. Using the drainage basins as planning boundaries allows logical tracking of natural water runoff and accounting of surface and groundwater supplies. The CVP and SWP service areas of the Extended Study Area are located within 9 of California’s 10 hydrologic regions. San Luis Reservoir falls within the San Joaquin River hydrologic region.

North Coast Hydrologic Region

Overall, groundwater quality in the North Coast Hydrologic Region is very good. Groundwater quality problems in this region include contamination from seawater intrusion and nitrates in shallow coastal groundwater aquifers; high total dissolved solids (TDS) and alkalinity in groundwater associated with the lake sediments of the Modoc Plateau basins; and iron, boron, and manganese in the inland groundwater basins of Mendocino and Sonoma counties. Septic tank failures in western Sonoma County, at Monte Rio and Camp Meeker, and along the Trinity River downstream of Lewiston Dam, are a concern because of potential impacts to groundwater wells (Department of Water Resources [DWR], 2005).

From 1994 through 2000, samples were taken from 584 public supply wells in 32 of the 63 basins and subbasins in this region. Of these wells, 95 percent met the state primary maximum contaminant levels (MCLs) for drinking water, and the remaining 5 percent of wells sampled exceeded one or more MCL (DWR, 2003).

San Francisco Bay Hydrologic Region

Groundwater quality throughout much of the San Francisco Bay Hydrologic Region is of good quality and suitable for most urban and agricultural uses with only local impairments, such as leaking underground storage tanks. Primary constituents of concern are high TDS, nitrate, boron, and organic compounds. The areas of high TDS (and chloride) concentrations are typically found in the region's groundwater basins that are situated close to the San Francisco Bay, such as the northern Santa Clara, southern Sonoma, Petaluma, and Napa valleys. Elevated levels of nitrate have been detected in a large percentage of private wells tested within the Coyote Subbasin and Llagas Subbasin of the Gilroy-Hollister Valley Groundwater Basin (in the Central Coast Hydrologic Region,) located to the south of the Santa Clara Valley (Santa Clara Valley Water District [SCVWD], 2001). The shallow aquifer zone within the Petaluma Valley also shows persistent nitrate contamination. Groundwater with high TDS, iron, and boron levels were present in the Calistoga area of Napa Valley, and elevated boron levels in other parts of Napa Valley make the water unfit for agricultural uses. Releases of fuel hydrocarbons from leaking underground storage tanks and spills/leaks of organic solvents at industrial sites have caused minor to potentially significant groundwater impacts in many basins throughout the region. Methyl tertiary butyl ether (MTBE) and chlorinated solvent releases to soil and groundwater continue to be problems (DWR, 2003).

From 1994 through 2000, samples were taken from 485 public supply water wells in 18 of the 33 basins and subbasins in this region. Analyzed samples indicate that 410 wells, or 85 percent, met the state primary MCLs for drinking water standards, and 75 wells, or 15 percent, have constituents that exceed one or more MCL (DWR, 2003).

Central Coast Hydrologic Region

Much of the groundwater in the Central Coast Hydrologic Region is impaired due to high mineralization. It is characterized by calcium sulfate to calcium sodium bicarbonate sulfate water types resulting from marine sedimentary rock in the watersheds. Water character is determined from chemical analyses by the dominant positively charged cation (e.g., sodium, calcium, or magnesium) with the dominantly negatively charged anion (e.g., chloride, sulfate, or bicarbonate). Where dominant cations and anions are not present there may be a combination of several compositions. Water quality problems most frequently encountered in the Central Coastal Basin pertain to excessive salinity or hardness of local ground waters. In some of the coastal groundwater basins, groundwater is pumped at a higher rate than the underground supply is replenished, such that seawater has pushed into some coastal freshwater aquifers and is degrading groundwater quality. Aquifers intruded by seawater are typically characterized by sodium chloride to calcium chloride, and have chloride concentrations greater than 500 milligrams per liter (mg/L). Groundwater basins that are affected by salinity include the Hollister area, the Carrizo Plain, the Santa Maria and Cuyama valleys, San Antonio Creek Valley, portions of the Santa Ynez Valley, and the Goleta and Santa Barbara areas. In several areas, groundwater exceeds the MCL for nitrate.

In the southern portion of Santa Clara County, elevated concentrations of nitrate and perchlorate have been detected. In late 2002, perchlorate emerged as a potentially significant groundwater contaminant in the southern end of Santa Clara County. The known extent of this groundwater chemical plume extends 10 miles, and more than 800 water supply wells have been affected (DWR, 2005).

From 1994 through 2000, samples were taken from 711 public supply water wells in 38 of the 60 basins and subbasins in this region. Analyzed samples indicate that 587 wells, or 83 percent, met the state primary MCLs for drinking water, and 124 wells, or 17 percent, have constituents that exceed one or more MCL (DWR, 2003).

South Coast Hydrologic Region

The South Coast Hydrologic Region is divided into three subregions: Los Angeles, Santa Ana and San Diego. Groundwater in basins of the Los Angeles subregion is mainly calcium sulfate and calcium bicarbonate in character. Nitrate content is elevated in some parts of the subregion. Volatile organic compounds (VOCs) have created groundwater impairments in some of the industrialized portions of the region. The San Gabriel Valley and San Fernando Valley groundwater basins both have multiple sites of contamination from VOCs. The main constituents in the contamination plumes are trichloroethylene (TCE) and tetrachloroethylene (PCE). Some of the locations have been declared federal Superfund sites. Contamination plumes containing high concentrations of TCE and PCE also occur in the Bunker Hill Subbasin of the Upper Santa Ana Valley Groundwater Basin. Some of these plumes are also designated as Superfund sites. Perchlorate is emerging as an important contaminant in several areas in this region.

Groundwater in basins of the Santa Ana subregion is primarily calcium and sodium bicarbonate in character. Local impairments from excess nitrate or VOCs have been recognized. Groundwater and surface water in the Chino Subbasin of the Santa Ana River Valley Groundwater Basin have elevated nitrate concentrations, partly derived from a large dairy industry in that area. In Orange County, water from the Santa Ana River provides a large part of the groundwater replenishment. The primary groundwater character in the San Diego subregion includes a combination of calcium and/or sodium cation, and bicarbonate and/or sulfate anions. Localized groundwater quality impairments by nitrate, sulfate, and TDS are found in this subregion. Camp Pendleton Marine Base, in the northwestern part of this subregion, is on the USEPA National Priorities List for soil and groundwater contamination by many constituents.

From 1994 through 2000, samples were taken from 2,342 public supply water wells in 47 of the 73 basins and subbasins in this region. Analyzed samples indicate that 1,360 wells, or 58 percent, met the state primary MCLs for drinking water, and 982 wells, or 42 percent, have constituents that exceed one or more MCL (DWR, 2003).

Sacramento River Hydrologic Region

Overall, groundwater quality in the Sacramento River Hydrologic Region is good, although there are local groundwater quality impairments. Natural water quality impairments occur at the northern end of the Sacramento Valley in the Redding subbasin, and along the margins of the valley and around the Sutter Buttes, where Cretaceous age marine sedimentary rocks containing brackish to saline water are near the surface. Groundwater near the Sutter Buttes is impaired because of local volcanic geology, and hydrogen sulfide is a problem in wells in the geothermal areas in the western part of the region. Human-induced impairments are usually associated with individual septic system development in shallow unconfined portions of aquifers, or in fractured hard rock areas where insufficient soil depths are available to properly leach effluent before it reaches the local groundwater supply. Some groundwater sources in this region do not meet State secondary MCLs for iron and manganese, and heavy metals from historical burn dumps also contaminate groundwater locally. In the Sierra foothills there is potential for encountering uranium and radon-bearing rock or sulfide mineral deposits containing heavy metals. Perchlorate, previously used as an oxidizer or booster for solid rocket fuel and now a human health concern in domestic water, has contaminated wells in Rancho Cordova, near Sacramento (DWR, 2005).

In the mountainous portions of this region, groundwater is of fairly good quality, but it may be contaminated by naturally occurring radon, uranium, or sulfide mineral deposits containing heavy metals. In particular, radon contamination is associated with granite, such as the granite batholith of the Sierra Nevada. Some groundwater sources do not meet State secondary MCLs for iron and magnesium. Also, because of the lack of community wastewater systems, individual septic tanks are prevalent for rural residential development in this region. The failure of septic tank systems can create sewage flows that have the potential to adversely affect nearby wells and groundwater quality.

From 1994 through 2000, samples were taken from 1,356 public supply water wells in 51 of the 88 basins and subbasins in the Sacramento River HR. Samples analyzed indicate that 1,282 wells, or 95 percent, met the state primary MCLs for drinking water, and 74 wells, or 5 percent, have constituents that exceed one or more MCL (DWR, 2003).

San Joaquin River Hydrologic Region

Groundwater quality throughout the San Joaquin River Hydrologic Region is adequate for most urban and agricultural uses. However, there are approximately 1,000 square miles overlying groundwater along the western edge of the valley floor that are contaminated with high salinity from naturally occurring marine sediments of the Coast Range. The salinity of groundwater in the region can increase as a result of agricultural practices in which the evapotranspiration of crops and wetlands leaves behind the majority of salts contained in the imported water (either imported surface water or groundwater). In addition, high water-table conditions underlying marginal lands along the western side of the San Joaquin River region contribute to subsurface drainage problems. To maintain a salt balance in the root zone, much of this salt is leached into the groundwater.

Nitrates that are generated from the disposal of human and animal wastes, or from the inefficient application of fertilizer and irrigation water, have contaminated 200 square miles of groundwater in the region, and threaten some domestic water supplies. Pesticides have contaminated 500 square miles of groundwater basins, primarily in agricultural areas on the east side of the San Joaquin Valley, where soil permeability is higher and the depth to groundwater is shallower. The entire Central Valley has approximately 500,000 single-family residential septic systems, each with leach fields that discharge to the groundwater. The most notable agricultural contaminant detected in groundwater samples from this region is dibromochloropropane (DBCP), which is a banned nematode pesticide that has been found mostly along the SR 99 corridor. There are also approximately 200 square miles of groundwater basins that are contaminated by naturally occurring selenium (DWR, 2005).

In the mountainous portions of this region, groundwater is of good quality, but it may be contaminated by naturally occurring radon, uranium, or sulfide mineral deposits containing heavy metals. In particular, radon contamination is associated with granite, such as the granite batholith of the Sierra Nevada. Some groundwater sources do not meet State secondary standards for both iron and magnesium. Also, because of the lack of community wastewater systems, individual septic tanks are prevalent for rural residential development in this region and have the potential to adversely affect nearby wells and groundwater quality.

From 1994 through 2000, samples were taken from 689 public supply water wells in 10 of the 11 basins and subbasins in this region. Samples analyzed indicate that 523 wells, or 76 percent, met the state primary MCLs for drinking water, and 166 wells, or 24 percent, have constituents that exceed one or more MCL (DWR, 2003).

Tulare Lake Hydrologic Region

Groundwater quality in the Tulare Lake Hydrologic Region is suitable for most beneficial uses; however, there are several areas with impairments to groundwater. On the region’s western side, salinity, sulfate, boron, chloride, and selenium limit the uses of groundwater. Salinity is the primary water quality factor affecting use of groundwater for irrigation and native habitat. Where groundwater quality is marginal to unusable for agriculture, farmers use good quality surface water to irrigate crops or blend higher quality surface water with poor quality groundwater to create a larger supply. The inefficiency of some crop irrigation systems can increase percolation of irrigation water into the shallow unconfined aquifers, causing drainage problems and degrading groundwater quality. This marginal to poor quality groundwater has mounded up to reach crop root zones in that area and is threatens the viability of agriculture there.

Agricultural runoff and drainage are also the main sources of nitrate, pesticides, and selenium that endanger groundwater and surface water beneficial uses. The basin also has a relatively large concentration of dairies that contribute microbes, salinity, and nutrients to both surface water and groundwater.

Nitrate has contaminated more than 400 square miles of groundwater in the Tulare Lake Basin. In addition, oilfield waste has affected water quality. There are more than 800 oilfield waste dischargers, of which 250 are regulated pursuant to waste discharge requirements (Central Valley Regional Water Quality Control Board [CVRWQCB], 2002).

Naturally occurring arsenic, as well as pesticides and industrial chemicals, have contaminated some groundwater supplies that are used for domestic water in the region. With newer federal and State drinking water rules being implemented over the past few years, numerous community domestic water well sources are noncompliant and have had to implement treatment methods or plans to reduce arsenic levels in drinking water. The contamination of almost 50 wells in Fresno/Clovis area due to high levels of DBCP and/or TCE, and other organic compounds resulted in the installation of activated charcoal filtration systems to remove these contaminants from the well water.

For many years, portions of the Tulare Lake region have experienced significant drainage problems, exacerbated by the fact that it is a basin with no significant water outflow to remove salts. The poorly drained area is concentrated along the western side of the San Joaquin Valley from Kern County north into the San Joaquin River Hydrologic Region. Although the San Joaquin Valley has some of the most productive agricultural lands in the world, much of the western side of the valley is plagued by poor subsurface drainage that adversely affects crop productivity. Between 1977 and 1991, the area affected by saline shallow groundwater on the western side doubled to approximately 1,200 square miles. A substantial portion of the valley, approximately 4,000 square miles, is threatened by saline shallow groundwater resulting from the lack of proper drainage (DWR, 2005).

From 1994 through 2000, samples were taken from 1,476 public supply water wells in 14 of the 19 groundwater basins and subbasins in this region. Evaluation of analyzed samples shows that 1,049 of the wells, or 71 percent, met the state primary MCLs for drinking water, and 427 wells, or 29 percent, exceeded one or more MCL (DWR, 2003).

South Lahontan Hydrologic Region

Groundwater quality in the South Lahontan Hydrologic Region is of good quality, although there are local impairments. The chemical character of the groundwater varies throughout the region, but most often is of calcium- or sodium-bicarbonate. Near and beneath dry lakes, sodium chloride and sodium sulfate-chloride water is common. Groundwater near the edges of valleys contains lower TDS content than water beneath the central part of the valleys or near dry lakes where water pools and dissolved chemicals concentrate as water evaporates, and may percolate through soils into the groundwater. At the lower elevations in this region, groundwater can be degraded, both naturally from geothermal activity, and as a result of activities such as recreational uses and cattle grazing. Arsenic, a known human carcinogen, is a health concern in the basin, and therefore, in Los Angeles as well. The vast majority of public water supply wells do meet drinking water standards. However, in places where these standards are exceeded, it is most often because of elevated levels of TDS, fluoride, or boron. The USEPA lists 13 sites of contamination in this region. Several domestic water supply wells in the Barstow area have been closed due to historical contamination from industrial and domestic wastewater. Three military installations in the southwestern part of the region are on the federal Superfund National Priorities List because of VOCs and other hazardous contaminants. In addition, the PG&E chromium groundwater contamination site in Hinkley is also within this region (DWR, 2005).

From 1994 through 2000, samples were taken from 605 public supply water wells in 19 of the 77 basins and subbasins in this region. Analyzed samples indicate that 506 wells, or 84 percent, met the state primary MCLs for drinking water, and 99 wells, or 16 percent, have constituents that exceed one or more MCL (DWR, 2003).

Colorado River Hydrologic Region

The groundwater in the Colorado River Hydrologic Region is impaired in many cases primarily due to high mineral concentrations. The chemical character of groundwater in this region is variable. Cation concentration is dominated by sodium, with calcium common and magnesium appearing less often. Bicarbonate is usually the dominant anion, although sulfate and chloride waters are also common. In basins with closed drainages, water character often changes from calcium-sodium bicarbonate near the margins to sodium chloride or chloride-sulfate beneath a dry lake. It is not uncommon for concentrations of dissolved constituents to rise dramatically toward a dry lake where saturation of mineral salts is reached. An example of this is found in the Bristol Valley Groundwater Basin, where the mineral halite (sodium chloride) is formed and then mined by evaporation of groundwater in trenches in Bristol (dry) Lake. The TDS content of groundwater is high in many of the basins in this region. High fluoride content is common; sulfate content occasionally exceeds drinking water standards; and high nitrate content is common, especially in agricultural areas. Potentially significant water quality concerns include nitrate pollution in Coachella Valley, Lucerne Valley, and Desert Hot Springs.

Two of the primary challenges in this region are overdraft in the Coachella Valley and leaking underground storage tanks. The USEPA has not yet placed any contamination sites in this region on the Superfund National Priorities List; however, one site is being considered because of high pesticide levels (DWR, 2005).

From 1994 through 2000, samples were taken from 314 public supply water wells in 23 of the 64 basins and subbasins in this region. Analyzed samples indicate that 270 wells, or 86 percent, met the state primary MCLs for drinking water standards, and 44 wells, or 14 percent, have constituents that exceed one or more MCL (DWR, 2003).

11.2.2 Secondary Study Area

11.2.2.1 Shasta Lake Area

The quality of water in underground basins and water-bearing soils is considered good throughout most of Shasta County. Little groundwater quality data are available from the vicinity of Shasta Lake because this area is not a designated groundwater basin. Potential hazards to groundwater quality involve nitrates and dissolved solids from agricultural and range practices, and septic tank failures. The ability of soils in Shasta County to support septic tanks and on-site wastewater treatment systems is for the most part severely limited, particularly on older valley terrace soils and certain loosely confined volcanic soils in the eastern portions of the county.

11.2.2.2 Sacramento River Downstream of Lake Shasta

The area of the Sacramento River downstream of Lake Shasta includes Keswick Reservoir, the RBPP, the Sutter Bypass, and the Yolo Bypass. In the Redding area downstream of Lake Shasta, groundwater composition varies. In some locations, it is characterized as magnesium-calcium bicarbonate and calcium-magnesium bicarbonate type water, some as magnesium-sodium bicarbonate and sodium-magnesium bicarbonate, some as sodium bicarbonate and sodium chloride type, and other areas as mixed cationic bicarbonate. TDS concentrations range from 70 to 360 mg/L (DWR, 2011a). Groundwater quality impairments include localized high boron, iron, manganese, and nitrate. High levels of total dissolved salts and chlorides are present in the lower Tehama and Tuscan formations. Sodium and boron is present at shallow depth where wells draw from the Chico Formation.

From the Shasta County line south, groundwater composition in the subbasins along the Sacramento River is characterized as calcium-magnesium bicarbonate and magnesium-calcium bicarbonate. TDS concentrations range from 120 to 558 mg/L (DWR, 2011a). Groundwater quality impairments are not widespread, are typically localized, and can include boron, chloride, high magnesium, TDS, calcium, and phosphorus. High nitrate concentrations have been noted in the Antelope area near Red Bluff (DWR, 1987) and in Chico (DWR, 1984). Also, in the Chico area, eight groundwater contamination plumes of PCE, TCE, pentachlorophenol, or chloroform were identified (California Department of Toxic Substances Control, 2004).

The U.S. Geological Survey (USGS), in cooperation with the California State Water Resources Control Board (SWRCB), sampled 66 wells in 2007 to 2008 in the Shasta and Tehama County area as part of their Groundwater Ambient Monitoring and Assessment (GAMA) Program. The concentrations of most constituents detected in groundwater samples from these wells were below drinking water thresholds. VOC and pesticides were detected in less than 25 percent of the samples and were generally less than one hundredth of any health-based threshold. N-nitrosodimethylamine was detected above the California Notification Level in one grid well. Concentrations of all nutrients and trace elements in samples from study unit wells were below the health based thresholds, with the exception of arsenic in three samples, which was above the California MCL A few samples contained iron, manganese, or pH at levels above the California secondary MCL or USEPA secondary MCL (USGS, 2009).

From Orland south, on the western side of the Sacramento River, calcium-magnesium bicarbonate and magnesium-calcium bicarbonate are the predominant groundwater types. Calcium bicarbonate waters occur locally from Orland to Artois, and near Stony Creek. Mixed character waters for different regions of the subbasin occur as follows: sodium bicarbonate waters from the Williams-Colusa area south to Grimes; magnesium-sodium bicarbonate or sodium-magnesium bicarbonate waters near the

Williams-Arbuckle area and locally near Zamora; and magnesium bicarbonate waters locally near Dunnigan. TDS values range from 120 to 1,220 mg/L, averaging 391 mg/L. Impairments in this range include high electrical conductivity (EC), TDS, nitrate; manganese impairments occur near Colusa. High TDS and boron occur near Knights Landing. High nitrates occur in Arbuckle, Knights Landing, and Willows. Localized areas have high manganese, fluoride, magnesium, sodium, iron, chloride, TDS, ammonia, and phosphorus (DWR, 2003).

In Sutter County, data collected by DWR from several wells indicate a TDS range of 133 to 1,660 mg/L. The primary groundwater chemistry in the subbasin is characterized by calcium, magnesium, sodium, chloride, sulfate and bicarbonate, which may occur in any combination. Groundwater containing calcium-magnesium bicarbonate or magnesium-calcium bicarbonate exists in the northwestern portion of the subbasin. Some groundwater quality data collected indicates some wells drilled to various depths contain chemical elements and compounds in amounts that exceed drinking water quality safety and aesthetic standards. Groundwater quality impairments in some portions of the County have naturally occurring levels of minerals, which present some concerns (taste, economics) (DWR, 2003).

The USGS collected samples from 108 wells in Butte, Colusa, Glenn, Sutter, Tehama, Yolo, and Yuba counties as part of the GAMA program (it also covers portions east of the Sacramento River presented in the Feather River discussion in Section 11.2.2.5). Most constituents that were detected in groundwater samples were found at concentrations below drinking water thresholds. VOCs were detected in less than 33 percent of the wells, and pesticides and pesticide degredates in more than 50 percent of the wells. All detections of these constituents in samples from all wells of this study unit were below health-based thresholds. All detections of trace elements in samples from this study unit's wells were below health-based thresholds, with the exceptions of arsenic and boron. Arsenic concentrations were above the California MCL threshold in eight grid wells, and boron concentrations were above the California notification level in two wells. Although the USGS study was primarily designed to evaluate quality for drinking water wells, they did sample some other well types to add additional information to the study. Arsenic was detected above the California MCL in two of these wells, and arsenic, barium, boron, molybdenum, strontium, and vanadium were detected above health-based thresholds in a few rice irrigation wells; again these wells are not used to supply drinking water. Chloride and sulfate concentrations exceeded California secondary MCL thresholds in two wells and one well, respectively. Iron, manganese, and TDS concentrations were above the California secondary MCL thresholds in 1, 12, and 6 wells, respectively. Nitrate (nitrite plus nitrate, as dissolved nitrogen) concentrations from two wells were above the California MCL (USGS, 2008).

South of Colusa County, the Sacramento River flows between Yolo and Solano counties to the west, and Sacramento County to the east. To the east, on the northern side of the American River, the chemistry and quality of groundwater has been assessed for the American Basin. Many areas of good quality groundwater exist in the North American subbasin. In some portions of the basin, groundwater quality is marginal. The three major groundwater types are magnesium-calcium bicarbonate or calcium-magnesium bicarbonate; magnesium-sodium bicarbonate or sodium-magnesium bicarbonate; and sodium-calcium bicarbonate or calcium-sodium bicarbonate (DWR, 1997).

Comparison of groundwater quality data with applicable water quality standards and guidelines for drinking and irrigation indicate elevated levels of some water quality parameters. This list includes TDS/specific conductance (measurements of dissolved substances in water), chloride, sodium, bicarbonate, boron, fluoride, nitrate, and iron, manganese. Arsenic may also be of concern in some locations within the subbasin (DWR, 1997).

High TDS levels exist in an area along the Sacramento River extending from Sacramento International Airport northward to the Bear River. The highest levels of TDS are found in an area extending just south of Nicholas to Verona, between Reclamation District 1001 and the Sutter Bypass. Some wells in this area have reported TDS concentrations exceeding 1,000 mg/L. This same area along the Sacramento River extending from Sacramento International Airport northward to the Bear River also contains high levels of chloride, sodium, bicarbonate, manganese, and arsenic. The groundwater in the southern part of the basin is characterized as of fairy good quality, low in disinfection by-product precursor materials, and moderate in mineral content, although some localized contamination issues exist.

Impairments include three sites within the subbasin with potentially significant groundwater contamination issues: the former McClellan AFB, Union Pacific Railroad Rail Yard in Roseville, and the Aerojet Superfund Site. Although the Aerojet site is south of the North American subbasin, a contaminant plume (including TCE and PCE) extends north from Aerojet, under the American River, and into the North American subbasin as described in a 2000 study by Montgomery Watson (as cited in DWR, 2003). Other localized areas of contamination exist throughout the basin and are usually smaller in scope and extent of contamination (DWR, 2003).

On the south side of the American River, groundwater is typically characterized by calcium-magnesium bicarbonate or magnesium-calcium bicarbonate. Other minor groundwater types include sodium calcium bicarbonate or calcium sodium bicarbonate in the vicinity of Elk Grove, and a magnesium sodium bicarbonate or sodium magnesium bicarbonate near the confluence of the Sacramento and American rivers. TDS concentrations range from 24 to 581 mg/L, and average 221 mg/L, based on 462 records from a 1991 report by Bertoldi and others (as cited in DWR, 2003). Impairments to the south of the American River include seven sites within the subbasin with significant groundwater contamination, identified in a 1997 report by Montgomery Watson (as cited in DWR, 2003). Included in the list are three USEPA Superfund sites: Aerojet, Mather Field, and the Sacramento Army Depot. Other sites are the Kiefer Boulevard Landfill, an abandoned PG&E site on Jiboom Street near Old Sacramento, and the Southern Pacific and Union Pacific rail yards in downtown Sacramento (DWR, 2003).

To the west of Sacramento County, groundwater in the Yolo region is characterized as a sodium magnesium, calcium magnesium, or magnesium bicarbonate type. The quality is considered well for both agricultural and municipal uses, even though the water is considered hard to very hard (typically over 180 mg/L calcium carbonate). Selenium and boron are found in higher concentrations locally as noted in a 1985 report by KID. Evensong (as cited in DWR, 2003). TDS concentrations range from 107 to 1,300 mg/L, and average 574 mg/L noted in a 2000 report by California Department of Health Services (as cited in DWR, 2003). Localized impairments include elevated concentrations of boron (as high as 2 to 3 mg/L) in groundwater along Cache Creek and in the Cache Creek Settling Basin area (DWR, 2003). Woodland has experienced nitrate contamination in certain wells. The City of Davis has experienced selenium contamination and localized areas of nitrate contamination. The CVRWQCB reported several sites in Davis, Woodland, West Sacramento, and Dunnigan with MTBE contamination (Yolo County Flood Control and Water Conservation District, 2000).

Groundwater within the Solano subbasin is considered to be of fairly good quality, and useable for beneficial uses. Groundwater characterization is primarily magnesium bicarbonate in the central and northern areas, sodium bicarbonate in the southern and eastern areas, and calcium magnesium or magnesium calcium bicarbonate around and west of Dixon. TDS values range from between 250 and 500 mg/L in the northwestern and eastern portions of the basin, and are found at levels higher than 500 mg/L in the central and southern areas. Data from DHS show the TDS minimum of 150, maximum 880, and average of 427 mg/L. In general, most of the water within the subbasin is classified as hard to very hard. Chloride concentrations are found over 100 mg/L in the southern areas, while sulfate concentration is greater than 50 mg/L in the southern areas. Boron concentrations are less than 0.75 mg/L, except in the southern and southeastern basin where concentrations average between 0.75 and 2.0 mg/L. Iron concentrations increase toward the eastern side of the subbasin, from less than 0.02 mg/L to greater than 0.05 mg/L along the Sacramento River, and manganese concentrations also increase from west to east with concentrations from .01 to over 0.1 mg/L found north of Rio Vista and east of the Solano-Yolo County line. Groundwater in this area is rather hard. High concentrations of bicarbonate, which cause precipitation of calcium and magnesium carbonates, are found in the southern portion of the basin. Other impairments to groundwater include arsenic, where concentrations are typically between 0.02 and 0.05 mg/L, with the highest concentrations found along the southeastern margin of the basin, and manganese, which is found at concentrations above the MCL of 0.05 mg/L along the Sacramento River along the eastern portion of the subbasin (DWR, 2003).

Groundwater quality within the Capay Valley Subbasin is derived almost exclusively from Cache Creek and its tributaries. Consequently, water quality samples taken from Cache Creek within the Capay Valley reflect the quality of the water within the groundwater basin. Water samples taken from a diversion dam near the lower end of the Capay Valley indicate principally good quality calcium-sodium bicarbonate-type with moderate to very high hardness. Highly mineralized water from Bear Creek and North Fork Cache Creek is a primary source of mineral constituents, especially boron, in groundwater in the Capay Valley Subbasin. TDS measured in water taken from six wells in the Capay Valley range from approximately 300 to 500 mg/L and are comparable to those found in water samples taken from Cache Creek (DWR, 2003).

11.2.2.3 Whiskeytown Area

The Whiskeytown area includes Whiskeytown Lake, Clear Creek, and Spring Creek. Little information is available from the mountainous portions of the Clear Creek and Spring Creek watersheds regarding groundwater quality because these creeks are not located within a defined groundwater basin, and as such, have not been assessed. Most groundwater in this area is high in iron and aluminum due to the minerals in the rock (National Park Service, 2004).

After Clear Creek enters the valley floor, it enters the Redding Groundwater Basin and Anderson Subbasin. Groundwater in the subbasin is characterized as magnesium-sodium bicarbonate and sodium-magnesium bicarbonate type waters. TDS concentrations range from 109 to 320 mg/L, averaging 194 mg/L. Localized areas with high iron, manganese, and nitrate occur in the subbasin (DWR, 2003).

11.2.2.4 Trinity River Watershed

The Trinity River watershed includes Trinity Lake, the Trinity River, Lewiston Lake, and the Klamath River downstream of the Trinity River. Nearly the entire length of the Trinity River watershed is outside of defined groundwater basins. Therefore, groundwater quality information is sparse. Septic tank failures along the Trinity River downstream from Lewiston Dam are a concern because of potential impacts to groundwater wells and recreational water quality (DWR, 2005).

In the Hoopa area, groundwater is predominantly **c**alcium-magnesium bicarbonate in character. TDS concentrations range from 95 to 159 mg/L, and average 125 mg/L. The primary groundwater quality impairments in the basin are locally high iron concentrations, and low pH values (most ranging from 6.1 to 6.9) (DWR, 2011a).

In the Lower Klamath River Valley area, groundwater is predominantly calcium bicarbonate. TDS concentrations range from 49 to 508 mg/L, and average 196 mg/L. Localized areas with high aluminum, iron, manganese, and TDS occur in the basin (DWR, 2011a).

11.2.2.5 Feather River Area

The Feather River area includes Lake Oroville, the Feather River, and the Thermalito Complex. Groundwater in the area of the Feather River downstream of Lake Oroville, as it flows through Butte County, is predominantly calcium-magnesium bicarbonate and magnesium-calcium bicarbonate waters in the Sacramento River Hydrologic Region. Magnesium bicarbonate waters occur locally near the Biggs-Gridley area, south and east to the Feather River. TDS concentrations range from 75 to 801 mg/L, averaging 235 mg/L (DWR, 2004). Localized high concentrations of manganese, iron, magnesium, TDS, specific conductance, and calcium occur in this area (DWR, 2003).

As the Feather River flows through Yuba County, the good groundwater quality characteristics are apparent in the overall salinity of groundwater in the Secondary Study Area. TDS concentrations in the area are typically below 500 mg/L throughout the entire basin. Data collected from wells indicate a TDS concentration range of 141 to 686 mg/L. The primary water chemistry in the area indicates calcium-magnesium bicarbonate or magnesium-calcium bicarbonate groundwater. Some magnesium bicarbonate exists in the northwestern portion of the basin (DWR, 2003).

In the Sutter County area, the region includes both the Feather and Sacramento rivers as they near their confluence. Therefore, groundwater quality co increased levels of selenium present in the groundwater supplies for the City of Davis, conditions are similar to those discussed in the appropriate areas for the Sacramento River downstream of Lake Shasta (Section 11.2.2.2).

Also, the USGS did some water quality sampling in this area for the GAMA Program, as discussed previously in Section 11.2.2.2 (Sacramento River Downstream of Lake Shasta), because their sampling encompassed the entire mid portion of the Sacramento Valley.

11.2.2.6 American River Area

The American River area includes Folsom Lake, the American River, and Lake Natoma. In the area near Sacramento, the region includes both the American and Sacramento rivers as they near their confluence. Therefore, groundwater quality conditions are similar to those discussed in the appropriate areas for the Sacramento River downstream of Lake Shasta (Section 11.2.2.2).

11.2.2.7 Delta Region

The Delta region includes the Sacramento-San Joaquin Delta and Suisun Bay. Groundwater quality throughout most of the Delta region is suitable for some urban and agricultural uses, with only local impairments. The character of the groundwater varies in different portions of the Delta. The primary constituents of concern are high TDS, nitrate, boron, chloride, and organic compounds. Other constituents that may have local impairments include arsenic and manganese. As a result of declining water levels, poor quality water has been moving to the east in the Stockton area. Projections indicate that a saline front is moving to the east approximately 150 to 250 feet per year. Groundwater extraction in the Eastern San Joaquin Subbasin has increased the flow of saline water from the west. There is a concern that the eastward migration of saltwater will degrade portions of the basin, rendering the groundwater unsuitable for urban and agricultural purposes (San Joaquin County Department of Public Works, 2004).

11.2.2.8 San Francisco Bay Area

The San Francisco Bay area includes San Pablo Bay and San Francisco Bay. Groundwater quality throughout most of the region is suitable for urban and agricultural uses, with only local impairments, such as leaking underground storage tanks. Groundwater in the Livermore Valley and Niles Cone (southern Alameda County) basins has high levels of TDS, chloride, boron, and hardness, such that both Alameda County Flood Control and Water Conservation District-Zone 7 and Alameda County Water District are implementing wellhead demineralization projects to improve the quality of this groundwater supply. In the Santa Clara Valley region, some of the underlying groundwater supplies are threatened by pollutants from various industrial activities and historical agriculture. SCVWD works to protect the quality of these supplies by aggressively responding to pollution threats, such as MTBE, PCE, TCE, and perchlorate. These pollution threats are individually identified and evaluated to prevent or mitigate for groundwater contamination. Elsewhere, groundwater in Petaluma Valley and the Gilroy-Hollister Valley has high levels of nitrate, which adversely affects the ability to use domestic wells for drinking water purposes. Groundwater recharge projects and the use of imported water have effectively halted land subsidence in most areas, and have successfully stopped or reversed seawater intrusion into aquifers around the bay (DWR, 2005).

11.2.3 Primary Study Area

11.2.3.1 Sites Reservoir, Dams, and Recreation Areas

Groundwater quality data for the Sites Reservoir Project (Project) area are limited.[1] Fifteen wells within the Project footprint were sampled in 2005. Groundwater quality in the Project footprint and adjacent area was fair, but high in mineral content. Salinity, measured as specific conductance, ranged from 680 to 2,190 micromhos per centimeter (µmhos/cm), and TDS values ranged from 375 to 1,291 mg/L. Sampling revealed that no Primary MCLs were exceeded. Of the 15 wells sampled, Secondary MCLs were exceeded for TDS in 14 wells, specific conductance in 12 wells, sulfate in 4 wells, pH in 3 wells, manganese and iron in 2 wells, and aluminum and chloride in 1 well each. Agricultural Water Quality Goals from the Food and Agriculture Organization of the United Nations (CVRWQCB, 2011) were exceeded for specific conductance and TDS in 14 wells each, sodium in 13 wells, chloride in 8 wells, boron in 6 wells, pH in 3 wells, and selenium in 1 well (Appendix 11A Groundwater Study Results 2007).

11.2.3.2 Holthouse Reservoir Complex

In the area of the proposed Holthouse Reservoir Complex, which includes the existing Funks Reservoir, there are few wells. One well could be sampled that was near this area. Groundwater from this well was extremely high in mineral content; for example, the specific conductance for this well was 38,200 µmhos/cm, and the TDS concentration was 27,400 mg/L. The Primary MCL for arsenic was exceeded. Secondary MCLs were exceeded for chloride, specific conductance, manganese, and TDS Agricultural Water Quality Goals were exceeded for boron, chloride, and manganese (Appendix 11A Groundwater Study Results 2007).

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[1] There is a limited number of well logs for wells in the Project area. Several of these wells were not in use or were otherwise unable to be sampled. There are also several wells in this area for which no well log was available. Two of these wells were sampled to provide data in areas where no other wells were located and where adequate well construction data were provided by the owner/ranch manager.

11.2.3.3 Glenn-Colusa Irrigation District Canal

Groundwater data from 19 wells in the vicinity of the Glenn-Colusa Irrigation District (GCID) Main Canal indicate good quality groundwater in this area. Impairments were not noted to be extensive, but some groundwaters had high mineral content. Specific conductance values ranged from 223 to 1,074 µmhos/cm, and TDS values ranged from 120 to 649 mg/L. Primary MCLs exceeded were for nitrite plus nitrate in two wells, and arsenic in one well. Secondary MCLs were exceeded for iron in four wells, TDS in three wells, and aluminum and specific conductance in two wells each. Agricultural Water Quality Goals were exceeded for specific conductance in eight wells, TDS in five wells, sodium in six wells, and copper in one well (DWR, 2007).

11.2.3.4 Tehama-Colusa Canal

Groundwater data from 58 wells sampled along the length of the Tehama-Colusa Canal indicate that the quality of the groundwater along the canal is good, with a few impairments. Specific conductance ranged from 138 to 986 µmhos/cm, and TDS values ranged from 112 to 520 mg/L. Nitrate values exceeded the Primary MCL from one well. Secondary MCLs were exceeded for specific conductance, iron, and TDS in three wells each, and pH in one well. Agricultural Water Quality Goals were exceeded for specific conductance in five wells, boron and TDS in three wells each, copper and sodium in two wells each, and pH in one well (DWR, 2007).

11.2.3.5 Delevan Pipeline, Terminal Regulating Reservoir Pipeline, Terminal Regulating Reservoir Pipeline Road, Sites/Delevan Overhead Power Line, and Delevan Pipeline Electrical Switchyard

Data from 19 wells in the vicinity of the Delevan Pipeline, Terminal Regulating Reservoir (TRR) Pipeline, TRR Pipeline Road, Sites/Delevan Overhead Power Line, and Delevan Pipeline Electrical Switchyard locations indicate that groundwater quality in this area is good; however, there are some impairments. This area had groundwater with a high mineral content, but concentrations were lower in proximity to the Sacramento River. Specific conductance values ranged from 324 to 2,245 µmhos/cm, and TDS ranged from 204 to 1,324 mg/L. The Primary MCL for arsenic was exceeded in four wells. Secondary MCLs were exceeded for manganese and specific conductance in nine wells each, TDS in eight wells, iron in five wells, and aluminum and sulfate in one well each. Recommended Agricultural Water Quality Limits were exceeded for sodium in 12 wells, specific conductance in 11 wells, TDS in 9 wells, chloride and manganese in 3 wells each, and iron in 1 well (DWR, 2007).

11.2.3.6 Terminal Regulating Reservoir, Glenn-Colusa Irrigation District Canal Connection to the Terminal Regulating Reservoir, Terminal Regulating Reservoir Pumping/Generating Plant, and Terminal Regulating Reservoir Electrical Switchyard

Data from four wells near the locations of the proposed TRR, GCID Main Canal Connection to the TRR, TRR Pumping/Generating Plant, and the TRR Electrical Switchyard indicate that groundwater quality in this area is fairly good, but high in mineral content. Specific conductance values ranged from 444 to 1,104 µmhos/cm, and TDS ranged from 259 to 608 mg/L. No Primary MCLs were exceeded. Secondary MCLs were exceeded for specific conductance and TDS in two wells each. Agricultural Water Quality Limits were exceeded for sodium in three wells, specific conductance and TDS in two wells each, and chloride in one well (DWR, 2007).

11.2.3.7 Delevan Pipeline Intake/Discharge Facilities

Data from nine wells near the proposed Delevan Pipeline Intake/Discharge Facilities location indicate that groundwater quality is good but high in mineral content. Specific conductance values ranged from 324 to 1,090 µmhos/cm, and TDS ranged from 204 to 622 mg/L. The Primary MCL for arsenic was exceeded in one well. Secondary MCLs were exceeded for manganese in six wells, specific conductance and iron in three wells each, and TDS in 2 wells. Recommended Agricultural Water Quality Limits were exceeded for specific conductance, sodium, and TDS in three wells each; manganese in two wells; and for arsenic, chloride, and iron in one well each (DWR, 2007).

11.2.3.8 Road Relocations, South Bridge, Sites Reservoir Inlet/Outlet Structure, Sites Pumping/Generating Plant, Sites Electrical Switchyard, Tunnel from Sites Pumping/Generating Plant to Sites Reservoir Inlet/Outlet Structure, and Field Office Maintenance Yard

Data from 21 wells near the locations of the proposed Road Relocations, South Bridge, Sites Reservoir Inlet/Outlet Structure, Sites Pumping/Generating Plant, Sites Electrical Switchyard, Tunnel from Sites Pumping/Generating Plant to Sites Reservoir Inlet/Outlet Structure, and Field Office Maintenance Yard were reviewed for groundwater quality in this area. The groundwater quality is fairly good, but impaired somewhat by high mineral content. Specific conductance values ranged from 290 to 2,190 µmhos/cm with 1 well at 38,200 µmhos/cm, and TDS ranged from 169 to 1,291 mg/L with 1 well at 27,400 mg/L. The Primary MCL for arsenic was exceeded from one well. Secondary MCLs were exceeded for TDS in 15 wells, specific conductance in 13 wells, manganese, pH, and sulfate each in three wells, and chloride and iron each in two wells. Agricultural Water Quality Goals were exceeded for specific conductance, sodium, and TDS in 14 wells each, chloride in 8 wells, boron in 6 wells, pH in 3 wells, and selenium in 1 well (DWR, 2007).

11.2.3.9 Project Buffer

The Project Buffer would surround groupings of Project facilities. Groundwater quality within the Project Buffer would, therefore, be the same as described for each of the Project facilities that are surrounded by the Project Buffer.

11.3 Environmental Impacts/Environmental Consequences

11.3.1 Evaluation Criteria and Significance Thresholds

Significance criteria represent the thresholds that were used to identify whether an impact would be potentially significant. Appendix G of the *CEQA Guidelines* suggests the following evaluation criteria for hydrology and groundwater quality (no criteria are specifically directed at groundwater quality):

Would the Project:

- Violate any groundwater quality standards or waste discharge requirements?
- Otherwise substantially degrade groundwater quality?

These evaluation criteria used for this impact analysis represent a combination of Appendix G criteria and professional judgment that considers current regulations, standards, and/or consultation with agencies, knowledge of the area, and the context and intensity of the environmental effects, as required pursuant to

NEPA. For the purposes of this analysis, an alternative would result in a potentially significant impact to groundwater quality if it would result in any of the following:

- A violation of any groundwater quality standards or waste discharge requirements, a change in groundwater quality resulting in adverse effects on designated beneficial uses of groundwater, or otherwise substantially degrade groundwater quality

11.3.2 Impact Assessment Assumptions and Methodology

Combinations of Project facilities were used to create Alternatives A, B, C, C_1, and D. In all resource chapters, the Authority and Reclamation described the potential impacts associated with the construction, operation, and maintenance of each of the Project facilities for each of the five action alternatives. Some Project features/facilities and operations (e.g., reservoir size, overhead power line alignments, provision of water for local uses) differ by alternative and are evaluated in detail within each of the resource areas chapters. As such, the Authority has evaluated all potential impacts with each feature individually and may choose to select or combine individual features as determined necessary.

Impacts associated with the construction, operation, and maintenance for Alternative C_1 would be the same as those for Alternative C and are therefore not discussed separately below.

11.3.2.1 Assumptions

The following assumptions were made regarding Project-related construction, operation, and maintenance impacts to groundwater quality:

- Direct Project-related construction, operation, and maintenance activities would occur in the Primary Study Area.
- Direct Project-related operational effects would occur in the Secondary Study Area.
- The only direct Project-related construction activity that would occur in the Secondary Study Area is the installation of two additional pumps into existing bays at the Red Bluff Pumping Plant.
- The only direct Project-related maintenance activity that would occur in the Secondary Study Area is sediment removal and disposal at the two intake locations (i.e., GCID Main Canal Intake and Red Bluff Pumping Plant).
- No direct Project-related construction or maintenance activities would occur in the Extended Study Area.
- Direct Project-related operational effects that would occur in the Extended Study Area are related to San Luis Reservoir operation; increased reliability of water supply to agricultural, municipal, and industrial water users; and the provision of an alternate Level 4 wildlife refuge water supply. Indirect effects on the operation of certain facilities that are located in the Extended Study Area, and indirect effects on the consequent water deliveries made by those facilities, would occur as a result of implementing the alternatives.
- The existing bank protection located upstream of the proposed Delevan Pipeline Intake/Discharge facilities would continue to be maintained and remain functional.

- No additional channel stabilization, grade control measures, or dredging in the Sacramento River at or upstream of the Delevan Pipeline Intake/Discharge facilities would be required.
- Project construction, operation, and maintenance activities will be performed after obtaining the appropriate clearances and permits (such as waste discharge requirement permits from the CVRWQCB).

11.3.2.2 Methodology

Existing conditions and the future No Project/No Action alternatives were assumed to be similar in the Primary Study Area given the generally rural nature of the area. Also, there is limited potential for growth and development in Glenn and Colusa counties within the 2030 study period used for this EIR/EIS, as further described in Chapter 2 Alternatives Analysis. As a result, within the Primary Study Area, it is anticipated that the No Project/No Action Alternative would not entail material changes in conditions as compared to the existing conditions baseline.

With respect to the Extended and Secondary study areas, the effects of the proposed action alternatives would be primarily related to changes to available water supplies in the Extended and Secondary study areas. Effects would also be related to the Project’s cooperative operations with other existing large reservoirs in the Sacramento watershed, and the resultant potential impacts and benefits to biological resources, land use, recreation, socioeconomic conditions, and other resource areas. DWR has projected future water demands through 2030 conditions, which assumes that the majority of CVP and SWP water contractors would use their total contract amounts, and that most senior water rights users would use most of their water rights. This increased demand, in addition to the projects currently under construction and those that have received approvals and permits at the time of preparation of the EIR/EIS, would constitute the No Project/No Action Condition. As described in Chapter 2 Alternatives Analysis, the primary difference in these projected water demands would be in the Sacramento Valley. As of the time of preparation of this EIR/EIS, the water demands have expanded to the levels projected to be achieved by 2030.

Accordingly, existing conditions and the No Project/No Action alternatives are assumed to be the same for this EIR/EIS and, as such, are referred to as the Existing Conditions/No Project/No Action Condition, which is further discussed in Chapter 2 Alternatives Analysis. With respect to applicable reasonably foreseeable plans, projects, programs, and policies that may be implemented in the future but that have not yet been approved, these are included as part of the analysis of cumulative impacts in Chapter 35.

A combination of data, published reports, modeling results, and professional experience with activities similar to those proposed was used to evaluate the potential impacts on groundwater quality from the alternatives. The data (detailed below) were used to assess existing groundwater quality and anticipate potential impacts that could result from Project-related activities in the three study areas.

The Extended and Secondary study area impact assessments relied on hydrologic and operational modeling performed using CALSIM II, which provided monthly river flows, and reservoir water surface elevations derived from monthly river flows and end-of-month reservoir storages, for the period of simulation extending from water year 1922 through 2003 (82-year simulation period). Detailed discussion of the CALSIM II model is provided in Appendix 6B Water Resources System Modeling. These modeling results were used in combination with professional judgment to assess the potential impacts of operation of the alternatives on groundwater quality.

Changes in groundwater flow directions could potentially result in the migration of lower quality groundwater into areas of higher quality groundwater. Potential impacts on groundwater quality from Project operations in the Secondary Study Area were further assessed by evaluating the potential for variations in groundwater flow directions resulting from changes in groundwater/surface water interaction because of increased or decreased Sacramento River diversions. Changes in groundwater flow directions resulting from potential changes in groundwater/surface water interaction were evaluated using a combination of CALSIM II and Central Valley Hydrologic Model modeling. The methodology used to estimate changes in groundwater/surface water interaction and resulting changes in groundwater and stream stage elevations (thereby flow directions) are described in Chapter 10 and Appendix 10A Groundwater Modeling.

DWR Bulletin 118-03 (DWR, 2003) was referenced to identify the groundwater basins within the Extended, Secondary, and Primary study areas, and to assess the groundwater quality within those basins from earlier assessments. In addition, DWR groundwater monitoring data (DWR, 2011a) were reviewed for the Primary and Secondary study areas. A survey of DWR well completion report records (DWR, 2011b) was conducted to determine the number and location of wells in the Primary Study Area.

Previously completed studies of potential project effects on groundwater quality, including an Oroville Facilities Federal Energy Regulatory Commission Relicensing groundwater study, were evaluated to determine the type and severity of impacts that might result in the Primary Study Area from Project-related activities. Worst-case specific EC conditions were simulated to assess the surface water quality of the proposed Sites Reservoir (refer to Appendix 7C Surface Water Quality Analysis for Electrical Conductivity at Proposed Intakes for a detailed description of the EC Mass Balance Approach and modeling results). Expected surface water quality conditions were then compared to existing groundwater quality conditions to determine if an adverse impact could occur.

Potential impacts of long-term reservoir seepage on groundwater flow directions in the Primary Study Area were forecast using a numerical groundwater flow model, SACFEM_{2013}. The methodology used to estimate seepage from the reservoirs and simulate the potential increase in groundwater levels within the Sacramento Valley Groundwater Basin are described in Chapter 10 and Appendix 10A Groundwater Modeling. Potential impacts to groundwater quality resulting from changes in groundwater flow directions were evaluated graphically by plotting groundwater flow direction vectors for the Existing Conditions/No Project/No Action Condition and the Alternative B groundwater flow model simulations. As discussed in Chapter 10, groundwater flow model impacts were performed for the Alternative B configuration because this configuration represented the largest footprint and highest operating stage for Sites Reservoir. Because the footprint and operational stage for Alternative A is smaller or lower than for Alternative B, potential changes in groundwater flow directions associated with Alternative A would be smaller than those for Alternative B. The footprints and operational stages for Alternatives C and D are the same as those for Alternative B; therefore, changes in groundwater flow directions would also be the same. Topics Eliminated from Further Analytical Consideration

No Project facilities or topics that are included in the significance criteria listed above were eliminated from further consideration in this chapter.

11.3.3 Impacts Associated with Alternative A

11.3.3.1 Extended Study Area – Alternative A

Construction, Operation, and Maintenance Impacts

Agricultural, Municipal, Industrial, and Wildlife Refuge Water Use

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Changes in Groundwater Flow Directions

Because there would not be any Project-related construction work or maintenance activities in the Extended Study Area, there would be **no impact** to groundwater quality associated with these activities.

The provision of an alternate source of wildlife refuge water supply would not affect groundwater flow directions (by changing rates of groundwater use), and would, therefore, have **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Project operation would have a beneficial, albeit limited, impact by increasing surface water supply reliability and consequently reducing reliance on groundwater in the CVP and SWP service areas within the Extended Study Area. Increased surface water supply reliability to agricultural, industrial, and municipal water users could result in decreased groundwater pumping. Decreased groundwater pumping would allow groundwater basins to recharge, resulting in improved groundwater quality. Additionally, irrigating with lower salinity water supplied from the Project, rather than groundwater, could alleviate existing increasing soil and groundwater salinity problems that result from evapotranspiration. Therefore, operational effects on groundwater quality within the Extended Study Area would be **beneficial**, when compared to the Existing Conditions/No Project/No Action Condition.

San Luis Reservoir

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Changes in Groundwater Flow Directions

Operational modeling for Alternative A, when compared to the Existing Conditions/No Project/No Action Condition, indicates that operation of the Project would result in continued water level fluctuations at San Luis Reservoir. Surface water elevation conditions (thereby groundwater recharge and flow directions) would be similar under Alternative A and under the Existing Conditions/No Project/No Action Condition, resulting in **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

11.3.3.2 Secondary Study Area – Alternative A

Construction, Operation, and Maintenance Impacts

Trinity Lake, Lewiston Lake, Trinity River, Klamath River Downstream of the Trinity River, Whiskeytown Lake, Spring Creek, Shasta Lake, Sacramento River, Keswick Reservoir, Clear

Creek, Lake Oroville, Thermalito Complex (Thermalito Diversion Pool, Thermalito Forebay, and Thermalito Afterbay), Feather River, Sutter Bypass, Yolo Bypass, Folsom Lake, Lake Natoma, American River, Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay, San Francisco Bay

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Changes in Groundwater Flow Directions

Project operation would result in improved surface water storage in reservoir facilities within the Secondary Study Area, which could slightly increase seepage and soil percolation that recharges groundwater in these areas. These changes are not expected to substantially affect groundwater quality. As discussed in Chapter 10, model output indicates that Project diversions under Alternative A would not result in significant changes to groundwater/surface water interaction or groundwater and stream elevations (thereby groundwater flow directions) as compared to the Existing Conditions/No Project/ No Action Condition and would have a **less-than-significant impact** on groundwater quality within the Secondary Study Area.

The installation, operation, and maintenance of an additional pump into an existing bay at the RBPP would have **no impact** on groundwater quality because it would neither extract groundwater nor increase groundwater recharge (thereby changing groundwater flow directions), when compared to the Existing Conditions/No Project/No Action Condition.

Hazardous Materials

The only direct Project-related maintenance activity that would occur within the Secondary Study Area is associated with the removal of sediment from the two existing canal intakes. Potential contamination of groundwater from hazardous materials would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

11.3.3.3 Primary Study Area – Alternative A

Construction, Operation, and Maintenance Impacts

Sites Reservoir Inundation Area

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Changes in Surface Water Infiltration and Groundwater Flow Directions

It is likely that, despite the grouting of the underlying rock formations, some water would leak from the reservoir and could increase groundwater recharge in nearby areas outside of the reservoir inundation area. Surface water quality modeling results indicate a worst-case long-term average EC of 190 to 192 µmhos/cm in Sites Reservoir (Appendix 7C Surface Water Quality Analysis for Electrical Conductivity at Proposed Intakes), as compared to the range in EC of 680 to 2,190 µmhos/cm measured for existing groundwater quality conditions within the reservoir footprint. The weight of the reservoir could, therefore, force higher quality surface water into the reservoir floor. There would also be additional percolation of surface water into the soils, and therefore, groundwater, beneath the reservoir. This surface water could beneficially alter shallow groundwater chemistry in and immediately around the reservoir. Therefore, reservoir inundation could have a **beneficial effect** to shallow groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Potential rates of seepage from the 1.3-million-acre-foot (MAF) Sites Reservoir footprint under the maximum Alternative A reservoir stage of approximately 480 feet North American Vertical Datum, 1988 (NAVD88) were estimated to be approximately 1,500 gallons per minute (gpm). As discussed in Chapter 10, the potential for reservoir seepage to result in changes in groundwater flow directions within the Colusa Subbasin was evaluated for the 1.8-MAF Sites Reservoir footprint, 520-foot NAVD88 operating stage for Alternative B. As discussed in Section 11.3.4, the model forecast changes in groundwater flow directions associated with the larger Sites Reservoir were minor as compared to the Existing Conditions/No Project/No Action Condition. Because the Alternative A Sites Reservoir is smaller than the Alternative B Sites Reservoir, the changes in groundwater flow directions resulting from reservoir seepage would also be smaller. Therefore, construction, operation, and maintenance of the Alternative A Sites Reservoir would have a **less-than-significant impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Salt Lake

As discussed in Chapter 3, a saline seep is present approximately 4 miles north of the town of Sites near the Salt Lake Fault. The saline seep, Salt Lake, is within the proposed inundation area of Sites Reservoir. The hydraulic pressure of the water column following reservoir inundation could reduce the rate of discharge of saline water in this area or reverse the hydraulic gradient such that seepage from the spring is eliminated. Depending on the nature of the source of the seep and the subsurface geologic structures, saline water may discharge in other areas. As described in Chapter 3, Salt Lake would be pressure grouted, and/or concrete caps would be constructed to avoid potential reservoir water quality issues. Additionally, existing salt deposits and highly saline soils in and surrounding Salt Lake will be capped with clay materials from construction of the dams and other project facilities to minimize potential surface seepage of saline water, which may follow new discharge pathways following inundation of Sites Reservoir. As detailed in Section 3.5 Environmental Commitments Included as Part of the Project and Alternatives, subsurface investigations would be conducted to confirm the nature and extent of the springs to design the appropriate treatment. Future observation of saline seeps outside of the reservoir or changed conditions of the springs once the reservoir is filled would be addressed by regular reservoir and facilities maintenance procedures. Grout and concrete caps would be engineered, designed, and constructed to prevent seepage using standard engineering practices. Therefore, construction, operation, and maintenance of the Alternative A Sites Reservoir would have a **less-than-significant impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Hazardous Materials

During construction in the Sites Reservoir Inundation Area it is possible that the operation and maintenance of construction equipment could result in hazardous materials spills. Potential contamination of groundwater from hazardous materials would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Abandoned Wells, Septic Systems, or Underground Storage Tanks

There are approximately 26 wells and numerous septic systems located within the proposed reservoir inundation area. In addition to water wells, there may be current or historic oil and gas wells, test wells, and/or boreholes. All well types, boreholes, and septic systems will be located, identified, and properly abandoned before or during construction to avoid possible contamination resulting from their improper abandonment and consequent inundation. These wells, boreholes, and septic systems are proposed in the environmental commitments included as part of the Project identified in Chapter 3. As such, **no impact** to groundwater quality is anticipated, when compared to the Existing Conditions/No Project/No Action Condition.

Sites Reservoir Dams

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Changes in Surface Water Infiltration and Groundwater Flow Directions

Sites and Golden Gate dams would be constructed on Stone Corral and Funks creeks, respectively; flows to those creeks would be maintained during construction. Some redirection of creek flows and stormwater management during construction may result in very minor redirection of groundwater recharge (potentially altering the volume infiltration of surface water and potentially changing groundwater flow directions), but not at a rate that would be expected to affect groundwater quality. Following completion of construction, flows would be maintained downstream of the dams. Therefore, the temporary dewatering of Funks and Stone Corral creeks during dam construction would have a **less-than-significant impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Hazardous Materials

During construction in the Sites Reservoir Dams, it is possible that the operation and maintenance of construction equipment could result in hazardous materials spills. Potential contamination of groundwater from hazardous materials would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Abandoned Wells, Septic Systems, or Underground Storage Tanks

There may be water wells, septic systems, or current or historic oil and gas wells, test wells, or boreholes at the dam sites. All well types, boreholes, and septic systems will be located, identified, and properly abandoned before or during construction to avoid possible contamination resulting from their improper abandonment and consequent inundation. These wells, boreholes, and septic systems are proposed in the environmental commitments included as part of the Project identified in Chapter 3. As such, **no impact** to groundwater quality is anticipated, when compared to the Existing Conditions/No Project/No Action Condition.

Dewatering

Temporary dewatering will be required during construction. Dewatering could expose soils and shallow groundwater to contamination from stormwater, construction materials, wastes, or other spilled materials.

Potential contamination of groundwater from dewatering would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Recreation Areas

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Hazardous Materials

During construction of the Recreation Areas, it is possible that the operation and maintenance of construction equipment could result in hazardous materials spills. In addition, during operation and maintenance, increased vehicle traffic and use of the recreation areas by recreationists could introduce contaminants (such as fuels, oils, and herbicides) that could enter the environment and subsequently compromise groundwater quality. Potential contamination of groundwater from hazardous materials would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/ No Project/No Action Condition.

Abandoned Wells, Septic Systems, or Underground Storage Tanks

There may be test wells or boreholes at the sites planned for Recreation Areas. All well types, boreholes, and septic systems will be located, identified, and properly abandoned before or during construction to avoid possible contamination resulting from their improper abandonment and consequent inundation. These wells, boreholes, and septic systems are proposed in the environmental commitments included as part of the Project identified in Chapter 3. As such, **no impact** to groundwater quality is anticipated, when compared to the Existing Conditions/No Project/No Action Condition.

Septic System, Leach Field, and Vault Toilet Construction

Vault toilets would be installed at all of the Recreation Areas according to local, State, and federal requirements and, as such, would have a **less-than-significant impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Road Relocations and South Bridge

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Hazardous Materials

During construction of the Road Relocations and South Bridge, it is possible that the operation and maintenance of construction equipment could result in hazardous materials spills. In addition, onsite batch plants for asphalt or concrete may be required. During operation, vehicles could have an adverse effect on groundwater quality resulting from spills or leaks. Potential contamination of groundwater from hazardous materials would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Abandoned Wells, Septic Systems, or Underground Storage Tanks

There may be water wells, septic systems, or current or historic oil and gas wells, test wells, or boreholes along or adjacent to the road relocations. All well types, boreholes, and septic systems will be located, identified, and properly abandoned before or during construction to avoid possible contamination resulting from their improper abandonment and consequent inundation. These wells, boreholes, and septic systems are proposed in the environmental commitments included as part of the Project identified in Chapter 3. As such, **no impact** to groundwater quality is anticipated, when compared to the Existing Conditions/No Project/No Action Condition.

Dewatering

Temporary dewatering may be required during construction. Dewatering could expose soils and shallow groundwater to contamination from stormwater, construction materials, wastes, or other spilled materials. Potential contamination of groundwater from dewatering would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Sites Pumping/Generating Plant, Sites Electrical Switchyard, Tunnel from Sites Pumping/Generating Plant to Sites Reservoir Inlet/Outlet Structure, Sites Reservoir Inlet/Outlet Structure, and Field Office Maintenance Yard

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Hazardous Materials

During construction of these facilities, it is possible that the operation and maintenance of construction equipment could result in hazardous materials spills. Potential contamination of groundwater from hazardous materials would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Abandoned Wells, Septic Systems, or Underground Storage Tanks

There may be water wells, septic systems, or current or historic oil and gas wells, test wells, or boreholes along or adjacent to these facilities. All well types, boreholes, and septic systems will be located, identified, and properly abandoned before or during construction to avoid possible contamination resulting from their improper abandonment and consequent inundation. These wells, boreholes, and septic systems are proposed in the environmental commitments included as part of the Project identified in Chapter 3. As such, **no impact** to groundwater quality is anticipated, when compared to the Existing Conditions/No Project/No Action Condition.

Dewatering

Construction of the Sites Pumping/Generating Plant, Sites Electrical Switchyard, Sites Reservoir Inlet/Outlet Structure, and Field Office Maintenance Yard may require temporary localized lowering of the groundwater levels. Construction of the tunnel from the Sites Pumping/Generating Plant to the Sites Reservoir Inlet/Outlet Structure would require dewatering. Potential contamination of groundwater from dewatering would be avoided through the implementation of environmental commitments proposed in

Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Septic System and Leach Field Construction

Leach fields and a water treatment facility would be installed at the Field Office Maintenance Yard. Septic systems and associated leach fields will be properly sited, designed, installed, operated, and maintained to avoid harmful contamination from wastewater according to local, State, and federal requirements and, as such, would have a **less-than-significant impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Holthouse Reservoir Complex

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Changes in Surface Water Infiltration and Groundwater Flow Directions

During the construction of Holthouse Reservoir, Funks Reservoir would be drained and dredged to design capacity. The reservoir would be drained for up to 2 years. During this time, groundwater quality may be adversely affected due to reduced seepage and percolation from the drained reservoir. Because this is a temporary activity, and soil permeability is low in the area, the impact to groundwater quality would be **less than significant**, when compared to the Existing Conditions/No Project/No Action Condition.

Inundation of Holthouse Reservoir would likely lead to higher groundwater levels in a localized area around the reservoir from reservoir leakage and soil percolation. Holthouse Reservoir surface water quality is assumed to be the same as that modeled for Sites Reservoir. Surface water quality modeling results indicate a worst-case long-term average EC of 190 to 192 µmhos/cm for Sites Reservoir (Appendix 7C Surface Water Quality Analysis for Electrical Conductivity at Proposed Intakes), as compared to the EC value of 38,200 µmhos/cm measured for existing groundwater quality conditions in the vicinity of Funks Reservoir. Therefore, this would a **beneficial effect** because shallow groundwater quality would be improved with better quality reservoir water, when compared to the Existing Conditions/No Project/No Action Condition.

Potential rates of seepage from the Holthouse Reservoir under the maximum Alternative A reservoir stage of approximately 206 feet NAVD88 were estimated to be approximately 220 gpm. The potential impact of combined seepage from the Holthouse and Alternative B Sites Reservoir inundation areas on groundwater levels (thereby groundwater flow directions) in the Colusa Subbasin were evaluated using SACFEM_{2013} and are discussed further in Section 11.3.4. Because model forecast changes in groundwater flow directions (discussed in the following section) were minor, construction, operation, and maintenance of Holthouse Reservoir would have a **less-than-significant impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Hazardous Materials

During the dredging of Funks and Holthouse reservoirs and construction of associated electrical facilities, it is possible that the operation and maintenance of construction equipment could result in hazardous materials spills. Potential contamination of groundwater from hazardous materials would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Abandoned Wells, Septic Systems, or Underground Storage Tanks

There are approximately three wells within a 1-mile radius of these facilities. There may also be septic systems, current or historic oil and gas wells, test wells, or boreholes along or adjacent to the Holthouse Reservoir Complex. All well types, boreholes, and septic systems will be located, identified, and properly abandoned before or during construction to avoid possible contamination resulting from their improper abandonment and consequent inundation. These wells, boreholes, and septic systems are proposed in the environmental commitments included as part of the Project identified in Chapter 3. As such, **no impact** to groundwater quality is anticipated, when compared to the Existing Conditions/No Project/No Action Condition.

Dewatering

Construction of the Holthouse Reservoir Complex may require temporary localized lowering of groundwater levels. Potential contamination of groundwater from dewatering would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Terminal Regulating Reservoir, Terminal Regulating Reservoir Pipeline, Terminal Regulating Reservoir Pipeline Road, Terminal Regulating Reservoir Pumping/Generating Plant, Terminal Regulating Reservoir Electrical Switchyard, and Glenn-Colusa Irrigation District Canal Connection to the Terminal Regulating Reservoir

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Changes in Groundwater Flow Directions

As discussed in Chapter 3, the TRR will be constructed with an ultra-violet-resistant polyvinyl chloride or high-density polyethylene liner to prevent or minimize seepage from the facility. As such, there will be no anticipated change in groundwater levels or flow direction associated with this facility. Therefore, this would have **no impact**, when compared to the Existing Conditions/No Project/No Action Condition.

Hazardous Materials

During the construction of the TRR and associated facilities, it is possible that the operation and maintenance of construction equipment could result in hazardous materials spills. Potential contamination of groundwater from hazardous materials would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Abandoned Wells, Septic Systems, or Underground Storage Tanks

There are approximately 10 wells within a 1-mile radius of the proposed TRR. There may also be septic systems, or current or historic oil and gas wells, test wells, or boreholes along or adjacent to these TRR facilities. All well types, boreholes, and septic systems will be located, identified, and properly abandoned before or during construction to avoid possible contamination resulting from their improper abandonment and consequent inundation. These wells, boreholes, and septic systems are proposed in the environmental commitments included as part of the Project identified in Chapter 3. As such, **no impact** to groundwater quality is anticipated, when compared to the Existing Conditions/No Project/No Action Condition.

Dewatering

Construction of these TRR facilities may require temporary localized lowering of groundwater levels. Dewatering could expose soils and shallow groundwater to contamination from stormwater, construction materials, wastes, or other spilled materials. Potential contamination of groundwater from dewatering would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Underground Utilities

The proposed TRR Pipeline route would cross an existing PG&E gas line. It is possible that other gas lines exist along the pipeline route. All underground utilities would be located prior to construction to ensure that no damage is incurred during construction of the pipeline, and as such, there would be **no impact** on groundwater quality is anticipated when compared to the Existing Conditions/No Project/No Action Condition.

Glenn-Colusa Irrigation District Canal Facilities Modifications

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Changes in Surface Water Infiltration and Groundwater Flow Directions

A portion of the earthen channel of the GCID Main Canal would be dewatered while 200 feet of the canal are lined with concrete. However, this construction is expected to occur during the regularly scheduled annual maintenance period for the canal, and would, therefore, not be expected to adversely affect groundwater flow directions or quality. Once the canal is lined, there could be a reduction in the localized rate of groundwater recharge. However, because only 200 feet of canal would be lined, the potential subsequent loss of infiltration of relatively higher quality surface water in that small area would have a **less-than-significant impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Hazardous Materials

During modifications of the GCID Main Canal facilities, it is possible that the operation and maintenance of construction equipment could result in hazardous materials spills. Potential contamination of groundwater from hazardous materials would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Sites/Delevan Overhead Power Line

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Hazardous Materials

During construction of the Sites/Delevan Overhead Power Line, it is possible that the operation and maintenance of construction equipment could result in hazardous materials spills. Potential contamination of groundwater from hazardous materials would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Delevan Pipeline and Delevan Pipeline Electrical Switchyard

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Hazardous Materials

During construction of the Delevan Pipeline and Delevan Pipeline Electrical Switchyard, it is possible that the operation and maintenance of construction equipment could result in hazardous materials spills. Potential contamination of groundwater from hazardous materials would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Dewatering

Temporary dewatering may be required during construction of these facilities. Dewatering could expose soils and shallow groundwater to contamination from stormwater, construction materials, wastes, or other spilled materials. Potential contamination of groundwater from dewatering would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Underground Utilities

The Delevan Pipeline route would cross an existing PG&E gas line. It is possible that other gas lines exist along the pipeline route. All underground utilities would be located prior to construction to ensure that no damage is incurred during construction of the pipeline, and as such, **no impact** on groundwater quality is anticipated when compared to the Existing Conditions/No Project/No Action Condition.

Delevan Pipeline Intake/Discharge Facilities

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Changes in Surface Water Infiltration and Groundwater Flow Directions

Filling of the intake/discharge forebay and afterbay would likely lead to higher groundwater levels in a localized area around the forebay and afterbay from leakage. Forebay and afterbay surface water quality is assumed to be the same as that modeled for Sites Reservoir. Surface water quality modeling results indicate a worst-case long-term average EC of 190 to 192 µmhos/cm in Sites Reservoir (Appendix 7C Surface Water Quality Analysis for Electrical Conductivity at Proposed Intakes), as compared to the range in EC of 324 to 1,090 µmhos/cm measured for existing groundwater quality conditions in the vicinity of the facilities footprint. This would be a **beneficial effect** because shallow groundwater quality would be improved with better quality surface water, when compared to the Existing Conditions/No Project/No Action Condition.

Hazardous Materials

During construction of the Delevan Pipeline Intake/Discharge Facilities, it is possible that the operation and maintenance of construction equipment could result in hazardous materials spills. Potential contamination of groundwater from hazardous materials would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Dewatering

Construction of the Delevan Pipeline Intake/Discharge Facilities would require dewatering. Dewatering could expose soils and shallow groundwater to contamination from stormwater, construction materials, wastes, or other spilled materials. Potential contamination of groundwater from dewatering would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Project Buffer

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Changes in Groundwater Flow Directions

Existing structures within the Project Buffer would be demolished, and any agricultural fields that are currently irrigated would not continue to receive irrigation. Any wells associated with those structures or used as irrigation sources may, therefore, no longer be used. The discontinued use of wells could result in increases in groundwater levels (thereby changes in flow directions). Because the discontinuation of groundwater pumping will be accompanied by the discontinuation of irrigation (reduced recharge), it is assumed that any changes in groundwater levels (thereby changes in flow directions) would be minimal. As such, there would be a **less-than-significant impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Hazardous Materials

During demolition of structures that are located within the Project Buffer, it is possible that the operation and maintenance of construction equipment could result in hazardous materials spills. Potential contamination of groundwater from hazardous materials would be avoided through the implementation of environmental commitments proposed in Chapter 3, and as such, there would be **no impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

11.3.4 Impacts Associated with Alternative B

11.3.4.1 Extended Study Area – Alternative B

Construction, Operation, and Maintenance Impacts

The impacts associated with Alternative B, as they relate to groundwater quality (**Impact GW Qual-1**), would be the same as described for Alternative A for the Extended Study Area.

11.3.4.2 Secondary Study Area – Alternative B

Construction, Operation, and Maintenance Impacts

The impacts associated with Alternative B, as they relate to groundwater quality (**Impact GW Qual-1**), would be the same as described for Alternative A for the Secondary Study Area.

11.3.4.3 Primary Study Area – Alternative B

Construction, Operation, and Maintenance Impacts

Many of the same Project facilities are included in Alternatives A and B (see Table 3-1 in Chapter 3 Description of the Sites Reservoir Project Alternatives). These facilities would require the same construction methods and operations and maintenance activities, and would, therefore, result in the same construction, operation, and maintenance impacts related to groundwater quality. Therefore, unless explicitly discussed below, impacts for all Project facilities are anticipated to be the same as those discussed for Alternative A.

If Alternative B is implemented, the footprint or construction disturbance area of Sites Reservoir and Dams, the Road Relocations and South Bridge, and the Sites/Delevan Overhead Power Line would differ from those of Alternative A. In addition, the Delevan Pipeline Intake/Discharge Facilities would be replaced by a discharge only facility.

The boundary of the Project Buffer would be the same for Alternatives A and B, but because the footprints of some of the Project facilities that are included in the Project Buffer would differ between the alternatives, the acreage of land within the Project Buffer would also differ. However, these differences in the size of the facility footprint, alignment, or construction disturbance area would not change the type of construction, operation, and maintenance activities that were described for Alternative A. They would, therefore, have the same impact on groundwater quality (**Impact GW Qual-1**) as described for Alternative A, with the exclusion of the potential impacts associated with the Delevan Pipeline Intake/ Discharge Facility forebay and afterbay that are included in Alternative A, but not Alternative B.

The Sites Reservoir Inundation Area would increase from a 1.3-MAF capacity (with Alternative A) to a 1.8-MAF capacity (with Alternative B). The larger reservoir size associated with Alternative B would require the same type of construction, operation, and maintenance activities as for Alternative A, and would, therefore, have the same potential for impact from hazardous materials (**Impact GW Qual-1: Hazardous Materials**) as described for Alternative A. Potential impacts associated with a larger reservoir on rates of groundwater recharge and abandoned wells, septic systems, or underground storage tanks are described below.

The footprint or construction disturbance area of the Road Relocations, South Bridge, and the Sites/ Delevan Overhead Power Line would differ between Alternatives A and B; however, Alternative B would require the same type of construction, operation, and maintenance activities as those for Alternative A. Therefore, the potential impacts from hazardous materials, abandoned wells, septic systems, underground storage tanks, and dewatering would be the same (**Impact GW Qual-1**) as those described for Alternative A.

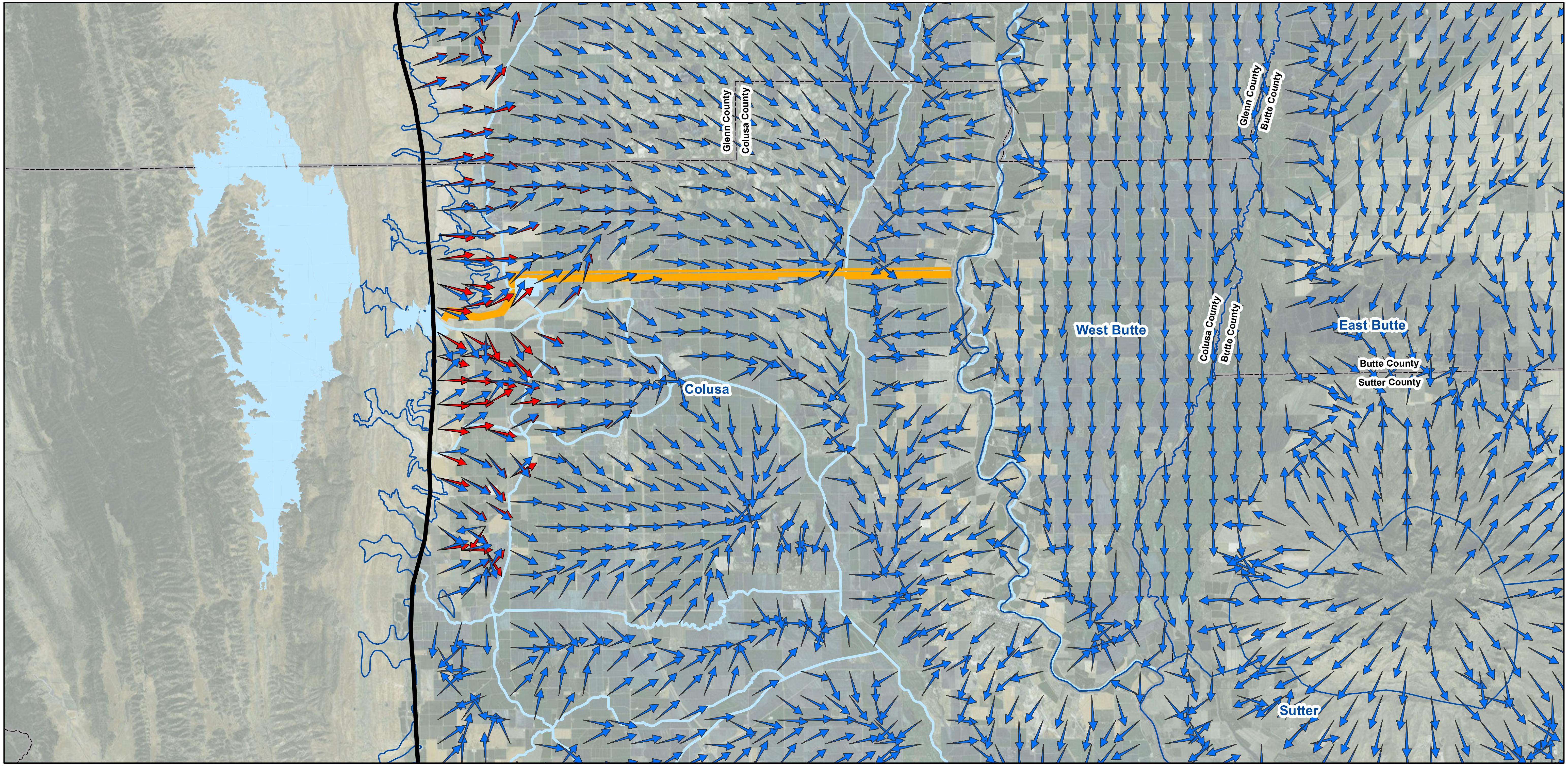
Sites Reservoir Inundation Area

Impact GW Qual-1: A Violation of Any Groundwater Quality Standards or Waste Discharge Requirements, a Change in Groundwater Quality Resulting in Adverse Effects to Designated Beneficial Uses of Groundwater, or Otherwise Substantially Degrade Groundwater Quality

Changes in Surface Water Infiltration and Groundwater Flow Directions

Refer to the **Impact GW Qual-1** discussion for the Alternative A Sites Reservoir Inundation Area. The greater volume of water in the Alternative B reservoir would not appreciably change the rate of groundwater forced into the soil from the weight of the reservoir water and from natural percolation from that described for Alternative A. It could, however, beneficially alter shallow groundwater chemistry in and immediately around the reservoir, as described for Alternative A. Therefore, the Sites Reservoir Inundation Area could have a **beneficial effect** on shallow groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

As discussed in Chapter 10, potential rates of seepage from the Sites and Holthouse reservoirs under the maximum Alternatives B through D reservoir stage of approximately 520 feet NAVD88 and 206 feet NAVD88, respectively, were estimated to be approximately 2,150 gpm. A discussion of the technical details associated with these estimates are provided in Appendix 10A Groundwater Modeling. Figures 11-1A and 11-1B present the distribution model forecast shallow groundwater flow directions for two time periods. Figure 11-1A presents simulated groundwater flow directions for the Existing Conditions/No Project/No Action Condition (blue arrows) and Alternative B (red arrows) under hydrologic conditions consistent with those of February 1980. This represents the period of the largest simulated increases in groundwater levels (thereby groundwater flow directions). Figure 11-1B presents simulated groundwater flow directions under hydrologic conditions consistent with those of April 1983, the period of the highest groundwater elevations. The arrows presented on Figures 11-1A and 11-1B are scaled such that shorter arrows represent groundwater flow under relatively slow groundwater velocities and longer arrows represent relatively fast groundwater velocities. Where the arrows overlap (i.e., the red arrows are not visible) on Figures 11-1A and 11-1B, the model forecast groundwater flow directions for the Existing Conditions/No Project/No Action Condition and Alternative B are the same. Areas where the red arrows are visible are those where the groundwater flow directions under Alternative B differ from the Existing Conditions/No Project/No Action Condition. As shown on Figures 11-1A and 11-1B, the arrows overlap over the majority of the area, indicating that model forecast groundwater flow directions and velocities are the same. Simulated Alternative B groundwater flow directions deviate from those for the Existing Conditions/No Project/No Action Condition along the western margin of the groundwater basin.



Legend

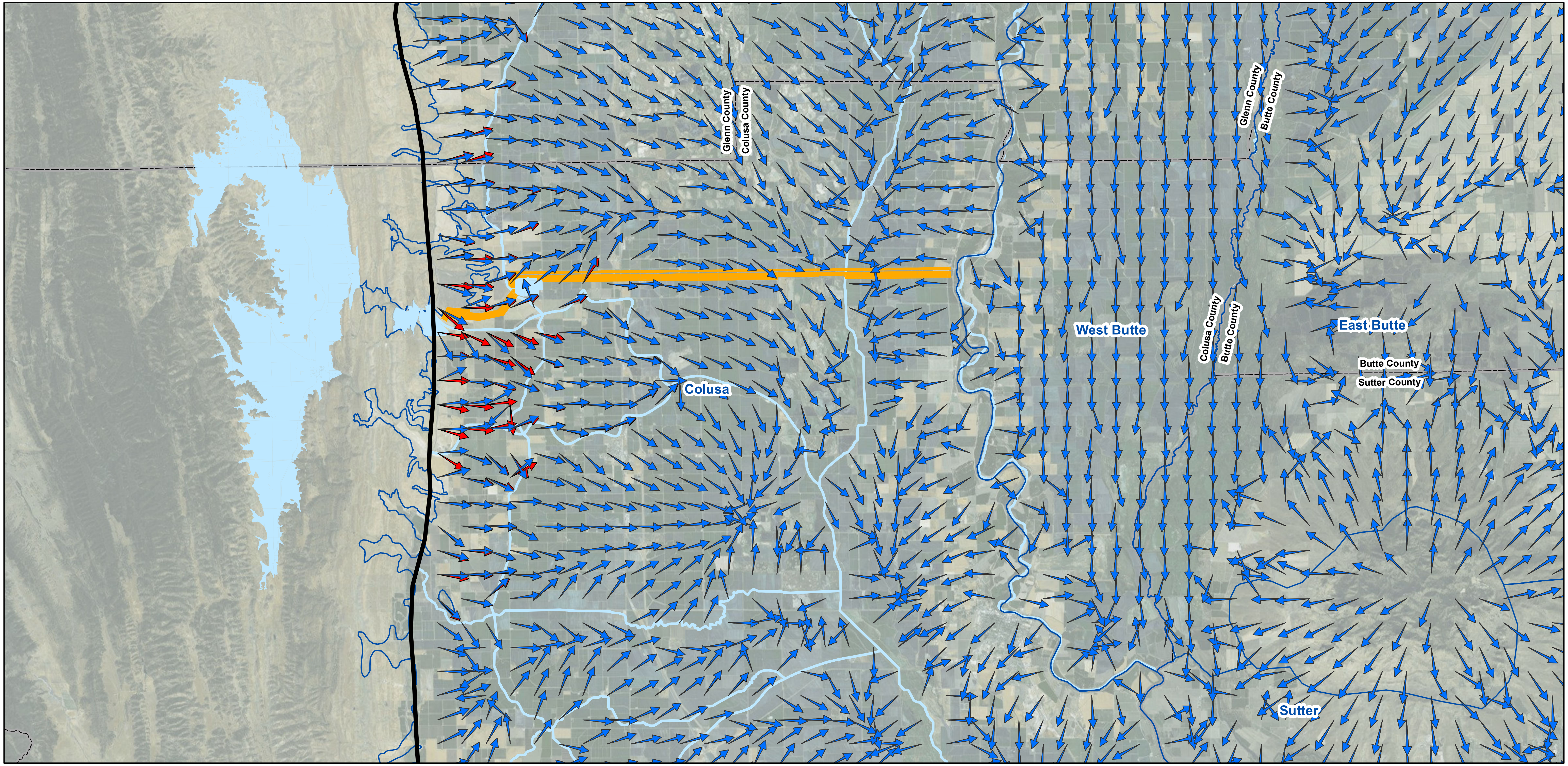
- SACFEM2013 Stream
- ▬ SACFEM2013 Model Boundary
- 🟦 Simulated Groundwater Flow Direction, Baseline
- 🟥 Simulated Groundwater Flow Direction, Alternative A

Select Project Features (Locations Approximate)

- 🟧 Pipeline Construction Disturbance Area
- 🟦 Reservoir
- ☐ Groundwater Subbasin Boundary
- ▭ County Boundary

Notes:
1. Groundwater Subbasin Boundary Source: https://gis.water.ca.gov/app/gicima/
2. bgs = below ground surface
3. Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 11-1A
Simulated Change in Groundwater Flow Direction Due to Seepage from Sites and Holthouse Reservoirs Alternative B, Shallow Aquifer, February 1980
Sites Reservoir Project EIR/EIS



Legend

- SACFEM2013 Stream
- SACFEM2013 Model Boundary
- 🟦 Simulated Groundwater Flow Direction, Baseline
- 🟥 Simulated Groundwater Flow Direction, Alternative A

Select Project Features (Locations Approximate)

- 🟧 Pipeline Construction Disturbance Area
- Reservoir
- Groundwater Subbasin Boundary
- County Boundary

N

0 1.25 2.5 5
Miles

Notes:
1. Groundwater Subbasin Boundary Source: https://gis.water.ca.gov/app/gicima/
2. bgs = below ground surface
3. Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 11-1B
Simulated Change in Groundwater Flow Direction Due to Seepage from Sites and Holthouse Reservoirs Alternative B, Shallow Aquifer, April 1983
Sites Reservoir Project EIR/EIS

This is the region of simulated increase in groundwater levels discussed in Chapter 10. The magnitude of the changes in model forecast groundwater flow directions is generally small. Therefore, construction, operation, and maintenance of Sites and Holthouse reservoirs would have a **less-than-significant impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Salt Lake

Although the inundation area would be larger under Alternative B than under Alternative A, the impact on saline seepage would be similar and would be subject to the same Environmental Commitments. Therefore, construction, operation, and maintenance of the Alternative B Sites Reservoir would have a **less-than-significant impact** on groundwater quality, when compared to the Existing Conditions/No Project/No Action Condition.

Abandoned Wells, Septic Systems, or Underground Storage Tanks

Refer to the **Impact GW Qual-1** discussion for the Alternative A Sites Reservoir Inundation Area. All well types, boreholes, and septic systems will be located, identified, and properly abandoned before or during construction to avoid possible contamination resulting from their improper abandonment and consequent inundation. These wells, boreholes, and septic systems are proposed in the environmental commitments included as part of the Project identified in Chapter 3. As such, **no impact** to groundwater quality is anticipated, when compared to the Existing Conditions/No Project/No Action Condition.

11.3.5 Impacts Associated with Alternative C

11.3.5.1 Extended Study Area – Alternative C

Construction, Operation, and Maintenance Impacts

The impacts associated with Alternative C, as they relate to groundwater quality (**Impact GW Qual-1**), would be the same as described for Alternative A for the Extended Study Area.

11.3.5.2 Secondary Study Area – Alternative C

Construction, Operation, and Maintenance Impacts

The impacts associated with Alternative C, as they relate to groundwater quality (**Impact GW Qual-1**), would be the same as described for Alternative A for the Secondary Study Area.

11.3.5.3 Primary Study Area – Alternative C

Construction, Operation, and Maintenance Impacts

Many of the Project facilities would be the same for Alternatives A, B, and C (see Table 3-1 in Chapter 3 Description of the Sites Reservoir Project Alternatives). These facilities would require the same construction methods and operations and maintenance activities and would, therefore, result in the same construction, operation, and maintenance impacts related to groundwater quality. Therefore, unless explicitly discussed below, impacts for all Project facilities are anticipated to be the same as those discussed for Alternative A.

The Alternative C design of the Sites Reservoir Inundation Area and Dams, Recreation Facilities, and Road Relocations and South Bridge is the same as described for Alternative B. These facilities would require the same construction methods and operation and maintenance activities regardless of alternative, and would, therefore, result in the same construction, operation, and maintenance impacts on groundwater quality (**Impact GW Qual-1**) as described for Alternative B.

The boundary of the Project Buffer would be the same for all alternatives, but because the footprints of some of the Project facilities that are included in the Project Buffer would differ between the alternatives, the acreage of land within the Project Buffer would also differ. However, these differences in the size of the area included within the buffer would not change the type of construction, operation, and maintenance activities that were described for Alternative A. They would, therefore, have the same impact on groundwater quality (**Impact GW Qual-1**) as described for Alternative A.

11.3.6 Impacts Associated with Alternative D

11.3.6.1 Extended Study Area – Alternative D

Construction, Operation, and Maintenance Impacts

The impacts associated with Alternative D, as they relate to groundwater quality (**Impact GW Qual-1**), would be the same as those for Alternative A for the Extended Study Area.

11.3.6.2 Secondary Study Area – Alternative D

Construction, Operation, and Maintenance Impacts

The impacts associated with Alternative D, as they relate to groundwater quality (**Impact GW Qual-1**), would be the same as those described for Alternative A for the Secondary Study Area.

11.3.6.3 Primary Study Area – Alternative D

Construction, Operation, and Maintenance Impacts

- The majority of the Project facilities for Alternative D are the same as those included in Alternatives A, B, C, and D (see Table 3-1 in Chapter 3 Description of the Sites Reservoir Project Alternatives). Construction, operation, and maintenance of Alternative D would be expected to result in similar impacts to groundwater quality. Therefore, unless explicitly discussed below, Alternative D facilities have the same impacts that are described for Alternative A as they relate to groundwater quality (**Impact GW Qual-1**). The following are Project facilities and impacts associated with Alternative D: Alternative D would include the development of only two recreation areas (Stone Corral Recreation Area and Peninsula Hills Recreation Area) instead of up to five recreation areas that could be developed for each of the other alternatives. Alternative D would include a boat ramp on the western side of the reservoir, where the existing Sites Lodoga Road would be inundated. Only two recreation areas under Alternative D is not expected to substantially change the potential impacts to groundwater quality compared to Alternative A.
- Under Alternative D, the TRR would be slightly smaller (approximately 80 acres smaller for Alternative D); however, the smaller TRR is not expected to change the potential impacts related to groundwater supplies or result in changes to groundwater quality compared to Alternative A.
- For Alternative D, the Delevan Pipeline alignment would be approximately 50 to 150 feet south of the alignment presented for Alternatives A, B, and C. The Alternative D alignment takes advantage of existing easements to reduce impacts on local landowners. The shift in alignment is not expected to change the potential impacts to groundwater supplies or result in changes to groundwater quality.

- The boundary of the Project Buffer would be the same for all alternatives, but because the footprints of some of the Project facilities included in the Project Buffer would differ among the alternatives, the acreage of land within the Project Buffer would also differ. However, these differences in the size of the area included within the buffer would not change the type of construction, operation, and maintenance activities; therefore, Alternative D would have impacts similar to those described for all other alternatives.
- Alternative D includes a north-south alignment of the Delevan Overhead Power Line, rather than the east-west alignment between the TRR and the Delevan Intake/Discharge facility. Alternative D includes a proposed electrical substation west of Colusa in addition to the substation near the Holthouse Reservoir. The Alternative D north-south alignment of the Delevan Overhead Power Line and related substation are not anticipated to result in different impacts on groundwater quality than those described for the east-west line alignment for the other alternatives. The north-south alignment would be approximately 1 mile longer; however, it would be located in or near an existing transportation and utility corridor for SR 45 and would not change the potential impacts related to groundwater quality.
- Under Alternative D, the Lurline Headwaters Recreation Area would not be constructed; therefore, the road segment providing access to that recreation area would not be required. Alternative D includes an additional 5.2 miles of roadway from Huffmaster Road to Leesville Road; otherwise, the design of the Sites Reservoir Inundation Area and Dams, and South Bridge would be the same as that under Alternative A and is not expected to change the potential impacts related to groundwater quality.

11.4 Mitigation Measures

Because no potentially significant impacts were identified, no mitigation is required or recommended. Environmental commitments, including construction management procedures (including utility identification), stormwater pollution prevention, spill prevention/hazardous materials handling, and dewatering Best Management Practices are included in all Project alternatives and discussed in Chapter 3 Description of the Sites Reservoir Project Alternatives.