Chapter 7
Geology and Soils

This chapter presents the existing conditions of geology and soils within the area of analysis and discusses potential effects on geology and soils from the proposed alternatives.

Because the Central Valley Project (CVP) Municipal and Industrial Water Shortage Policy (M&I WSP) alternatives would not involve the construction or modification of infrastructure that could be adversely affected by seismic events, seismicity is not discussed in this chapter. Further, the alternatives do not require construction activities; therefore, people and/or structures would not be exposed to geologic hazards such as ground failure or liquefaction. The focus of this chapter is on the chemical processes, properties, and potential erodibility of soils due to potential decreases in agricultural water deliveries. This analysis considers how factors such as surface soil texture, wind velocity and duration, and shrink-swell potential may affect soils.

7.1 Affected Environment

This section presents the area of analysis for potential geology and soils effects, the applicable federal, state, and county-level regulations pertaining to soil conservation and erosion impacts, and the existing conditions for soils in the counties in the area of analysis.

7.1.1 Area of Analysis

The area of analysis includes the areas where CVP agricultural water service contractors are located, and thus, where impacts related to geology and soils could occur. The area of analysis is shown in Figure 7-1 and includes areas in the following counties:

- Sacramento Valley Region
  - Tehama County
  - Glenn County
  - Colusa County
  - Sutter County
  - Yolo County

- San Joaquin River Region
  - San Joaquin County
  - Contra Costa County
  - Alameda County
  - Stanislaus County
  - Merced County
  - Madera County
  - Fresno County
- Tulare Lake Region
  - Fresno County
  - Tulare County
  - Kings County
  - Kern County

The Sacramento Valley Region falls within the North of the Sacramento-San Joaquin River Delta (Delta) geographic area, and the San Joaquin River and Tulare Lake regions generally fall within the South of Delta geographic area.

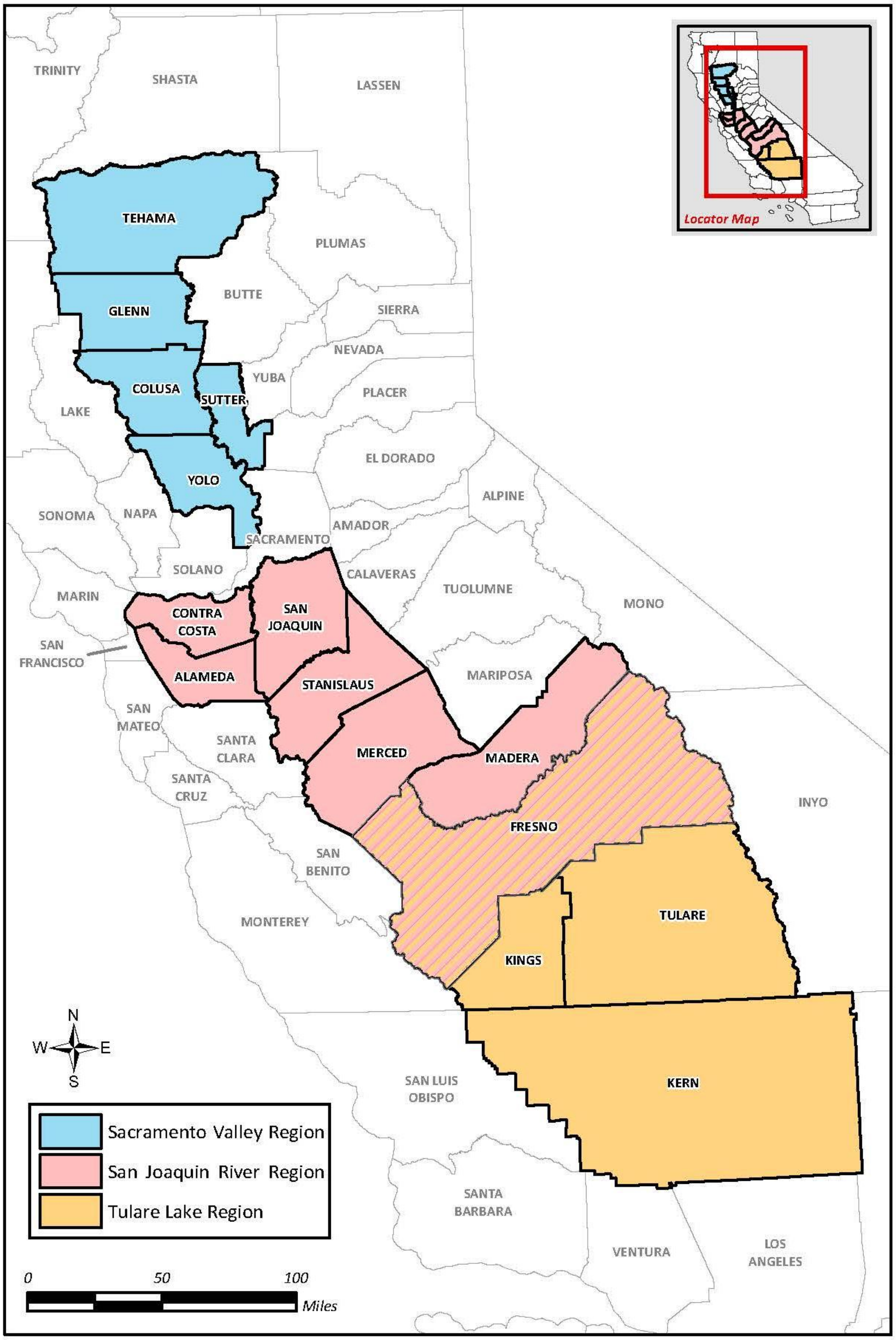


Figure 7-1. Geology and Soils Area of Analysis

7.1.2 Existing Conditions

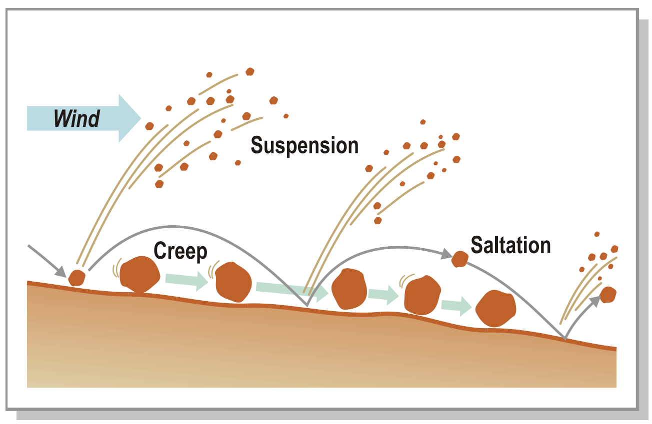
Potential effects associated with implementation of the M&I WSP alternatives are related to soil erosion and soil expansiveness.

7.1.2.1 Soil Erosion by Wind

Soil erosion by wind is a complex process involving detachment, transport, sorting, abrasion, avalanching, and deposition of soil particles. Winds above a threshold velocity (13 miles per hour at one foot above ground) blowing over erodible soils can cause erosion in three ways (James et al. 2009, USDA NRCS 2009a):

- **Saltation:** Individual particles are lifted off the soil surface by wind; then they return and the impact dislodges other particles.
- **Suspension:** Dislodged particles, small enough to remain airborne for an extended period of time (less than 0.1 millimeter in diameter), are moved upward by diffusion.
- **Surface creep**: Sand-sized particles are set in motion by the effect of saltating particles. During high winds, these sand sized particles creep slowly along the surface.

Figure 7-2 shows the wind erosion processes described above. Wind erosion and the release of windblown dust are influenced by soil erodibility, climatic factors, soil surface roughness, width of field, and the quantity of vegetative coverage. Soils most vulnerable to windblown erosion are coarser textured soils like sandy loams, loamy sands, and sands (USDA NRCS 2009a). Specifically, soils are vulnerable to wind erosion when (USDA NRCS 2009a):



Source: James et al. 2009

Figure 7-2. Wind Erosion Processes

- The soil is dry, loose, and finely granulated;
- The soil surface is smooth with little or no vegetation present;
- Fields are sufficiently large, and therefore, susceptible to erosion; and,
- There is sufficient wind velocity to move soil.

Wind erosion can also be a concern because it reduces soil depth and can remove organic matter and needed plant nutrients by dispersing the nutrients contained in the surface soils. Fields continually subjected to erosion can result in land that is incapable of returning to cropping (USDA NRCS 2009a). Wind erodibility for soils in the area of analysis is measured by the wind erodibility group (WEG) rating assigned by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). WEGs consist of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The susceptibility to erosion is measured on an 8-point scale where soils assigned to group 1 are the most susceptible to wind erosion and soils assigned to group 8 are the least susceptible (USDA, NRCS 2009a). Soil susceptibility ratings are generally as follows:

- Low: WEG 6-8
- Moderate: WEG 3-5
- High: WEG 1-2

Increases in erosion from wind blowing across exposed nonpasture agricultural land can also result in particulate matter emissions. Chapter 8, Air Quality, discusses effects of fugitive dust emissions as a result of soil erosion and soil expansiveness.

7.1.2.2 Expansive Soils

In addition to soil erosion, expansive properties, also known as linear extensibility, represent another soil attribute that could be affected by changes in water deliveries to agricultural water service contractors under the alternatives.

Expansive soils are soils with the potential to experience considerable changes in volume, either shrinking or swelling, with changes in moisture content. Therefore, the expansive nature of soils is characterized by their shrink-swell capacity. Changes in soil volume are often expressed as a percent, and in soil surveys the percent represents the overall change for the whole soil.

Soils composed primarily of sand and gravel are not considered expansive (i.e., the soil volume does not change with a change in moisture content). Soils containing silts and clays may possess expansive characteristics. The magnitude of shrink-swell capacity in expansive soils is influenced by:

- Amount of expansive silt or clay in the soil;
- Thickness of the expansive soil zone;
- Thickness of the active zone (depth at which the soils are not affected by dry or wet conditions); and
- Climate (variations in soil moisture content as attributed to climatic or human-induced changes).

Soils are classified as having low, moderate, high, and very high potential for volume changes. The linear extensibility is expressed by percentages; the range of valid values is from 0 to 30 percent (USDA, NRCS 2013). Table 7-1 summarizes shrink-swell classes and the associated linear extensibility percentage. If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures (USDA NRCS 2013).

Table 7-1. Shrink-Swell Class and Linear Extensibility

Shrink-Swell Class	Linear Extensibility
Low	< 3%
Moderate	3-6%
High	6-9%
Very High	≥ 9%

Source: USDA, NRCS no date.

7.1.2.3 Sacramento Valley Region

There are three major landform types in the Sacramento Valley Region area (each with its own characteristic soils): floodplain; basin rim/basin floor; and terraces, foothills, and mountains. The characteristics of soils associated with these landforms are summarized below.

- **Floodplain:** Floodplain lands contain two main soil types: alluvial soils and aeolian soils (soils that have accumulated by the deposition of sand-sized particles by wind action). The alluvial soils make up some of the best agricultural land in the State, whereas the aeolian soils are prone to wind erosion and are deficient in plant nutrients.

- **Basin rim/basin floor:** Basin landforms consist of poorly drained soils, such as the saline and alkali soils found in the valley trough and on the basin rims. These soils are used mainly for pasture, rice, and cotton.

- **Terraces:** Terrace soils are above the valley floor and are used primarily for grazing.

- **Foothills and mountains:** The upper watershed of the Sacramento Valley primarily drains foothill soils. These soils are on the hilly-to-mountainous terrain surrounding the Sacramento Valley, and are formed in place through the decomposition and disintegration of the underlying parent material. The most prevalent foothill soil groups are those with a deep depth (greater than 40 inches), shallow depth (less than 20 inches), and very shallow depth (less than 12 inches) to bedrock. Deep (greater than 40 inches) soils are in the important timberlands of the area and occur in the high rainfall zones at the higher elevations in the mountains east of the valley. Shallow (less than 20 inches) soils, used for grazing, occur in the medium- to low-rainfall zone at lower elevations on both sides of the valley. Very shallow (less than 12 inches) soils are found on steep slopes, mainly at higher elevations. Foothill soils in the northern counties in the area of analysis are primarily used for livestock grazing while mountain meadow areas are used for a mixture of grazing and growing crops (Shasta County 2004). These soils are not useful for agriculture, grazing, or timber because of their very shallow depth, steep slopes, and stony texture.

The following sections summarize the soil types in each county in the Sacramento Valley Region area of analysis from north to south. Figures 7-3 and 7-4 show the main soil textures and shrink-swell potentials for soils in counties in the Sacramento Valley Region area of analysis.

Tehama County In the western part of the county in the Coast Ranges, soils consist of gravelly loam, gravelly sandy loam, and very gravelly silt loam with some minor areas of clay loam, stony clay, and unweathered bedrock along the northwestern edge of the county (USDA, NRCS 2014t). The eastern portion of the county in the southern Cascades is primarily composed of stony sandy loam, gravelly sandy loam, and gravelly loam (USDA, NRCS 2014t). The foothills of the southern Cascades consist of stony clay loam, sandy loam, and extremely gravelly sand. The middle portion of the county consists of cobbly loams, silt loams, and clays (USDA, NRCS 2014t).

The majority of the county, including areas in the Coast Ranges and the southern Cascades, have low shrink-swell potential (USDA, NRCS 2014s). These areas also have low susceptibility to wind erosion (USDA, NRCS 2014u). In the western foothills, there are areas of moderate and high shrink-swell potential and moderate susceptibility to wind erosion (USDA, NRCS 2014s and 2014u). There are also areas of high shrink-swell potential and moderate wind erosion susceptibility in the valley area (USDA, NRCS 2014s and 2014u).

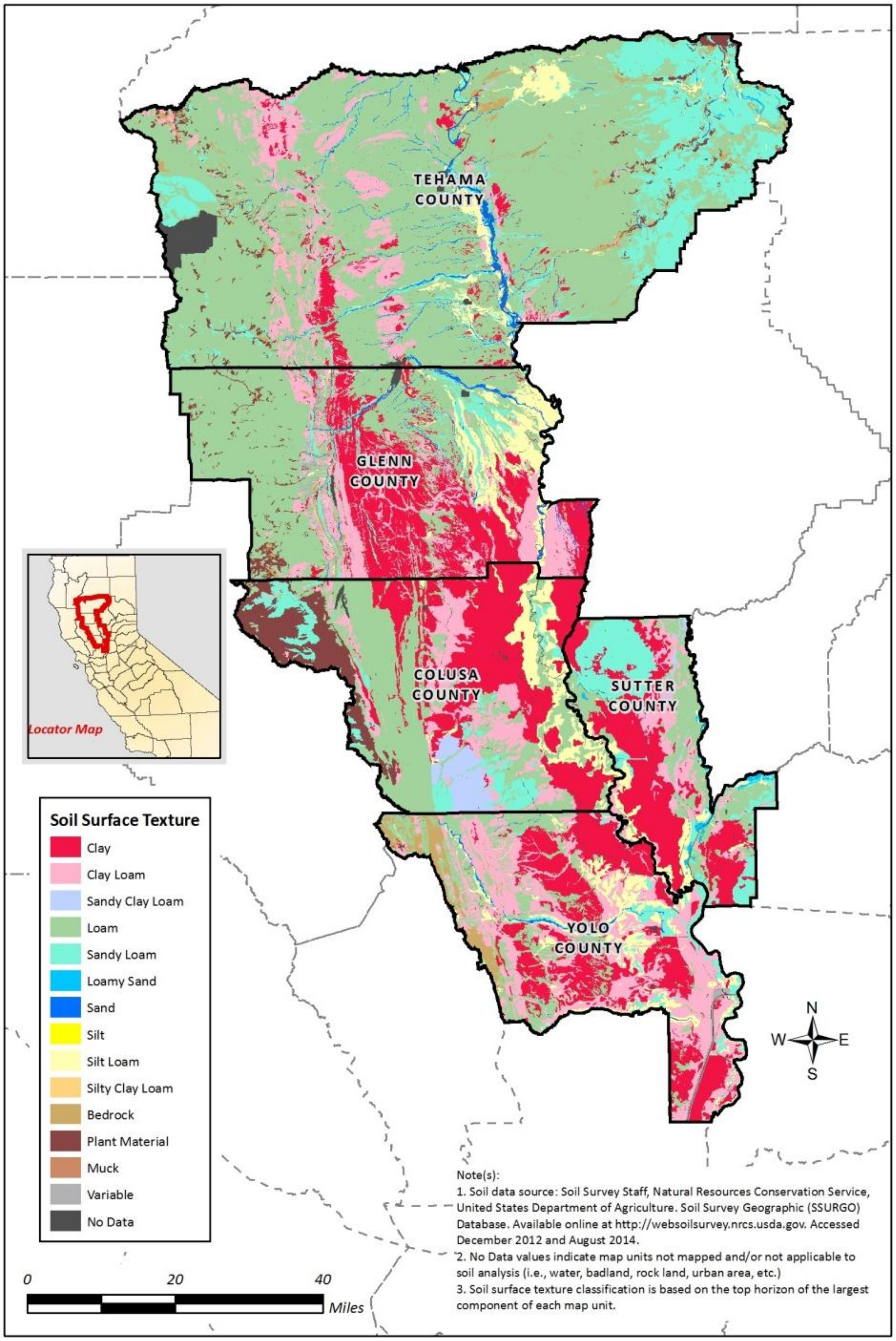


Figure 7-3. Soil Surface Texture – Sacramento Valley Region

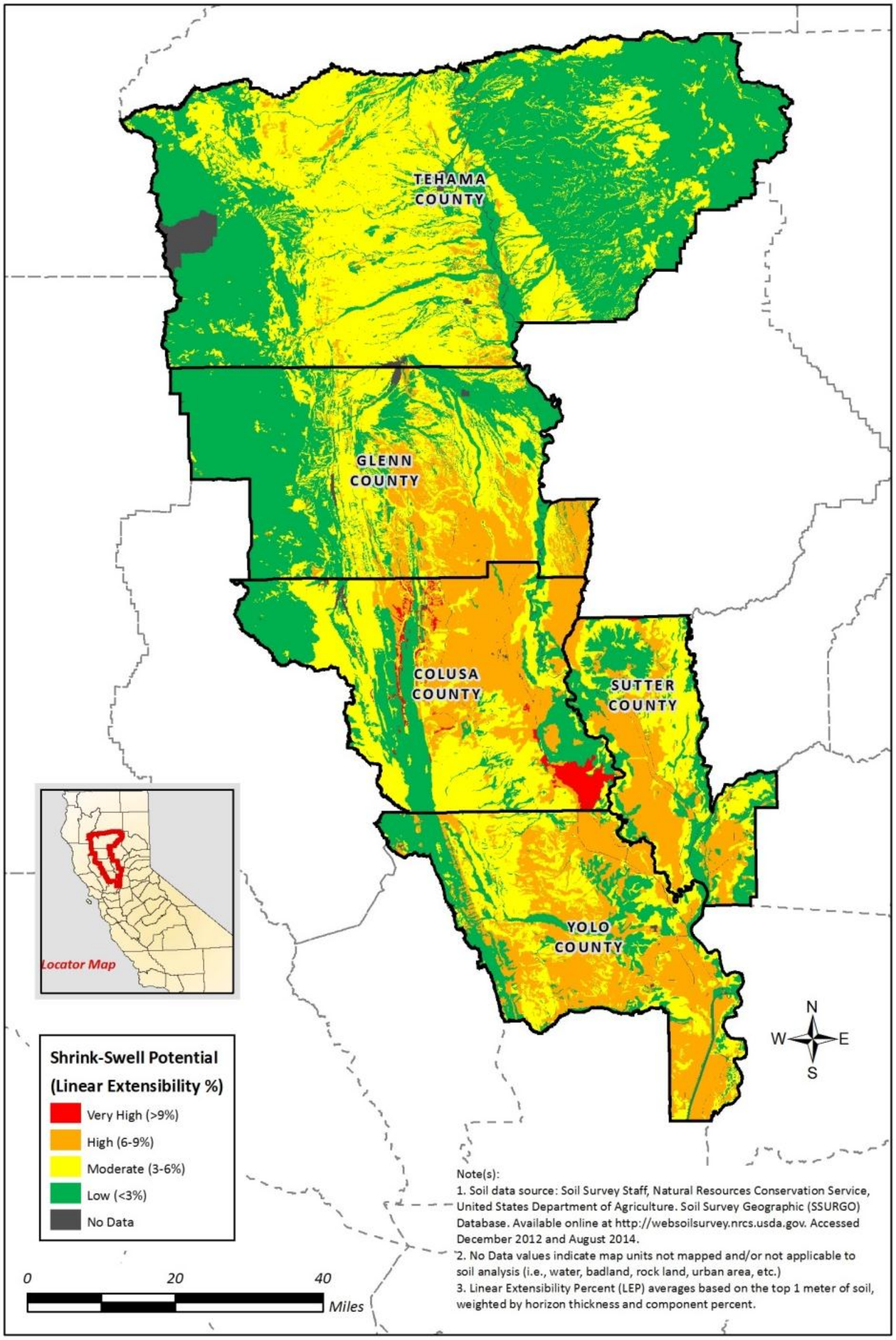


Figure 7-4. Shrink-Swell Potential – Sacramento Valley Region

Glenn County Soils in the eastern part of the county are mainly composed of unweathered bedrock, clays, and silty clay loam (USDA, NRCS 2011b). These soils have mid-range erodibility and low to high shrink-swell potentials (USDA, NRCS 2011a and 2011c). Smaller portions of very gravelly sandy loam and loam border these dominant eastern soils. These soils have mid-range erodibility and low shrink-swell potential. The center of the county is defined by areas of loam, gravelly clay, gravelly clay loam, clay loam, and unweathered bedrock. These soils have mid-range erodibility and high shrink-swell potentials.

Colusa County The western part of Colusa County is a mixture of areas of moderately decomposed plant material, silt loam, gravelly sandy loam, very gravelly loam, sandy loam, and gravelly loam (USDA, NRCS 2009c). These soils have low to mid-range erodibility and low to moderate shrink-swell potentials (USDA, NRCS 2009d and 2009b). The central part of the county is composed of clay loam and loam with some areas in the south central part of the county which are sandy clay loam. These soils have low erodibility and low shrink-swell potentials. In the eastern part of the county, there are two areas of land that have a combination of clay loam and sandy loam, one in the south of the county and one in the north. These soils have low to mid-range erodibility and low to moderate shrink-swell potentials. The remainder of the eastern part of the county is silty clay, silt loam, clay, and clay loam (USDA, NRCS 2009c). The silty clay and clay soils have mid-range erodibility and high shrink-swell potentials. The clay loam soils have low erodibility and low shrink-swell potentials.

Sutter County The eastern part of the county is a mixture of loams, clay loam, sandy loam, and an area of silty clay in the southeastern corner of the county. These soils have low to mid-range erodibility and low to high shrink-swell potentials. The western part of the county is largely comprised of clay, with a band of clay soils running down the mid-western area of the county. The western boundary of the county is defined by loam, silty clay, and silty clay loam. Clays in this area have mid-range erodibility and high shrink-swell potentials. Soils along the western boundary of the county have high to low erodibility and low shrink-swell potentials, with one area of high shrink-swell potential in the northwestern corner of the county (USDA, NRCS 2009h, 2009i, and 2009j).

Yolo County The soils along the western boundary of Yolo County are a mixture of cobbly clay, clay, and silt loam (USDA, NRCS 2007b). These soils have low erodibility and low shrink-swell potentials. The central part of the county is a diverse mixture of sandy loams, gravelly loams, gravelly sandy loam, silt loam, silty clay loam, and silty clay. Soils throughout the western part of the county have low erodibility and low to high shrink-swell potentials (USDA, NRCS 2007a and 2007c). The eastern part of the county is mainly composed of silt loam, loam, and silty clay loam. These soils are also defined by low erodibility and low to high shrink-swell potentials. There are two areas of very fine sandy loam in the northeast and southeast parts of the county (USDA, NRCS 2007b). These soil types have mid-range erodibility and high erosion potentials.

7.1.2.4 San Joaquin River Region

The San Joaquin River Region area of analysis contains portions of the Coast Ranges, Great Valley and Sierra Nevada geomorphic provinces of California. This area contains the same four major landform types (each with its own characteristic soils) as described for the Sacramento Valley Region area of analysis (Chapter 7.1.2.3): floodplain; basin rim/basin floor; terraces; and foothills and mountains.

The following sections summarize the soil types in each county in the San Joaquin River Region area of analysis from north to south. Figures 7-5 and 7-6 show the surface soil textures and shrink-swell potentials for soils in counties in the San Joaquin River Region area of analysis.

San Joaquin County In the western part of the county, fine sandy loam and clay loam predominate (USDA, NRCS 2014e). There are also areas of coarse sandy loam along the western edge of the county. The southern part of the county is characterized by clay and silty clay with areas of clay loam and sandy loam. The eastern part of the county has similar clay, clay loam, and silt loam materials with areas of coarse sandy loam along the eastern edge of the county. The loamy soils around the western and eastern edges of the county have low shrink-swell potential, while the clays in the central and southern part of the county are characterized by moderate to high shrink-swell potentials (USDA, NRCS 2014d). Soils in the eastern and southern parts of the county have mid-range to high susceptibility to wind erosion. There is also a band of soils through the central part of the county with mid-range to high susceptibility to wind erosion (USDA, NRCS 2014f). Many soil groups in the central and southern parts of the county, as well as along the eastern edge of the county, have low susceptibility to wind erosion.

Contra Costa County In the eastern portion of the county, soils are primarily clay, clay loam, sand, loam, and silty clay loam (USDA, NRCS 2014q). The loamy soils and sand along the eastern portion of the county have mid-range susceptibility to wind erosion, while the clays have a low susceptibility to wind erosion (USDA, NRCS 2014r). The loamy soils and sands have a low shrink-swell potential while the clays and clay loams are characterized by moderate to high shrink-swell potentials (USDA, NRCS 2014p). The soils along the eastern county line have a low to moderate susceptibility to wind erosion and a high to moderate shrink-swell potential (USDA, NRCS 2014p and 2014r).

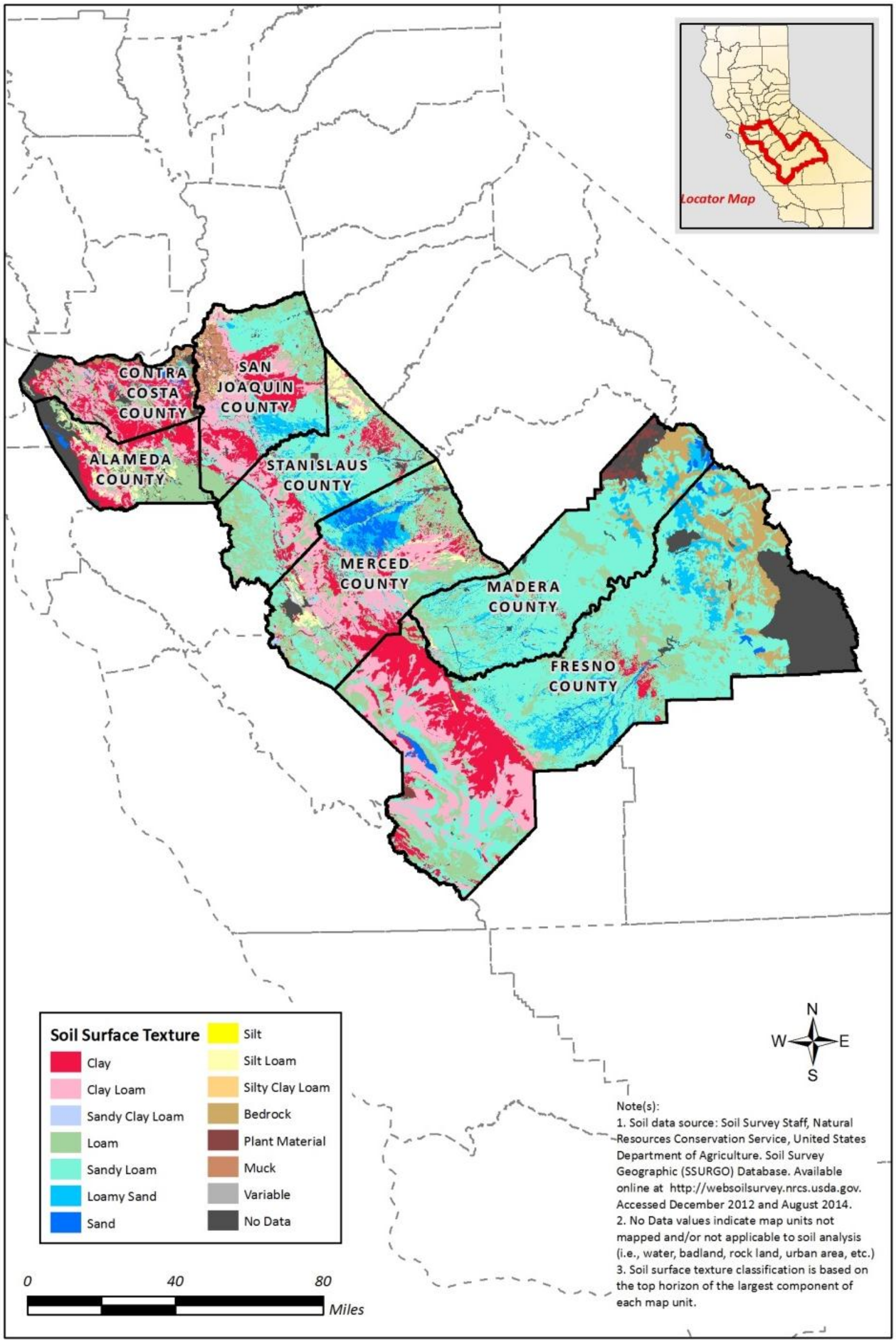


Figure 7-5. Soil Surface Texture – San Joaquin River Region

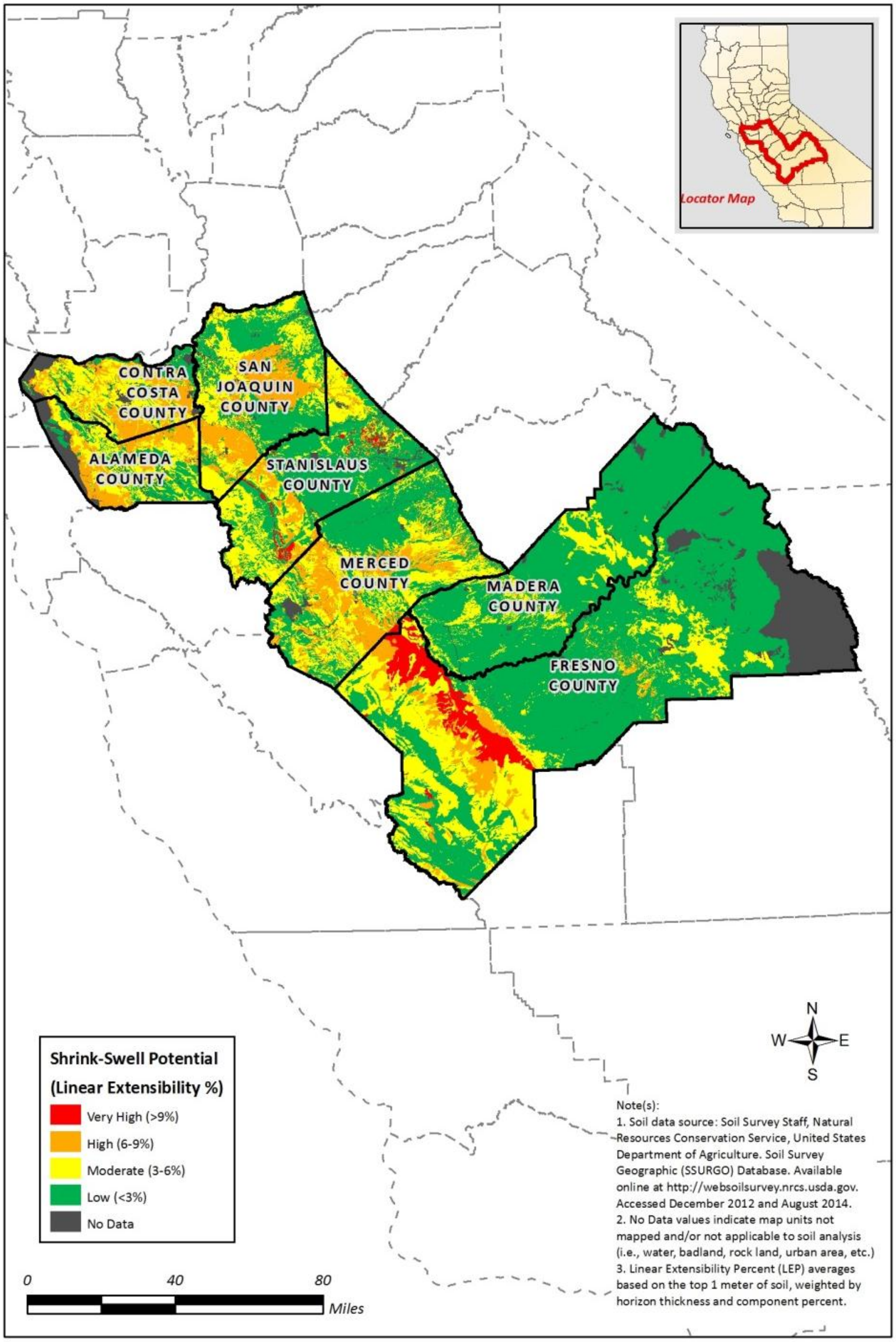


Figure 7-6. Shrink-Swell Potential – San Joaquin River Region

Alameda County The western part of the county near Lake Chabot and extending south to the boundary with Santa Clara County is comprised of moderately hard sedimentary rocks (USDA, Soil Conservation Service [SCS] 1966). Soils in the central and southern parts of the county consist of loamy floodplain soils and terrace soils while soils in the south part of the county contain higher clay content (USDA, NRCS 2014n). Soils throughout the south and northwest of the county have moderate to low shrink-swell potentials (USDA, NRCS 2014m). Soils along the northern border of the county and in the northeast have moderate to high shrink-swell potentials. The majority of soils in the county are characterized by low susceptibility to wind erosion. There are some areas in the middle of the county that are moderately susceptible to wind erosion (USDA, NRCS 2014o).

Stanislaus County The western part of the county consists of mountainous and foothill soils that are silty clay loam and loam in texture (USDA, NRCS 2014k). Also predominant in this area are soils that are sandy loam and clay loam in texture. The mountain and foothill soils are largely characterized by low shrink-swell potential; however, the mountainous soils also contain small areas of moderate to high shrink-swell potential. In the central part of the county, including the valley area, soils consist of clays, clay loams, and loams (USDA, NRCS 2014k). These soils consist of a mixture of low shrink-swell potential (in the valley) to high shrink-swell potential (some areas in the foothills), depending on the clay content of the soil (USDA, NRCS 2014j). There is one area of very high shrink-swell potential in the southwestern part of the county (USDA, NRCS 2014j). Throughout the county, soils range from low to mid-range susceptibility to wind erosion; this pattern occurs both in the mountainous areas as well as in the valley (USDA, NRCS 2014l). Generally, soils that have a higher sand component, such as in the southern mountain area in the county and in the foothills, are characterized by moderate susceptibility to wind erosion. Soils in the county with higher clay content have a lower susceptibility to wind erosion (USDA, NRCS 2014l).

Merced County Soil textures in the western portion of the county consist mainly of fine sandy loam, fine sand, and loamy sand (USDA, NRCS 2008b). These soils have high erosion potentials and low shrink-swell potentials (USDA, NRCS 2008a and 2008c). Soils in the southern county are dominated by loam, silt loam, and silt clay loam. These soils have low to mid-range erodibility and low shrink-swell potentials. The north-central area of the county is mainly fine sand and the south-central portion of the county contains clay loam. These soils generally have low erodibility and low to high shrink-swell potentials (USDA, NRCS 2008a, 2008b, and 2008c). Soils in the eastern county are generally comprised of silt loam and gravelly loam. These soils have low erosion potentials and low shrink-swell ratings.

Madera County Soil textures in the western portion of the county consist mainly of sandy clay loam, loam, sandy loam, and loamy sand (USDA, NRCS 2014h). These soils have mid-range erodibility and have low to moderate shrink-swell potentials (USDA, NRCS 2014g and 2014i). In areas along the San Joaquin River, the soil texture is silt and sandy loam (USDA, NRCS 2014h). These soils have low to mid-range erodibility and moderate shrink-swell potential (USDA, NRCS 2014g and 2014i).

Fresno County Soil textures in the eastern county are dominated by gravelly loam, gravelly sandy loam, and sandy loam (USDA, NRCS 2014z). These soils have low to mid-range erodibilities and low shrink-swell potentials (USDA, NRCS 2014y and 2014aa). In areas along the San Joaquin River and the Fresno Slough, the soil texture is sandy loam (USDA, NRCS 2014z). Sandy loam has mid-range erodibility and high to very high shrink-swell potential. The western edge of the county is defined by the Coast Ranges and consists mainly of clay loam, gravelly clay loam, loam, sandy loam, and silty clay loam (USDA, NRCS 2006). The alluvial fans extending eastward into the valley are comprised of clay, clay loam, and sandy loam soils. Lands adjacent to the San Joaquin River include soils with clay and clay loam textures (USDA, NRCS 2006). The soils along the western edge of Fresno County have low to moderate shrink-swell potentials, with small areas of high to very high shrink-swell potentials (USDA, NRCS 2014y). The loamy soils with a higher percentage of clay have a low susceptibility to wind erosion (USDA, NRCS 2014aa). As the sand content increases in the loamy soils and in the alluvial fans, the susceptibility to wind erosion increases.

7.1.2.5 Tulare Lake Region

The Tulare Lake Region area of analysis contains portions of the Coast Ranges, Great Valley, and Sierra Nevada geomorphic provinces of California. This area contains the same four major landform types (each with its own characteristic soils) as described for the Sacramento Valley Region area of analysis (Chapter 7.1.2.3): floodplain; basin rim/basin floor; terraces; and foothills and mountains.

The following sections summarize the soil types in each county in the Tulare Lake Region area of analysis from north to south. Figures 7-7 and 7-8 show the surface soil textures and shrink-swell potentials for soils in counties in the Tulare Lake Region area of analysis.

Fresno County Soil textures in the eastern county are dominated by gravelly loam, gravelly sandy loam, and sandy loam (USDA, NRCS 2014z). These soils have low to mid-range erodibilities and low shrink-swell potentials (USDA, NRCS 2014y and 2014aa). In areas along the San Joaquin River and the Fresno Slough, the soil texture is sandy loam (USDA, NRCS 2014z). Sandy loam has mid-range erodibility and high to very high shrink-swell potential. The western edge of the county is defined by the Coast Ranges and consists mainly of clay loam, gravelly clay loam, loam, sandy loam, and silty clay loam (USDA, NRCS 2006). The alluvial fans extending eastward into the valley are comprised of clay, clay loam, and sandy loam soils. Lands adjacent to the San Joaquin River include soils with clay and clay loam textures (USDA, NRCS 2006). The soils along the western edge of Fresno County have low to moderate shrink-swell potentials, with small areas of high to very high shrink-swell potentials (USDA, NRCS 2014y).

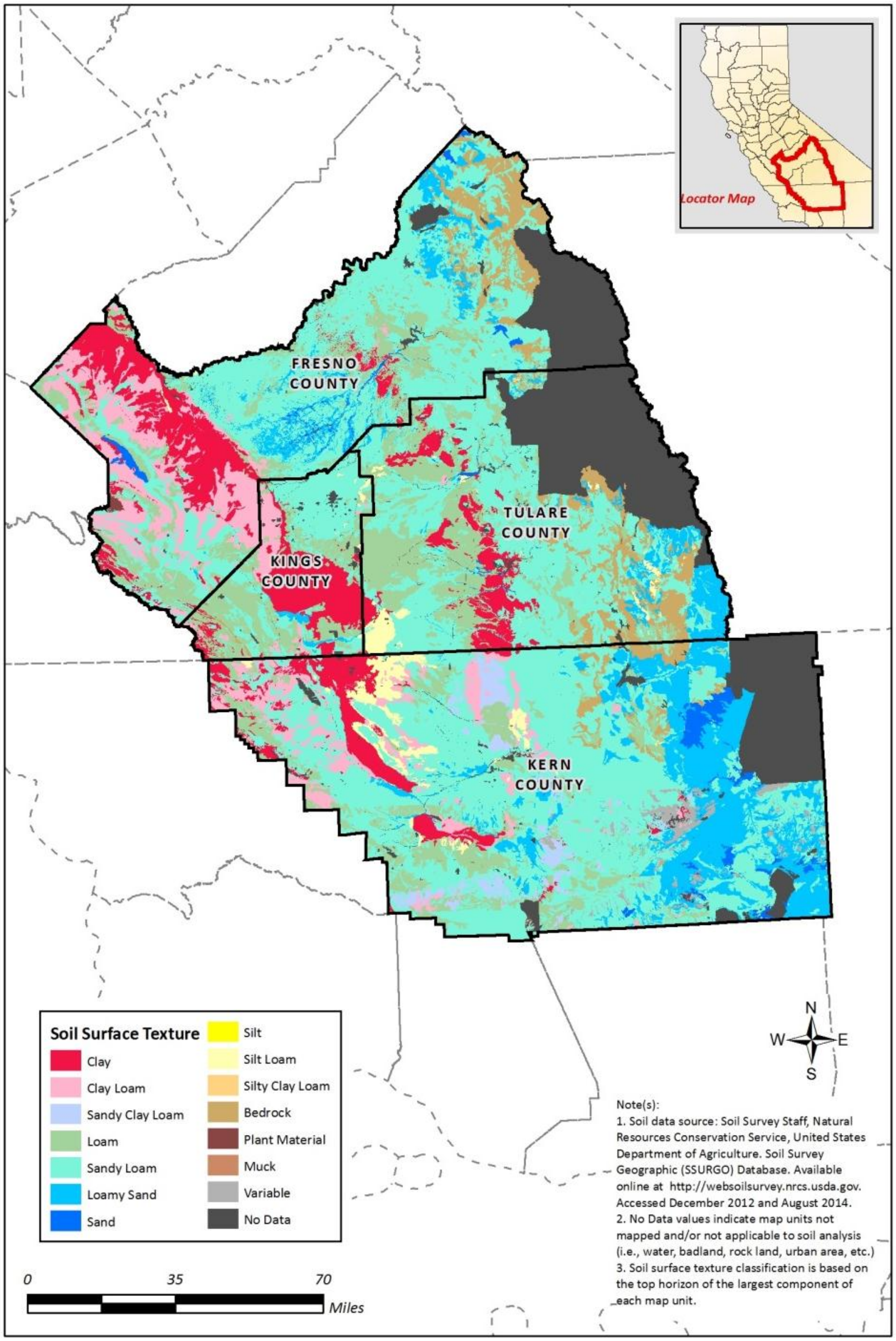


Figure 7-7. Soil Surface Texture – Tulare Lake Region

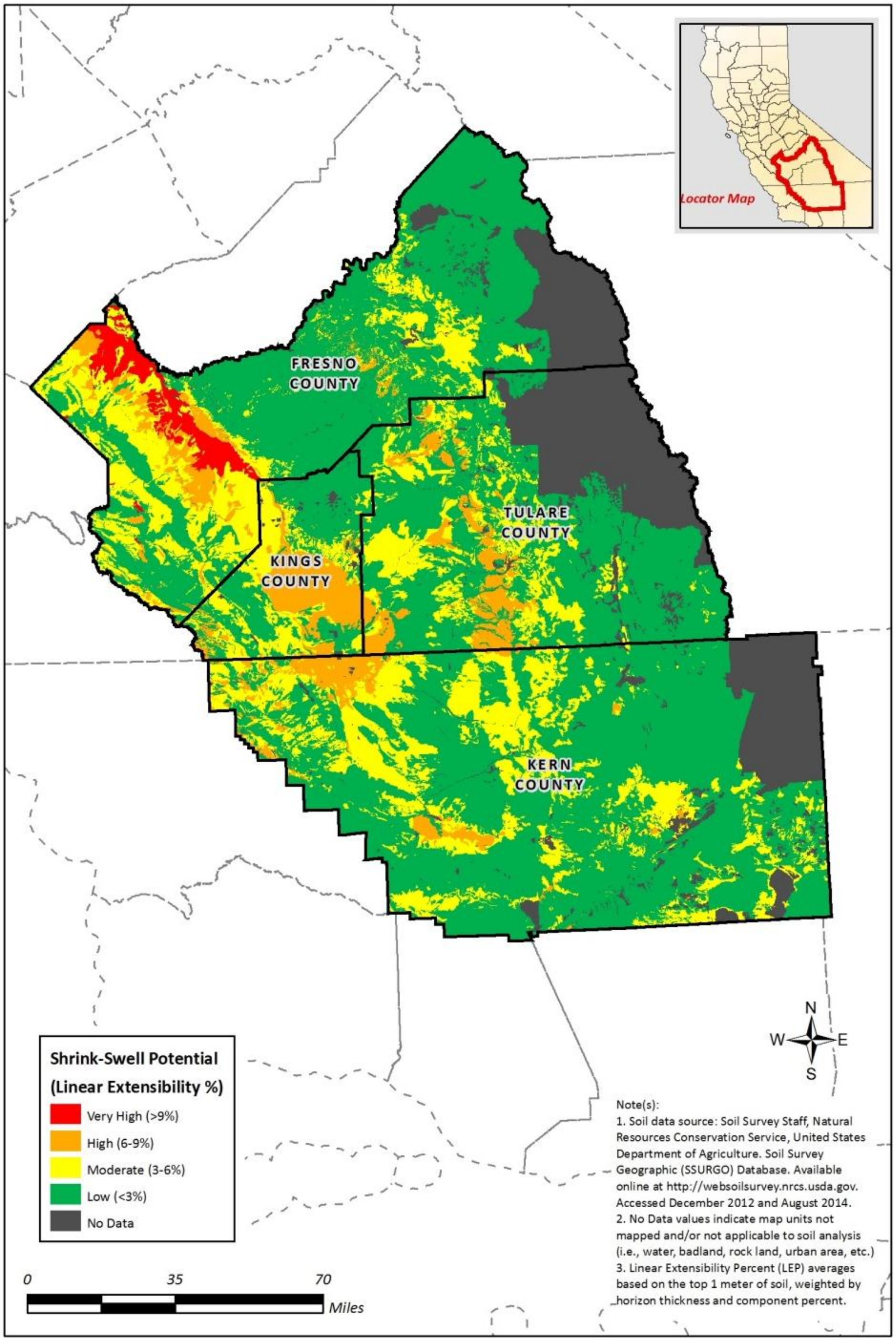


Figure 7-8. Shrink-Swell Potential – Tulare Lake Region

The loamy soils with a higher percentage of clay have a low susceptibility to wind erosion (USDA, NRCS 2014aa). As the sand content increases in the loamy soils and in the alluvial fans, the susceptibility to wind erosion increases.

Tulare County The western county is characterized by loam, loamy sand, silty clay, and sandy loam (USDA, NRCS 2014w). These soils have low shrink-swell potential and moderate susceptibility to wind erosion except for the silty clay area in the southwestern corner of the county which has high shrink-swell potential and low susceptibility to wind erosion (USDA, NRCS 2014v and 2014x). Soils in the central-western part of the county consist of loamy sand and sandy loam (USDA, NRCS 2014w). Soils in this area of the county have mainly low shrink-swell potentials with some minor areas of moderate and high shrink-swell potentials. Additionally, soils in this area have moderate susceptibility to wind erosion (USDA, NRCS 2014x). In the mountainous and foothill area of the central part of the county, soils consist of loams, gravelly sandy loam, clay, clay loam, and gravelly loam, with some small areas of fine sandy loam (USDA, NRCS 2014w). These soils have mainly low shrink-swell potentials and moderate susceptibility to wind erosion with areas of moderate and high shrink-swell potentials and low susceptibility to wind erosion in the foothills (USDA, NRCS 2014v and 2014x).

Kings County The northeastern part of the county is characterized by fine sandy loam, clay loam, and very fine sandy loam soils (USDA, NRCS 2009f).. These soils have high erosion potentials and low shrink-swell potential (USDA, NRCS 2009e and 2009g). Moving south, there is a band of loam soils that borders the clay area of the Tulare Lake bed. These soils have low erodibility and low to high shrink-swell potentials. The northwestern edge of the county is predominantly comprised of clay loam soils with low erosion potential and moderate shrink-swell potential.

Kern County The soils within the north-central part of the county are characterized by sandy clay loam, clay loam, loam, loam, clay loam, and silt (USDA, NRCS 2014b).The loamy soils have mid-range erodibility and low to moderate shrink-swell potentials. The silts have a low susceptibility to erosion and a moderate shrink-swell potential (USDA, NRCS 2014c and 2014a).

7.2 Environmental Consequences

These sections describe the environmental consequences associated with each alternative.

7.2.1 Assessment Methods

The environmental consequences of the proposed alternatives were analyzed qualitatively, based on a review of the soil and geologic data presented above. Analysis of impacts focuses on each alternative’s potential to result in decreased CVP deliveries to agricultural water service contractors. Depending on the precipitation year type, changes in CVP deliveries would cause no change, an increase, or a decrease in the total irrigated acreage. The changes to total irrigate acreage could result in the following effects:

- Erosion of soils from wind blowing over fields with no vegetative cover.
- Changes in soil moisture and resulting shrinking and swelling from different irrigation patterns.

Bare agricultural fields can result in wind erosion and loss of topsoil. In turn, loss of topsoil can degrade soil quality and decrease the agricultural potential of land. Effects to soils were considered adverse if the alternative would affect irrigated acreage such that substantial soil erosion (i.e., loss of topsoil) and the shrinking and swelling of soils on agricultural lands in the area of analysis would occur. Agricultural soils shrink and swell in response to winter rains and irrigation cycles (soils are irrigated, then left to dry out, then irrigated again). Project-related changes in water deliveries to agricultural water service contractors could affect expansive soils by altering the moisture content of soils due to changes in irrigation cycles. Soil movement through shrinking and swelling can cause damage to structures and/or roads built on or near the expansive soils. Agricultural lands are subject to normal swelling and shrinkage during growing and harvesting cycles and structures and roads in the vicinity of the cropland are also subject to these changes.

This section estimates the potential effects on total irrigated acreage from the alternatives. Impacts from changes to agricultural water service contractor CVP supplies were analyzed using results from Statewide Agricultural Production (SWAP) Model. See Appendix D, Statewide Agricultural Production Model Documentation, for a description of the assumptions and methods used in the SWAP regional agricultural production and economic optimization model. The model provided the total irrigated acreage under each alternative in three modeled regions: Sacramento Valley, San Joaquin River, and Tulare Lake. The Sacramento Valley Region falls within the North of Delta geographic area, and the San Joaquin River and Tulare Lake regions fall within the South of Delta geographic area. Potential changes to soil erosion and expansiveness were assessed qualitatively.

7.2.2 Alternative 1: No Action

Changes in CVP deliveries to agricultural water service contractors under the No Action Alternative could affect soil erosion compared to existing conditions. Under the No Action Alternative, CVP deliveries to agricultural water service contractors in all areas would be lower than under existing conditions; however, there would be some minor increases in irrigated acreage as contractors are able to make use of other supplemental supplies.

All regions would experience an increase in irrigated agricultural lands under wet, above normal, below normal, and dry water years compared to existing conditions. In the Sacramento Valley, San Joaquin River, and Tulare Lake regions, the increase in acreage would range up to 3,000 acres, 3,000 acres, and 20,000 acres, respectively. For these water years, the change in irrigated acreage would reduce the potential for soil erosion that occurs from winds blowing over bare fields. This would be a benefit of the No Action Alternative. The increase in farming activities would cause some soil loss from discing, harvesting, and movement of farm equipment. These practices are normal on agricultural lands in the CVP service area and would not result in significant soil erosion.

In critical water years, the San Joaquin Valley and Tulare Lake regions would also have an increase in irrigated acreage – 4,000 acres and 1,000 acres, respectively. Effects from increased agricultural acreage would be the same as described above.

Under the No Action Alternative, the Sacramento Valley Region would experience a decrease in irrigated acreage of 13,000 acres compared to existing conditions in critical water years, which could increase soil erosion. However, this amount only represents a reduction of one percent in irrigated acreage in the region. As described in Chapter 7.1.2, and shown in Figure 7-3, the predominant soils in the Sacramento ValleyRegion have a low susceptibility to erosion. Therefore, the No Action Alternative would not result in substantial soil erosion.

Changes in CVP deliveries to agricultural water service contractors under the No Action Alternative could affect soil movement compared to existing conditions. Under the No Action Alternative, the amount of total irrigated acreage would decrease in the Sacramento ValleyRegion (0.6 percent) and increase in the San Joaquin River (0.2 percent) and Tulare Lake (0.9 percent) regions.

As noted above, soil movement through shrinking and swelling can cause damage to structures and/or roads built on or near the expansive soils. The changes in irrigated acreage will occur in areas that are already subject to swelling and shrinkage during annual growing and harvesting cycles, and would not damage structures or pose a risk to life or property. Therefore, there would be no impacts from soil movement under the No Action Alternative.

The No Action Alternative could cause indirect effects from actions contractors would take from future water shortages. Agricultural contractors would have reduced allocations of CVP water under the No Action Alternative compared to existing conditions. To supplement reduced water supplies, it is possible that agricultural contractors could participate in water transfers from contractors north of the Delta to receive additional water. Contractors selling water for transfer could use cropland idling as a method to increase water supplies to buyers south of the Delta. Indirect effects of these activities could include increased fugitive dust from new barren land.

7.2.3 Alternative 2: Equal Agricultural and M&I Allocation

Changes in CVP deliveries to agricultural water service contractors under the Equal Agricultural and M&I Allocation Alternative could affect soil erosion compared to the No Action Alternative. Under Alternative 2, there would be an increase in CVP deliveries to agricultural water service contractors. These increased water deliveries could result in changes in total irrigated acreage in the future. The increased agricultural water deliveries would result in greater irrigated cropland as compared to the No Action Alternative in certain water years. Potential impacts resulting from these changes are described below.

The Sacramento Valley and Tulare Lake regions would experience an increase in irrigated agricultural lands under below normal, dry, and critical years compared to the No Action Alternative. In the Sacramento Valley and Tulare Lake regions, the increase in irrigated acreage would range up to 10,000 acres and 34,000 acres, respectively. Crop plantings would reduce the potential for soil erosion that occurs from winds blowing over bare fields. This would be a benefit of Alternative 2. The increase in farming activities would cause some soil loss from harvesting and movement of farm equipment. These practices are normal on agricultural lands in the Sacramento Valley and Tulare Lake regions and would not result in significant soil erosion.

Under Alternative 2, there would be no change to total irrigated acreage in the San Joaquin River Region relative to the No Action Alternative. Farmers would continue to manage idled fields to control soil erosion impacts and protect the quality of soils for future plantings. Therefore, Alternative 2 would not result in significant soil erosion in the San Joaquin River Region.

Changes in CVP deliveries to agricultural water service contractors under Alternative 2 could affect soil movement compared to the No Action Alternative. Under Alternative 2, the amount of total irrigated acreage would increase in the Sacramento Valley Region (0.7 percent) and Tulare Lake (1.6 percent) regions, while there would be no change to total irrigated acreage in the San Joaquin River Region.

As noted above, soil movement through shrinking and swelling can cause damage to structures and/or roads built on or near the expansive soils. The changes in irrigated acreage will occur in areas that are already subject to swelling and shrinkage during annual growing and harvesting cycles, and would not damage structures or pose a risk to life or property. Therefore, there would be no impacts from soil movement under the Alternative 2.

Implementation of Alternative 2 could cause indirect effects from actions contractors would take from future water shortages. Because agricultural contractors would have a larger allocation of water during water shortages compared to the No Action Alternative, no additional actions to supplement water are expected to occur. As a result, there would be no indirect effects from implementation of Alternative 2.

7.2.4 Alternative 3: Full M&I Allocation Preference

Changes in CVP deliveries to agricultural water service contractors under Alternative 3 could affect soil erosion compared to the No Action Alternative. Under Alternative 3, there would be a decrease in CVP deliveries to agricultural water service contractors during water shortage years compared to the No Action Alternative. These changes in water deliveries could result in a decrease in total irrigated acreage due to reduced water supplies.

In below normal, dry, and critical years, the total irrigated acreage would decrease compared to the No Action Alternative. In the Sacramento Valley and Tulare Lake Regions, the decrease in acreage would range up to 4,000 acres and 23,000 acres, respectively. The decrease in irrigated acreage could increase soil erosion. As discussed in the No Action Alternative, the soils in the Sacramento Valley Region have a low susceptibility to erosion. As discussed in Chapter 7.1, and shown in Figure 7-7, the agricultural areas of the Tulare Lake Region include a mix of soil types, including soils with a moderate susceptibility to wind erosion as well as soils that are less susceptible to wind erosion. However, the decrease in total irrigated acreage would only represent a reduction of 0.3 percent and 1.1 percent in irrigated acreage in the Sacramento Valley and Tulare Lake regions, respectively. Therefore, Alternative 3 would not result in substantial soil erosion.

Under Alternative 3, there would be no change to total irrigated acreage in the San Joaquin River Region relative to the No Action Alternative. The impact to soil erosion under Alternative 3 would be the same as those under Alternative 2.

Changes in CVP deliveries to agricultural water service contractors under Alternative 3 could affect soil movement compared to the No Action Alternative. Under Alternative 3, the amount of total irrigated acreage would decrease in the Sacramento Valley Region (0.3 percent) and Tulare Lake (1.1 percent) regions, while there would be no change to total irrigated acreage in the San Joaquin River Region.

As noted above, soil movement through shrinking and swelling can cause damage to structures and/or roads built on or near the expansive soils. The changes in irrigated acreage will occur in areas that are already subject to swelling and shrinkage during annual growing and harvesting cycles, and would not damage structures or pose a risk to life or property. Therefore, there would be no impacts from soil movement under the Alternative 3.

Implementation of Alternative 3 could cause indirect effects from actions contractors would take from future water shortages. As described previously, agricultural contractors would have reduced allocations of CVP water under Alternative 3 compared to the No Action Alternative. To supplement reduced water supplies, it is possible that agricultural contractors could participate in water transfers from contractors north of the Delta to receive additional water. Contractors selling water for transfer could use cropland idling as a method to increase water supplies to buyers south of the Delta. Indirect effects of these activities could include increased fugitive dust from new barren land.

7.2.5 Alternative 4: Updated M&I WSP

There would be no changes to CVP deliveries to agricultural water service contractors under Alternative 4 compared to the No Action Alternative, and, as a result, no changes to irrigated agricultural acreage. Therefore, there would be no impacts associated with soil erosion or soil movement.

7.2.6 Alternative 5: M&I Contractor Suggested WSP

There would be no changes to CVP deliveries to agricultural water service contractors under Alternative 5 compared to the No Action Alternative, and, as a result, no changes to irrigated agricultural acreage. Therefore, there would be no impacts associated with soil erosion or soil movement.

7.3 Mitigation Measures

The project alternatives would not result in adverse impacts associated with soil erosion or soil movement, therefore, no mitigation measures are needed.

7.4 Unavoidable Adverse Impacts

None of the action alternatives would result in unavoidable adverse impacts to geology and soils.

7.5 Cumulative Effects

The timeframe for the geology and soils cumulative effects analysis extends from 2010 through 2030, a 20-year period. The cumulative effects area of analysis for geology and soils is the same as shown in Figure 7-1. This section analyzes cumulative effects using the project method, which is further described in Chapter 20, Cumulative Effects Methodology. Chapter 20 describes the projects included in the cumulative condition. The following sections describe potential geology and soils cumulative effects for each of the proposed alternatives.

7.5.1 Alternative 2: Equal Agricultural and M&I Allocation

Changes in CVP deliveries to agricultural water service contractors under Alternative 2, in combination with other cumulative projects, could affect soil erosion. Water management activities that could result in cumulative effects with the M&I WSP include the Long-Term Water Transfers and State Water Project (SWP) water transfers. Long-Term Water Transfers could increase the amount of water available to agricultural water service contractors south of the Delta. As part of the Long-term water transfers, croplands north of the Delta could be idled to increase the available agricultural water supply.

Cropland idling implemented under the SWP transfers could result in a maximum of 64,750 acres of idled farmland. SWP cropland idling transfers would be a temporary effect and would not result in land being converted to incompatible uses. CVP water deliveries to the Sacramento Valley Region in critical condition years result in an increase of 10,000 acres in total irrigated acreage, which could help to offset the soil erosion as a result of the SWP transfers idled farmland. Under the cumulative condition, land classifications could change if parcels are repeatedly idled under other water transfer programs.

In the Tulare Lake River Region, Alternative 2 would increase total irrigated acreage by 34,000 acres during a critical condition year. This would benefit the already increased amount of water available to agricultural water service contractors south of the Delta from the Long-Term Water Transfers program. The cumulative increases in water available to agricultural water service contractors would have a beneficial impact relative to soil erosion.

Changes in CVP deliveries to agricultural water service contractors under Alternative 2, in combination with other cumulative projects, could affect soil movement. The SWP water transfers would be minimal and temporary in nature and transfers would affect a small percentage of the overall total irrigated acreage within counties in the area of analysis. The cropland idling implemented under the Long-Term Water Transfers program could cause a conversion of agricultural lands, which could impact soil movement. As described above, Alternative 2 would result in the increase in total irrigated acreage in the Sacramento Valley and Tulare Lake regions, along with the no change in total irrigated acreage in the San Joaquin River Region. Since these changes would occur in areas already impacted by agricultural practices, Alternative 2 would not contribute to a cumulative impact to soil movement.

7.5.2 Alternative 3: Full M&I Allocation Preference

Changes in CVP water deliveries for agricultural water service contractors under Alternative 3, in combination with other cumulative projects, could affect soil erosion. CVP water deliveries to the Sacramento Valley and Tulare Lake Regions in critical condition years would result in a decrease in total irrigated acreage of 4,000 acres and 23,000 acres, respectively. The decrease in CVP water deliveries to the Sacramento Valley Region, along with the increased idled farmland as a result of SWP transfers north of the Delta, would contribute to cumulative impacts relative to soil erosion. The decrease in total irrigated acreage in the Tulare Lake Region could be offset by the additional water from the Long-Term Water Transfers program. Therefore, cumulative changes in irrigated acreage would be minor and no cumulative impacts relative to soil erosion would occur.

Changes in CVP deliveries to agricultural water service contractors under Alternative 3, in combination with other cumulative projects, could affect soil movement. The SWP water transfers would be minimal and temporary in nature and transfers would affect a small percentage of the overall total irrigated acreage within counties in the area of analysis. The cropland idling implemented under the Long-Term Water Transfers program could cause a conversion of agricultural lands, which could impact soil movement. As described above, during critical condition years, Alternative 3 would result in the project-related decrease in total irrigated acreage would be 0.3 percent and 1.1 percent in the Sacramento Valley and Tulare Lake regions respectively. Since these changes would occur in areas already impacted by agricultural practices, Alternative 3 would not contribute to a cumulative impact to soil movement.

7.5.3 Alternative 4: Updated M&I WSP

CVP deliveries under Alternative 4 would be the same as the No Action Alternative. Therefore, there would be no cumulative effects on geology and soils associated with Alternative 4.

7.5.4 Alternative 5: M&I Contractor Suggested WSP

CVP deliveries under Alternative 5 would be the same as the No Action Alternative. Therefore, there would be no cumulative effects on geology and soils associated with Alternative 5.

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Chapter 8
Air Quality

This chapter presents the existing air basin characteristics within the area of analysis and discusses potential effects on air quality from the proposed alternatives. Appendix E, Air Quality Emission Calculations, provides detailed emission calculations for the alternatives.

8.1 Affected Environment

This section provides an overview of applicable air quality standards and provides a description of the air basins in the study area.

8.1.1 Area of Analysis

The air quality impact analysis evaluates the existing conditions and effects in the air basins included in the study area. Chapter 1 identifies the study area affected by the proposed alternatives.

8.1.2 Regulatory Setting

Air quality management and protection responsibilities exist in federal, state, and local levels of government. The federal Clean Air Act (CAA) and California Clean Air Act (CCAA) are the primary statutes that establish ambient air quality standards and establish regulatory authorities to enforce regulations designed to attain those standards.

8.1.2.1 Federal

Clean Air Act The United States Environmental Protection Agency (USEPA) is responsible for implementation of the CAA. The CAA was enacted in 1955 and was amended in 1963, 1965, 1967, 1970, 1977, 1990, and 1997. Under authority of the CAA, USEPA established National Ambient Air Quality Standards (NAAQS) for the following criteria pollutants: carbon monoxide (CO); lead (Pb); nitrogen dioxide (NO_2); ozone (O_3); inhalable particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}); fine particulate matter with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$); and sulfur dioxide (SO_2).

Table 8-1 presents the current NAAQS for the criteria pollutants. Ozone is a secondary pollutant, meaning that it is formed in the atmosphere from reactions of precursor compounds under certain conditions. Primary precursor compounds that lead to formation of O_3 include volatile organic compounds (VOC)[1] and nitrogen oxides (NOx). $PM_{2.5}$ can be emitted directly from sources (e.g., engines) or can form in the atmosphere from precursor compounds. $PM_{2.5}$ precursor compounds in the area of analysis include sulfur oxides (SOx), NOx, VOC, and ammonia (NH_3).

Table 8-1. National Ambient Air Quality Standards

Pollutant	Averaging Time	NAAQS Primary	NAAQS Secondary	Violation Criteria
O_3	8 Hour	0.075 ppm (147 µg/m^3)	Same as Primary Standard	Annual fourth-highest daily maximum 8-hour concentration, averaged over three years
PM_{10}	24 Hour	150 µg/m^3	Same as Primary Standard	Not to be exceeded more than once per year on average over three years
$PM_{2.5}$	24 Hour	35 µg/m^3	Same as Primary Standard	98th percentile, averaged over three years
$PM_{2.5}$	Annual[1]	12.0 µg/m^3	15 µg/m^3	Annual mean, averaged over three years
CO	1 Hour	35 ppm (40 mg/m^3)	--	Not to be exceeded more than once per year
CO	8 Hour	9 ppm (10 mg/m^3)	--	
NO_2	1 Hour	100 ppb (188 µg/m^3)	--	98th percentile, averaged over three years
NO_2	Annual	0.053 ppm (100 µg/m^3)	Same as Primary Standard	Annual mean
SO_2	1 Hour	75 ppb (196 µg/m^3)	--	99th percentile of 1-hour daily maximum concentrations, averaged over three years
SO_2	3 Hour	--	0.5 ppm (1,300 µg/m^3)	Not to be exceeded more than once per year
SO_2	24 Hour	0.014 ppm (for certain areas)[2]	--	Not to be exceeded more than once per year
SO_2	Annual	0.030 ppm (for certain areas)[2]	--	Annual mean
Pb	Rolling 3-Month Average	0.15 µg/m^3	Same as Primary Standard	Not to be exceeded

Source: California Air Resources Board (CARB) 2013; USEPA 2012a; USEPA 2012b; USEPA 2012c.

[1] The California Air Resources Board and some air districts using the term “reactive organic gases,” which is similar to the term “volatile organic compounds” used by the USEPA, but with different exempt compounds. For this analysis, VOC is used throughout.

Notes:

[1] On January 15, 2013, the USEPA published a final rule to lower the primary annual $PM_{2.5}$ NAAQS to 12.0 µg/m^3. The final rule became effective on March 18, 2013 (78 Federal Register [FR] 3086).

[2] On June 22, 2010, the 24-hour and annual primary SO_2 NAAQS were revoked (75 Federal Register [FR] 35520). The 1971 SO_2 NAAQS (0.14 parts per million [ppm] and 0.030 ppm for 24-hour and annual averaging periods) remain in effect until one year after an area is designated for the 2010 1-hour primary standard. CARB recommended that all of California be designated attainment for the 1-hour SO_2 NAAQS (CARB 2011). Although the USEPA designated as nonattainment most areas in locations where existing monitoring data from 2009-2011 indicated violations of the 1-hour SO_2 NAAQS, they deferred action on all other areas. As a result, the USEPA has not yet finalized area designations for California (78 FR 47191).

[3] The Pb NAAQS was revised on November 12, 2008 to a rolling 3-month average (73 FR 66964). The 1978 Pb NAAQS (quarterly average) remained in effect until one year after an area was designated for the 2008 standard. On December 31, 2010, final area designations for the 2008 Pb standards became effective; therefore, the 1978 Pb NAAQS is no longer in effect in California (75 FR 71033).

Key:

-- = no standard

µg/m^3 = micrograms per cubic meter

mg/m^3 = milligrams per cubic meter

ppb = parts per billion

ppm = parts per million

The Federal CAA requires states to classify air basins (or portions thereof) as either “attainment” or “nonattainment” with respect to criteria air pollutants, based on whether the NAAQS have been achieved, and to prepare State Implementation Plans (SIPs) containing emission reduction strategies to maintain the NAAQS for those areas designated as attainment and to attain the NAAQS for those areas designated as nonattainment. Air basins affected by the proposed action and alternatives include the following:

- Sacramento Valley (includes contractors located in Shasta, Tehama, Glenn, Colusa, Yolo, Sutter, and Sacramento counties and the western portion of Placer County);

- Mountain Counties (includes contractors located El Dorado County and the eastern portion of Placer County);

- San Francisco Bay (includes contractors located in Contra Costa, Alameda, and Santa Clara counties);

- San Joaquin Valley (includes contractors located in San Joaquin, Stanislaus, Merced, Fresno, Kings, and Tulare counties and the western portion of Kern County); and

- North Central Coast (includes contractors in Santa Cruz, Monterey, and San Benito counties).

Figure 8-1 identifies the air basins that would be affected by the alternatives.

Source: CARB 2003a.

Figure 8-1. California Air Basins

General Conformity Section 176 (c) of the Clean Air Act (42 United States Code [U.S.C.] 7506(c)) requires any entity of the federal government that engages in, supports, or in any way provides financial support for, licenses or permits, or approves any activity to demonstrate that the action conforms to the applicable SIP required under Section 110 (a) of the Federal CAA (42 U.S.C. 7410(a)) before the action is otherwise approved. In this context, conformity means that such federal actions must be consistent with a SIP's purpose of eliminating or reducing the severity and number of violations of the NAAQS and achieving expeditious attainment of those standards. Each federal agency must determine that any action proposed that is subject to the regulations implementing the conformity requirements will, in fact, conform to the applicable SIP before the action is taken. The Central Valley Project (CVP) Municipal and Industrial Water Shortage Policy (M&I WSP) is subject to the general conformity rule because it is sponsored and supported by a federal agency, the Bureau of Reclamation (Reclamation), and the type of action is not exempt or presumed to conform.

On April 5, 2010, the USEPA revised the general conformity regulations at 40 Code of Federal Regulations (CFR) 93 Subpart B for all federal activities except those covered under transportation conformity (75 FR 17254). The revisions were intended to clarify, streamline, and improve conformity determination and review processes, and to provide transition tools for making conformity determinations for new NAAQS. The revisions also allowed federal facilities to negotiate a facility-wide emission budget with the applicable air pollution control agencies, and to allow the emissions of one precursor pollutant to be offset by the emissions of another precursor pollutant. The revised rules became effective on July 6, 2010.

The general conformity regulations apply to a proposed federal action in a nonattainment or maintenance area if the total of direct[2] and indirect[3] emissions of the relevant criteria pollutants and precursor pollutants caused by the proposed action equal or exceed certain de minimis amounts, thus requiring the federal agency to make a determination of general conformity. A Federal agency can indirectly control emissions by placing conditions on Federal approval or Federal funding.

Table 8-2 presents the de minimis amounts for nonattainment areas. The de minimis threshold for all maintenance areas is 100 tons per year (tpy), except for Pb, which has a de minimis threshold of 25 tpy.

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[2] Direct emissions are those that are caused or initiated by the Federal action, and occur at the same time and place as the Federal action.
[3] Indirect emissions are reasonably foreseeable emissions that are further removed from the Federal action in time and/or distance, and can be practicably controlled by the Federal agency on a continuing basis (40 CFR 93.152).

Table 8-2. General Conformity De Minimis Thresholds

Pollutant	Classification or Emissions Type	De Minimis Threshold (tpy)
O_3 (VOCs or NOx)	Serious NAA	50
O_3 (VOCs or NOx)	Severe NAA	25
O_3 (VOCs or NOx)	Extreme NAA	10
O_3 (VOCs or NOx)	Other NAA	100
CO	n/a	100
SO_2	n/a	100
NO_2	n/a	100
PM_{10}	Moderate NAA	100
PM_{10}	Serious NAA	70
$PM_{2.5}$	Direct emissions	100
$PM_{2.5}$	SO_2 precursor	100
$PM_{2.5}$	NOx precursor	100
$PM_{2.5}$	VOC or NH_3 precursor[1]	100
Pb	n/a	25

Source: USEPA 2014a; 40 CFR 93.153.

Notes:

[1] Pollutant not subject to de minimis threshold if the state does not determine it to be a significant precursor to $PM_{2.5}$ emissions.

Key:

n/a = not applicable

NAA = nonattainment area

The general conformity regulations incorporate a stepwise process, beginning with an applicability analysis. According to USEPA guidance (USEPA 1994), before any approval is given for a proposed action to go forward, the regulating federal agency must apply the applicability requirements found at 40 CFR 93.153(b) to the proposed action. The guidance states that the applicability analysis can be (but is not required to be) completed concurrently with any analysis required under the National Environmental Policy Act (NEPA). If the regulating federal agency determines that the general conformity regulations do not apply to the proposed action (meaning the project emissions do not exceed the de minimum thresholds), no further analysis or documentation is required.

If the general conformity regulations apply to the proposed action, the regulating federal agency must next conduct a conformity evaluation in accordance with the criteria and procedures in the implementing regulations, publish a draft determination of general conformity for public review, and then publish the final determination of general conformity. For a required action to meet the conformity determination emissions criteria, the total of direct and indirect emissions from the action must be in compliance or consistent with all relevant requirements and milestones contained in the applicable SIP (40 CFR 93.158(c)), and in addition must meet other specified requirements, such as:

- For any criteria pollutant or precursor, the total of direct and indirect emissions from the action is specifically identified and accounted for in the applicable SIP's attainment or maintenance demonstration (40 CFR 93.158(a)(1)); or

- For precursors of O_3, NO_2, or particulate matter, the total of direct and indirect emissions from the action is fully offset within the same nonattainment (or maintenance) area through a revision to the applicable SIP or a similarly enforceable measure that effects emission reductions so that there is no net increase in emissions of that pollutant (40 CFR 93.158(a)(2)); or

- For O_3 or NO_2, the total of direct and indirect emissions from the action is determined and documented by the State agency primarily responsible for the applicable SIP to result in a level of emissions which, together with all other emissions in the nonattainment (or maintenance) area, would not exceed the emissions inventory specified in the applicable SIP (40 CFR 93.158(a)(5)(i)(A)); or

- For O_3 or NO_2, the total of direct and indirect emissions from the action (or portion thereof) is determined by the State agency responsible for the applicable SIP to result in a level of emissions which, together with all other emissions in the nonattainment (or maintenance) area, would exceed the emissions inventory specified in the applicable SIP and the State Governor or the Governor's designee for SIP actions makes a written commitment to USEPA for specific SIP revision measures reducing emissions to not exceed the emissions inventory (40 CFR 93.158(a)(5)(i)(B)).

8.1.2.2 State

California Clean Air Act The CCAA substantially added to the authority and responsibilities of the State's air pollution control districts (APCDs). The CCAA establishes an air quality management process that generally parallels the Federal process. The CCAA, however, focuses on attainment of the California Ambient Air Quality Standards (CAAQS) that, for certain pollutants and averaging periods, are typically more stringent than the comparable NAAQS. The CAAQS are included in Table 8-3.

Table 8-3. California Ambient Air Quality Standards

Pollutant	Averaging Time	CAAQS	Violation Criteria
O_3	1 Hour	0.09 ppm (180 µg/m^3)	Not to be exceeded
O_3	8 Hour	0.070 ppm (137 µg/m^3)	Not to be exceeded
PM_{10}	24 Hour	50 µg/m^3	Not to be exceeded
PM_{10}	Annual	20 µg/m^3	Not to be exceeded
$PM_{2.5}$	Annual	12 µg/m^3	Not to be exceeded

Pollutant	Averaging Time	CAAQS	Violation Criteria
CO	1 Hour	20 ppm (23 mg/m^3)	Not to be exceeded
CO	8 Hour	9.0 ppm (10 mg/m^3)	Not to be exceeded
NO_2	1 Hour	0.18 ppm (339 µg/m^3)	Not to be exceeded
NO_2	Annual	0.030 ppm (57 µg/m^3)	Not to be exceeded
SO_2	1 Hour	0.25 ppm (655 µg/m^3)	Not to be exceeded
SO_2	24 Hour	0.04 ppm (105 µg/m^3)	Not to be exceeded
Pb	30 Day Average	1.5 µg/m^3	Not to be equaled or exceeded
Visibility Reducing Particles	8 Hour	See footnote 1	Not to be exceeded
Sulfates	24 Hour	25 µg/m^3	Not to be equaled or exceeded
Hydrogen Sulfide	1 Hour	0.03 ppm (42 µg/m^3)	Not to be equaled or exceeded
Vinyl Chloride	24 Hour	0.01 ppm (26 µg/m^3)	Not to be equaled or exceeded

Source: CARB 2013.

Note:

[1] In 1989, CARB converted both the general statewide 10-mile visibility standard and the Lake Tahoe 30-mile visibility standard to instrumental equivalents, which are “extinction of 0.23 per kilometer” and “extinction of 0.07 per kilometer” for the statewide and Lake Tahoe Air Basin standards, respectively.

Key:
µg/m^3 = micrograms per cubic meter
mg/m^3 = milligrams per cubic meter
ppm = parts per million

The CCAA requires that the CAAQS be met as expeditiously as practicable, but does not set precise attainment deadlines. Instead, the act established increasingly stringent requirements for areas that will require more time to achieve the standards.

The air quality attainment plan requirements established by the CCAA are based on the severity of air pollution problems caused by locally generated emissions. Upwind APCDs are required to establish and implement emission control programs commensurate with the extent of pollutant transport to downwind districts.

The California Air Resources Board (CARB) is responsible for developing emission standards for on-road motor vehicles and some off-road equipment in the state. In addition, CARB develops guidelines for the local districts to use in establishing air quality permit and emission control requirements for stationary sources subject to the local air district regulations.

8.1.2.3 Regional/Local

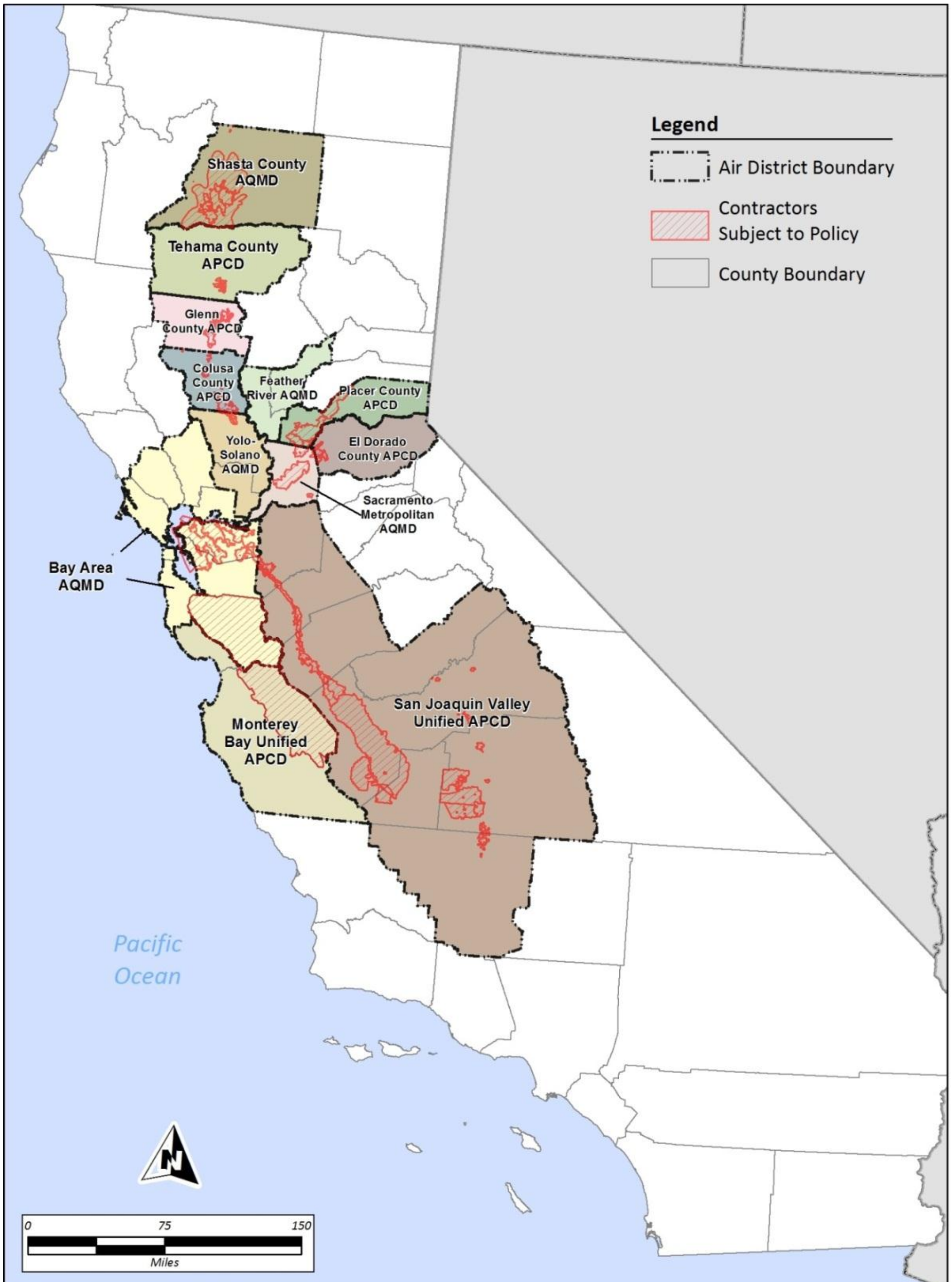
Multiple air quality management districts (AQMDs) and APCDs have jurisdiction over the area of analysis. The following APCDs/AQMDs regulate air quality within the area of analysis:

- Shasta County AQMD;
- Tehama County APCD;
- Glenn County APCD;
- Colusa County APCD;
- Feather River AQMD[4];
- Placer County APCD;
- El Dorado County APCD
- Yolo-Solano AQMD;
- Sacramento Metropolitan AQMD;
- Bay Area AQMD[5];
- San Joaquin Valley APCD[6]; and
- Monterey Bay Unified APCD[7].

The various AQMDs and APCDs are required to adopt plans describing how they intend to meet the CAAQS and NAAQS. These plans require, among other emissions-reducing activities, control technology for existing sources; control programs for area sources and indirect sources; a permitting system designed to ensure no net increase in emissions from any new or modified permitted sources of emissions; transportation control measures; sufficient control strategies to achieve a five percent or more annual reduction in emissions (or 15 percent or more in a three-year period) for VOC, NOx, CO, and PM_{10}; and demonstration of compliance with CARB's established reporting periods for compliance with air quality goals.

Figure 8-2 depicts the location of each air district in relation to the affected CVP contractors.

[4] Includes contractors located in Sutter and Yuba counties.
[5] Includes contractors located in Contra Costa, Alameda, and Santa Clara counties.
[6] Includes contractors located in San Joaquin, Stanislaus, Merced, Fresno, Kings, and Tulare counties and the western portion of Kern County.
[7] Includes contractors located in Santa Cruz, Monterey, and San Benito counties.



O:\73399-Municipal Industrial EIS\MXD\Air\Air140730\Figure 9-2 California Air Districts.mxd

Source: CARB 2003b.

Figure 8-2. California Air Districts

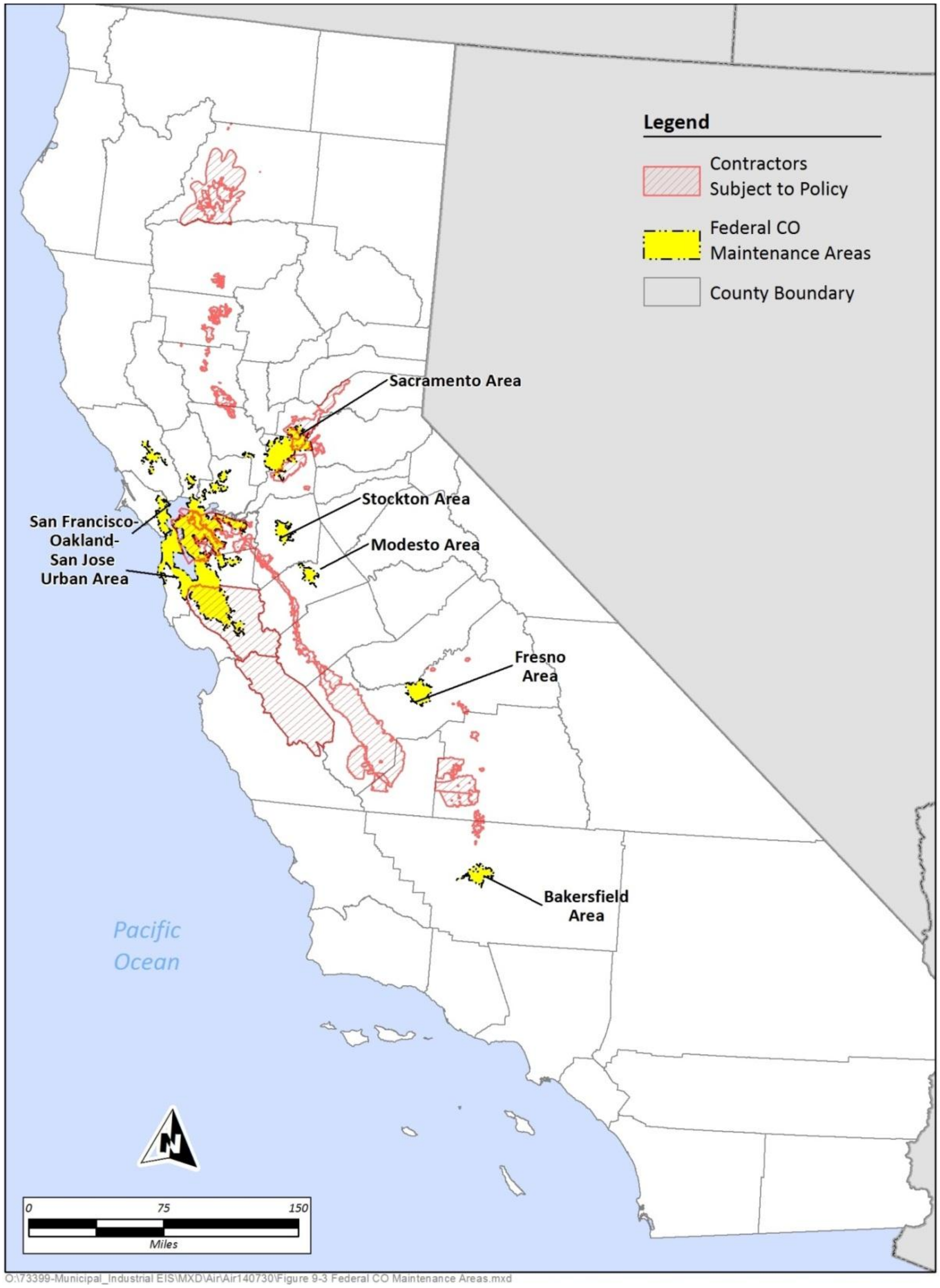
8.1.3 Existing Conditions

The following sections describe the air basins within the M&I WSP area of analysis. The entire study area is in attainment of the NO_2, SO_2, and Pb NAAQS. Certain urbanized areas are designated as maintenance areas for the CO NAAQS, as summarized below.

- Bakersfield (Kern County);
- Fresno (Fresno County);
- Modesto (Stanislaus County);
- Sacramento urban area[8];
- San Francisco-Oakland-San Jose urban area[9]; and
- Stockton (San Joaquin County).

No contractors affected by the M&I WSP are located within the maintenance areas for Bakersfield, Fresno, Modesto, and Stockton. Figure 8-3 shows the maintenance areas for the federal CO standard.

[8] Includes portions of Placer, Sacramento, and Yolo counties.
[9] Includes San Francisco County and portions of Alameda, Contra Costa, Marin, Napa, San Mateo, Santa Clara, Solano, and Sonoma counties.



Source: USEPA 2014b.

Figure 8-3. Federal CO Maintenance Areas

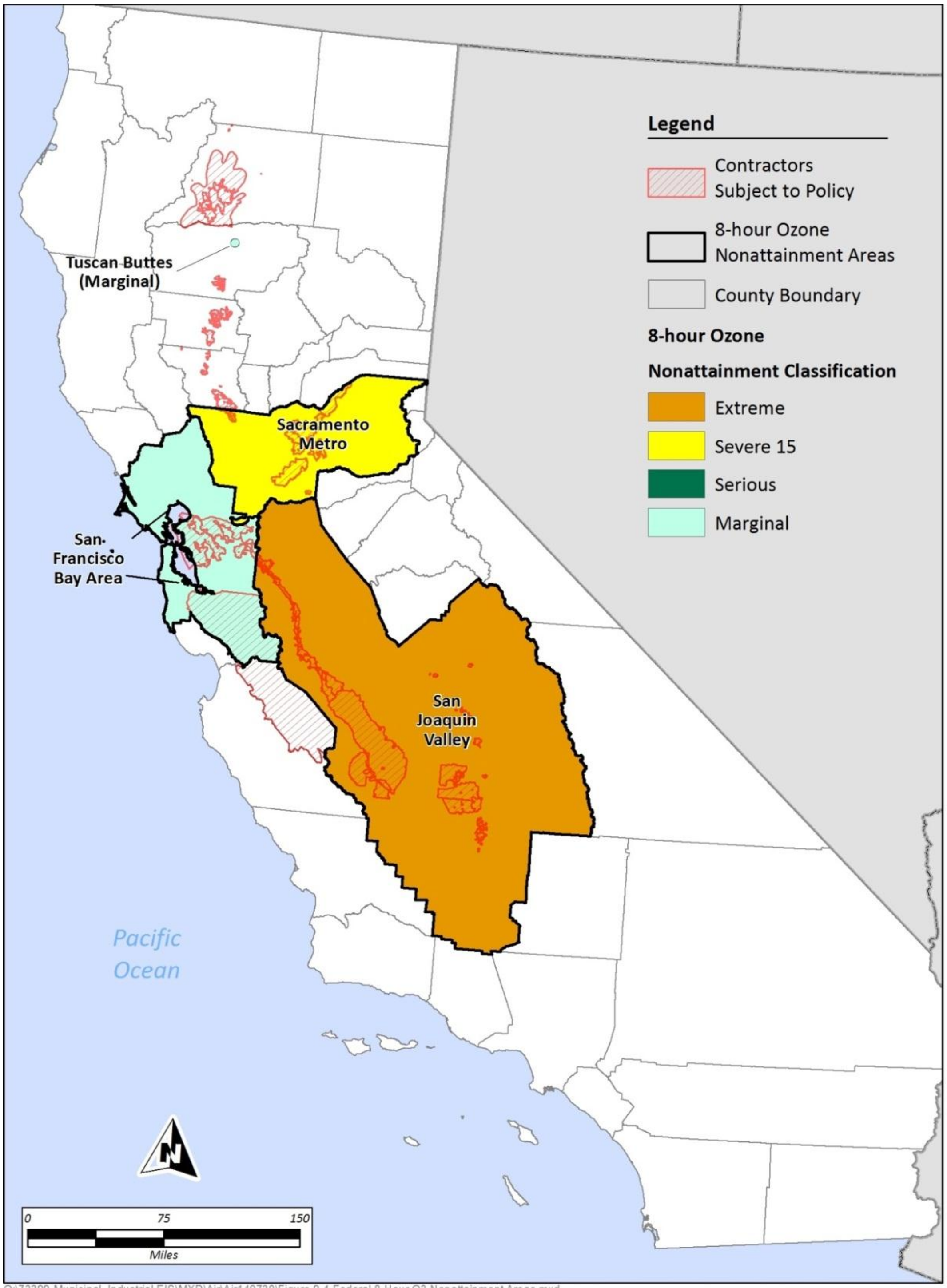
8.1.3.1 Federal 8-Hour O_3 Attainment Status

Table 8-4 summarizes the federal 8-hour O_3 attainment status for air basins within the area of analysis. No contractors are located in the portion of Tehama County (Tuscan Buttes) that is designated as a marginal O_3 nonattainment area. Contractors located in the northern portion of Sacramento Valley (Shasta, Tehama, Glenn, and Colusa counties) are located in areas designated as attainment for the O_3 standard, as are those located in the North Central Coast Air Basin (Monterey, San Benito, and Santa Cruz counties). All other contractors are located in nonattainment areas. Figure 8-4 shows the federal nonattainment areas for the 8-hour O_3 standard.

Table 8-4. Federal Nonattainment Areas for the 8-Hour O_3 NAAQS

Designated Area	Classification	Counties
Sacramento Metro	Severe	El Dorado (P)
Sacramento Metro	Severe	Placer (P)
Sacramento Metro	Severe	Sacramento
Sacramento Metro	Severe	Solano (P)
Sacramento Metro	Severe	Sutter (P)
Sacramento Metro	Severe	Yolo
San Francisco Bay	Marginal	Alameda
San Francisco Bay	Marginal	Contra Costa
San Francisco Bay	Marginal	Marin
San Francisco Bay	Marginal	Napa
San Francisco Bay	Marginal	San Francisco
San Francisco Bay	Marginal	San Mateo
San Francisco Bay	Marginal	Santa Clara
San Francisco Bay	Marginal	Solano (P)
San Francisco Bay	Marginal	Sonoma (P)
San Joaquin Valley	Extreme	Fresno
San Joaquin Valley	Extreme	Kern (P)
San Joaquin Valley	Extreme	Kings
San Joaquin Valley	Extreme	Madera
San Joaquin Valley	Extreme	Merced
San Joaquin Valley	Extreme	San Joaquin
San Joaquin Valley	Extreme	Stanislaus
San Joaquin Valley	Extreme	Tulare

Source: 40 CFR 81.305; USEPA 2014a
Notes:
Key:
P = partial



O:\73399-Municipal Industrial EIS\MXD\Air\Air140730\Figure 9-4 Federal 8-Hour O3 Nonattainment Areas.mxd

Source: USEPA 2014b.

Figure 8-4. Federal 8-Hour O_3 Nonattainment Areas

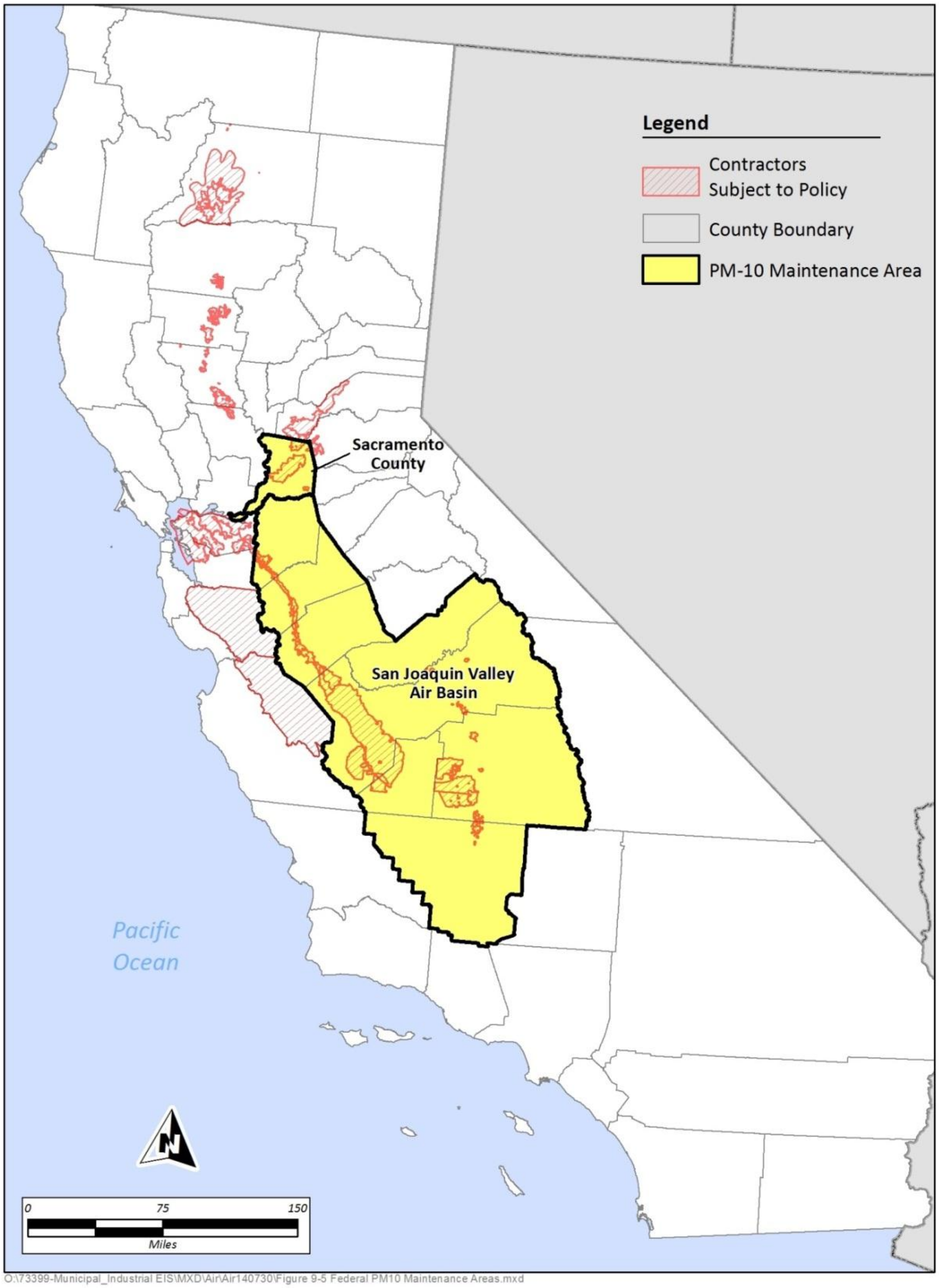
8.1.3.2 Federal PM_{10} Attainment Status

Table 8-5 summarizes the PM_{10} attainment status for air basins located within the area of analysis. As shown in the table, Sacramento County and the San Joaquin Valley are designated as maintenance areas. All other areas affected by the proposed project are located in attainment areas. Figure 8-5 shows the federal PM_{10} maintenance areas.

Table 8-5. Federal Maintenance Areas for the PM_{10} NAAQS

Air Basin	Classification	Counties
Sacramento Valley	Maintenance	Sacramento
San Joaquin Valley	Maintenance	Fresno
San Joaquin Valley	Maintenance	Kern (P)
San Joaquin Valley	Maintenance	Kings
San Joaquin Valley	Maintenance	Madera
San Joaquin Valley	Maintenance	Merced
San Joaquin Valley	Maintenance	San Joaquin
San Joaquin Valley	Maintenance	Stanislaus
San Joaquin Valley	Maintenance	Tulare

Source: 40 CFR 81.305; USEPA 2014a
Key:
P = partial



Source: USEPA 2014b.

Figure 8-5. Federal PM_{10} Maintenance Areas

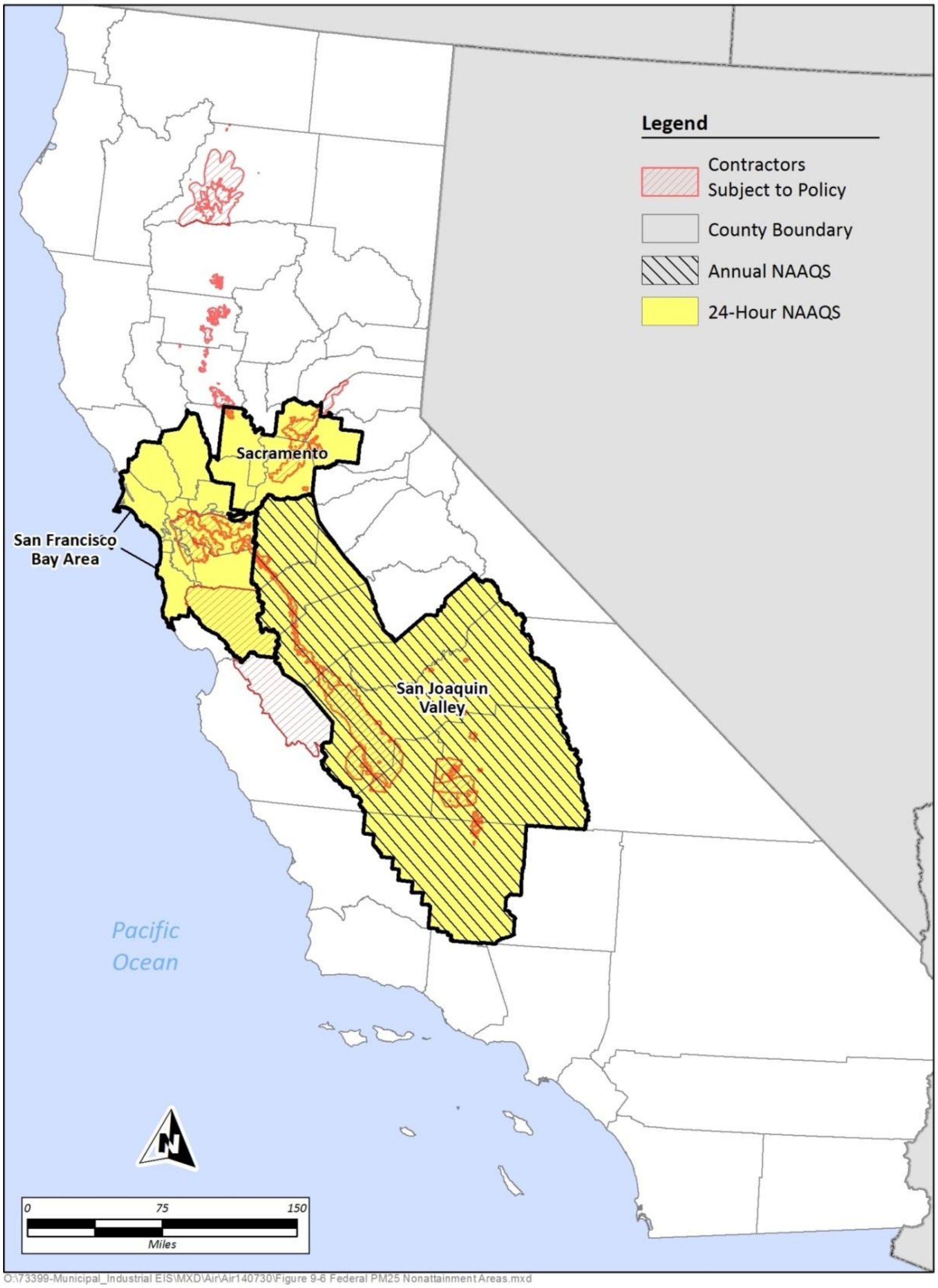
8.1.3.3 Federal $PM_{2.5}$ Attainment Status

Table 8-6 summarizes the $PM_{2.5}$ attainment status for air basins located within the area of analysis. Two $PM_{2.5}$ standards are currently in effect: 1) the 24-hour NAAQS effective in 2006 and 2) the annual average NAAQS effective in 1997. Regions are either in nonattainment of the 2006 standard or in nonattainment for both the 2006 and 1997 standards; there are no areas in the state that are in nonattainment of only the 1997 standard. Sacramento County, the San Francisco Bay Area, the San Joaquin Valley, and the urban areas of Chico and Yuba City-Marysville are designated as nonattainment areas for the $PM_{2.5}$ NAAQS. Figure 8-6 shows the federal $PM_{2.5}$ nonattainment areas.

Table 8-6. Federal Nonattainment Areas for the $PM_{2.5}$ NAAQS

Designated Area	County	Annual Status (1997)	24-Hour Status (2006)
Sacramento	El Dorado (P)	A	N
Sacramento	Placer (P)	A	N
Sacramento	Sacramento	A	N
Sacramento	Solano (P)	A	N
Sacramento	Yolo (P)	A	N
San Francisco Bay	Alameda	A	N
San Francisco Bay	Contra Costa	A	N
San Francisco Bay	Marin	A	N
San Francisco Bay	Napa	A	N
San Francisco Bay	San Francisco	A	N
San Francisco Bay	San Mateo	A	N
San Francisco Bay	Santa Clara	A	N
San Francisco Bay	Solano (P)	A	N
San Francisco Bay	Sonoma (P)	A	N
San Joaquin Valley	Fresno	N	N
San Joaquin Valley	Kern (P)	N	N
San Joaquin Valley	Kings	N	N
San Joaquin Valley	Madera	N	N
San Joaquin Valley	Merced	N	N
San Joaquin Valley	San Joaquin	N	N
San Joaquin Valley	Stanislaus	N	N
San Joaquin Valley	Tulare	N	N
Yuba City-Marysville	Sutter	A	N
Yuba City-Marysville	Yuba (P)	A	N

Key:
A = attainment
N = nonattainment
P = partial



Source: USEPA 2014b.

Figure 8-6. Federal $PM_{2.5}$ Nonattainment Areas

8.2 Environmental Consequences

These sections describe the environmental consequences associated with each alternative.

8.2.1 Assessment Methods

Groundwater pumping activities by farmers affected by the action alternatives could change air emissions in the area of analysis if the amount of annual groundwater pumped in an action alternative changed compared to the No Action Alternative. For this analysis, it was conservatively assumed that only diesel-fueled pumps would be used during any groundwater pumping activities. While a range of fuel types (including electric engines), engine sizes (horsepower [hp]), and pumping rates would be used in the area of analysis, average values were used to provide a high-level analysis. Because the current study is a high-level analysis, detailed information on specific farmers, engines, or pumping rates was not available. However, engine size and pumping rates were estimated as 160 hp and 2,500 gallons per minute using known pump information from previous analyses in the study area. Emissions were calculated using the following method (required conversions excluded from equation shown below):

> *Annual amount of groundwater pumped (change from Existing Conditions or No Action Alternative) / pump rate (gallons per minute) x emission factor (grams per hp-hr) x engine size (hp)*

Agricultural engines are subject to CARB's Airborne Toxic Control Measure (ATCM) for Stationary Compression Ignition Engines (17 California Code of Regulations [CCR] 93115). The ATCM contains emissions limits on diesel engines greater than 50 hp, particularly for diesel particulate matter, based on the size and use of the engine. In addition to requiring the use of CARB diesel fuel[10] or an alternative fuel like biodiesel, the ATCM also contains schedules of required emission reductions that phase-in depending on engine use (e.g., agriculture, emergency, etc.), size (hp), and calendar year. All engines were assumed to be in compliance with the ATCM. Emission standards for in-use stationary diesel-fueled engines used in agricultural operations were used in the emission calculations.

Additionally, changes in the irrigated acreage could affect fugitive dust emissions in the area of analysis. Fugitive dust emissions could occur from two main sources: 1) land preparation and harvesting; and 2) windblown dust erosion. If the amount of irrigated acreage were to decrease between an action alternative and the No Action Alternative, then there would be an increase in barren land. As a result, fugitive dust emissions from land preparation and harvesting would

[10] "CARB diesel fuel" is defined as diesel fuel that meets the specifications of vehicular diesel fuel, namely meeting a 15 ppm sulfur standard.

decrease, while fugitive dust emissions from windblown dust erosion would increase.

The following documents were used to estimate emissions from groundwater pumping and changes in fugitive dust from irrigated acreages for agricultural contractors and from changes in water deliveries to M&I contractors:

- Statewide Agricultural Production (SWAP) model results (see Appendix D, Statewide Agricultural Production Model Documentation) for changes in agricultural groundwater pumping and irrigated acreages in the modeled Sacramento Valley, San Joaquin River, and Tulare Lake regions
- CalSim II model results (see Appendix B, Water Operations Model Documentation) for changes in water deliveries for M&I water service contractors
- Diesel engine emission standards established in 17 CCR 93115.8 and 13 CCR 2423
- Diesel engine emission factors from the USEPA's *Compilation of Air Pollutant Emission Factors* (AP-42), specifically from the following chapter:
  - Chapter 3.3: Gasoline and Diesel Industrial Engines (USEPA 1996)
- CARB Emission Inventory Documentation for the following categories:
  - Section 7.4: Agricultural Land Preparation (CARB 2003c)
  - Section 7.5: Agricultural Harvest Operations (CARB 2003d)
  - Section 7.12: Windblown Dust – Agricultural Lands (CARB 1997)
- CARB Size Fractions for particulate matter (CARB 2012)

Several air districts recommend the use of the California Emissions Estimator Model (CalEEMod) for California Environmental Quality Act analyses; however, CalEEMod was developed for estimating impacts from land use development projects, such as those that would be subject to San Joaquin Valley APCD Rule 9510 (Indirect Source Review). Because CalEEMod is not designed to estimate emissions from stationary sources, it was necessary to calculate emissions with an alternative method.

This analysis summarizes emissions by air basin. Analyzing air quality emissions is a complex undertaking and areas designated nonattainment or maintenance for an air pollutant could be a sub-region within an air basin. For example, the PM_{10} maintenance area for the Sacramento Valley Air Basin only occurs within

Sacramento County (see Table 8-5). As a result, only PM_{10} emissions that occur within Sacramento County should be evaluated for this specific maintenance area.

8.2.1.1 SWAP Model Area Designations

The Sacramento Valley Air Basin closely follows the Sacramento Valley Region modeled with the SWAP model. SWAP model regions 2 through 6 include portions of Tehama, Glenn, Butte, Colusa, Sutter, Yuba, Yolo, and Solano counties. Although a small portion of region 6 occurs in the San Francisco Bay Air Basin in Solano County, it was assumed for the purposes of this analysis that all region 6 impacts would occur in the Sacramento Valley Air Basin.

Sacramento County is located at the southern edge of the Sacramento Valley Air Basin, but it was modeled with the San Joaquin River Region because a portion of SWAP model region 9 extends through Sacramento County. As a result, any emissions occurring within region 9 were assumed to occur entirely within Sacramento County for general conformity purposes. This approach provides a conservative evaluation because region 9 also includes portions of Yolo, Solano, San Joaquin, Contra Costa, and Alameda counties.

The San Joaquin Valley Air Basin contains both the San Joaquin River and Tulare Lake SWAP regions. As a result, any emissions that would occur in these two regions were combined when evaluating impacts. To be conservative, emissions from region 9 are also included with the San Joaquin Valley Air Basin and any emissions from region 9 are only assumed to be equivalent to Sacramento County for general conformity purposes.

Detailed calculations are provided in Appendix E, Air Quality Emission Calculations.

8.2.1.2 CalSim II Model Area Designations

The air quality analysis uses CalSim II modeling results to determine water supply delivery effects from the No Action and action alternatives. The difference in water supply deliveries between an action alternative and the No Action Alternative (or between the No Action Alternative and Existing Conditions) was calculated to evaluate the effects of each alternative. CalSim II provides output for each year during the period of record. This data was compiled to determine results by water year type (wet, above normal, below normal, dry, and critical), and then averaged over the period of record. The analysis presented in this section for each alternative indicates modeled M&I deliveries to water users north of the Sacramento-San Joaquin River Delta (Delta) and south of the Delta.

8.2.2 Alternative 1: No Action

The No Action Alternative includes the most likely future conditions in the absence of the action alternatives. Compared to existing conditions in 2010, the No Action Alternative would result in an increase in irrigated land as surface water from the CVP is used, which would also decrease groundwater pumping.

As a result, exhaust emissions from groundwater pumping would decrease while fugitive dust emissions from barren land would increase.

Table 8-7 summarizes the SWAP model results for changes in agricultural production that would occur under the No Action Alternative. Specific impacts in the Sacramento Valley Air Basin and in the San Joaquin Valley Air Basin are summarized below.

Table 8-7. SWAP Output for No Action Alternative (Change from Existing Agricultural Water Use Conditions)

Location	Year Type	Groundwater Pumping (TAF/year)[1]	Irrigated Acreage (thousand acres/year)[1]
Sacramento Valley Air Basin	Wet	(67.8)	3
	Above Normal	(70.5)	2
	Below Normal	(69.4)	2
	Dry	(62.1)	(<1)
	Critical	(50.1)	(13)
San Joaquin Valley Air Basin	Wet	(70.0)	11
	Above Normal	(79.9)	11
	Below Normal	(24.7)	23
	Dry	(36.8)	13
	Critical	4.2	5

Note:
[1] Parentheses indicate a decrease in agricultural production compare to Existing Conditions.
Key:
TAF = thousand acre-feet

Allocation of available CVP water supplies between M&I and Agricultural water service contractors under the No Action Alternative could result in a change in emissions if more pumping is necessary to deliver water. As discussed in Chapter 4, Surface Water, M&I water service contractor deliveries to north of Delta contractors would be increased by 90,000 acre-feet (AF) in critically dry water years to 189,000 AF in wet water years when compared to existing conditions. Additionally, M&I water service contractor deliveries for south of Delta contractors would be increased by 20,000 AF in critically dry years to 45,000 AF in wet years when compared to existing conditions. This change is primarily driven by projected future population growth and the associated increases in M&I water demands in all water years.

Although it is expected that additional pumping by water service contractors would be required to transfer the increased water supplies through the CVP system, the conveyance pumps are anticipated to be largely electrically-driven. As a result, there would be no localized air quality impacts from water delivery to M&I contractors, but emissions at the powerplants servicing the electric grid could increase compared to existing conditions. Although there could be a net increase in emissions, combustion equipment operating at the powerplants would be permitted by the local air districts and there would be emissions would be accounted for in the SIP.

8.2.2.1 Sacramento Valley Air Basin

Maintaining the current water shortage allocations to agricultural and M&I water service contractors in the Sacramento Valley Air Basin could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. As described for the Assessment Methods, any changes in groundwater pumping or irrigated acreages that occur within the Sacramento Valley Region in the SWAP model are assumed to be entirely contained within the Sacramento Valley Air Basin. As illustrated in Table 8-7, groundwater pumping activities would decrease across all water year types compared to existing conditions. As shown in Table 8-8, exhaust emissions from groundwater pumping would decrease across all water year types for agricultural contractors in the Sacramento Valley Air Basin.

Table 8-8. No Action Alternative: Change in Groundwater Pumping Emissions from Existing Conditions (tpy) in Sacramento Valley Air Basin

Year Type[1]	VOC	NOx	CO	SOx	PM_{10}	$PM_{2.5}$
W	(4)	(74)	(97)	(24)	(6)	(6)
AN	(4)	(77)	(101)	(25)	(6)	(6)
BN	(4)	(75)	(99)	(25)	(6)	(6)
D	(4)	(67)	(89)	(22)	(5)	(5)
C	(3)	(54)	(72)	(18)	(4)	(4)

Note:
[1] Parentheses indicate reduced emissions (beneficial impact)
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; CO = carbon monoxide; D = dry condition; NOx = nitrogen oxides; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; SOx = sulfur oxides; VOC = volatile organic compound; W = wet condition;

Maintaining the current water shortage allocations to agricultural and M&I water service contractors in the Sacramento Valley Air Basin could affect agricultural production, leading to changes in fugitive dust emissions from land preparation and harvesting activities from agricultural contractors, as well as changes to windblown dust erosion. Land preparation and harvesting activities would increase in response to more irrigated acreages. With an increase in the amount of land being irrigated, land preparation and harvesting activities would increase and windblown dust would decrease compared to existing conditions.

Table 8-9 summarizes the changes in fugitive dust emissions from changes to the irrigated acreages. As shown in the table, there would be a net increase in PM_{10} and $PM_{2.5}$ emissions.

Table 8-9. No Action Alternative: Change in Fugitive Dust Emissions from Existing Conditions (tpy) in Sacramento Valley Air Basin

Year Type[1]	PM_{10} Land Prep.	PM_{10} Harvesting	PM_{10} Erosion	PM_{10} Total	$PM_{2.5}$ Land Prep.	$PM_{2.5}$ Harvesting	$PM_{2.5}$ Erosion	$PM_{2.5}$ Total
W	215	13	(2)	227	32	2	(<1)	34
AN	210	13	(1)	221	31	2	(<1)	33
BN	219	15	(1)	233	33	2	(<1)	35
D	185	9	<1	195	28	1	<1	29
C	147	8	8	164	22	1	2	25

Note:
[1] Parentheses indicate reduced emissions (beneficial impact).
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; D = dry condition; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; W = Wet condition

8.2.2.2 San Joaquin Valley Air Basin

Maintaining the current water shortage allocations to agricultural and M&I water service contractors in the San Joaquin Valley Air Basin could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. As described for the Assessment Methods, any changes in groundwater pumping or irrigated acreages that occur within the San Joaquin River and Tulare Lake regions in the SWAP model are assumed to be entirely contained within the San Joaquin Valley Air Basin. As illustrated in Table 8-7, groundwater pumping activities would decrease across all water year types except for critically dry years where it would increase. As shown in Table 8-10, exhaust emissions from groundwater pumping would increase during critically dry years, but would decrease during other years.

Table 8-10. No Action Alternative: Change in Groundwater Pumping Emissions from Existing Conditions (tpy) in San Joaquin Valley Air Basin

Year Type[1]	VOC	NOx	CO	SOx	PM_{10}	$PM_{2.5}$
W	(4)	(76)	(100)	(25)	(6)	(6)
AN	(5)	(87)	(114)	(28)	(7)	(7)
BN	(1)	(27)	(35)	(9)	(2)	(2)
D	(2)	(40)	(53)	(13)	(3)	(3)
C	<1	5	6	1	<1	<1

Note:
[1] Parentheses indicate reduced emissions (beneficial impact)
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; CO = carbon monoxide; D = dry condition; NOx = nitrogen oxides; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; SOx = sulfur oxides; VOC = volatile organic compound; W = wet condition;

Maintaining the current water shortage allocations to agricultural and M&I water service contractors in the San Joaquin Valley Air Basin could affect agricultural production, leading to changes in fugitive dust emissions from land preparation and harvesting activities from agricultural contractors, as well as changes to windblown dust erosion. The SWAP model simulates adjustments made by farmers to maximize economic profit. The increase in groundwater pumping cost between 2030 and existing conditions in 2010 is expected to increase by 17 percent. In response to the increase cost of groundwater pumping, farmers will substitute away from groundwater pumping to minimize costs by either using surface water in districts where there is excess capacity or by shifting the crop mix toward crops that use less water per acre. As a result, farmers are expected to decrease the amount of groundwater pumped in response to economic pressures.

Table 8-11 summarizes the changes in fugitive dust emissions from changes to the irrigated acreages. PM_{10} emissions would increase during all year types. $PM_{2.5}$ emissions are generally driven more by exhaust than by erosion because erosion particles tend to be coarser and larger than $PM_{2.5}$. As a result, $PM_{2.5}$ emissions fluctuate and would increase during all years except below normal years, when emissions would decrease.

Table 8-11. No Action Alternative: Change in Fugitive Dust Emissions from Existing Conditions (tpy) in San Joaquin Valley Air Basin

Year Type[1]	PM_{10} Land Prep.	PM_{10} Harvesting	PM_{10} Erosion	PM_{10} Total	$PM_{2.5}$ Land Prep.	$PM_{2.5}$ Harvesting	$PM_{2.5}$ Erosion	$PM_{2.5}$ Total
W	89	1	(56)	33	13	<1	(11)	2
AN	88	1	(55)	34	13	<1	(11)	2
BN	134	14	(122)	26	20	2	(24)	(2)
D	94	4	(71)	27	14	1	(14)	<1
C	59	(3)	(24)	32	9	(<1)	(5)	4

Note:
[1] Parentheses indicate reduced emissions (beneficial impact).
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; D = dry condition; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; W = Wet condition

Land preparation and harvesting emission factors vary by crop type and changes in $PM_{2.5}$ emissions could also be driven by changes in crop types during different water year types. The below normal conditions shows a substantial increase away from field and forage crops and towards vegetable/truck crops and orchards/vineyards. Additionally, the below normal conditions observe a large increase in irrigated acreages in the Tulare Lake Region compared to San Joaquin River Region. Because the emission factor for fugitive dust is higher in the Tulare Lake Region than in the San Joaquin River Region, this shift in production is also illustrated in the results for this water year. Detailed calculations are provided in Appendix E.

8.2.2.3 General Conformity

Changes in emissions that would occur from groundwater pumping and differences in irrigated acreages could exceed the general conformity de minimis thresholds. The general conformity regulations apply to proposed federal actions in nonattainment or maintenance areas if the relevant criteria pollutants and precursor pollutants caused by the action equal or exceed certain de minimis thresholds (see Table 8-2). The No Action Alternative serves as the baseline from which the action alternatives are compared for the general conformity applicability evaluation. As a result, a general conformity evaluation is not applicable to this alternative.

8.2.2.4 Indirect Effects

The No Action Alternative could cause indirect effects from actions contractors would take from future water shortages. Because CVP deliveries to agricultural contractors would be larger compared to existing conditions in 2010, no additional actions to supplement water are expected to occur. As a result, there would be no indirect effects from the No Action Alternative.

8.2.3 Alternative 2: Equal Agricultural and M&I Allocation

Under Alternative 2, M&I water service contractors and agricultural water service contractors would have the same CVP water allocations during shortages. This means that in years when the CVP water supplies are not adequate to provide water to all water service contractors, agricultural and M&I water service contractor allocations would be reduced by the same percentage. Compared to the No Action Alternative, Alternative 2 would result in an increase in irrigated land as surface water from the CVP is used, which would also decrease groundwater pumping. As a result, exhaust emissions from groundwater pumping would decrease while fugitive dust emissions from barren land would increase.

Table 8-12 summarizes the SWAP model results for changes in agricultural production that would occur under Alternative 2. Specific impacts in the Sacramento Valley Air Basin and in the San Joaquin Valley Air Basin are summarized below.

Table 8-12. SWAP Output for Alternative 2 (Change from No Action Alternative Agricultural Water Use)

Location	Year Type	Groundwater Pumping (TAF/year)[1]	Irrigated Acreage (thousand acres/year)[1]
Sacramento Valley Air Basin	Wet	(3.0)	<1
	Above Normal	(4.6)	<1
	Below Normal	(1.3)	3
	Dry	(1.4)	5
	Critical	(3.1)	10

Location	Year Type	Groundwater Pumping (TAF/year)[1]	Irrigated Acreage (thousand acres/year)[1]
San Joaquin Valley Air Basin	Wet	(34.6)	<1
	Above Normal	(50.0)	<1
	Below Normal	(43.1)	7
	Dry	(42.2)	28
	Critical	(48.3)	34

Note:
[1] Parentheses indicate a decrease in agricultural production compare to No Action Alternative.
Key:
TAF = thousand acre-feet

Allocation of available CVP water supplies between M&I and Agricultural water service contractors under Alternative 2 could result in a change in emissions if more pumping is necessary to deliver water. As discussed in Chapter 4, Surface Water, M&I deliveries to north of Delta contractors would be decreased by 21,000 AF in wet water years to 176,000 AF in critically dry water years when compared to the No Action Alternative. Additionally, M&I deliveries would be decreased by 32,000 AF in wet years to 78,000 AF in critically dry years when compared to the No Action Alternative. Because this alternative would give a greater preference to agricultural water service contractors when compared to the No Action Alternative, M&I users would see a corresponding reduction in water deliveries.

Although it is expected that additional pumping would be required to transfer the increased water supplies through the CVP system, the conveyance pumps are anticipated to be largely electrically-driven. As a result, emissions at the powerplants servicing the electric grid could decrease.

8.2.3.1 Sacramento Valley Air Basin

Equal allocation of available CVP water supplies between agricultural and M&I water service contractors in the Sacramento Valley Air Basin could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. As described for the Assessment Methods, any changes in groundwater pumping or irrigated acreages that occur within the SWAP Sacramento Valley Region are assumed to be entirely contained within the Sacramento Valley Air Basin. Groundwater pumping activities would decrease across all water year types under Alternative 2 (see Table 8-12). As shown in Table 8-13, exhaust emissions from groundwater pumping would decrease during all water years for agricultural contractors in the Sacramento Valley Air Basin.

Table 8-13. Alternative 2: Change in Groundwater Pumping Emissions from No Action Alternative (tpy) in Sacramento Valley Air Basin

Year Type[1]	VOC	NOx	CO	SOx	PM_{10}	$PM_{2.5}$
W	(<1)	(3)	(4)	(1)	(<1)	(<1)
AN	(<1)	(5)	(7)	(2)	(<1)	(<1)
BN	(<1)	(1)	(2)	(<1)	(<1)	(<1)
D	(<1)	(1)	(2)	(<1)	(<1)	(<1)
C	(<1)	(3)	(4)	(1)	(<1)	(<1)

Note:
[1] Parentheses indicate reduced emissions (beneficial impact)
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; CO = carbon monoxide; D = dry condition; NOx = nitrogen oxides; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; SOx = sulfur oxides; VOC = volatile organic compound; W = wet condition;

Equal allocation of available CVP water supplies between agricultural and M&I water service contractors in the Sacramento Valley Air Basin could affect agricultural production, leading to changes in fugitive dust emissions from land preparation and harvesting activities from agricultural contractors, as well as changes to windblown dust erosion. As more surface water is available to agricultural contractors during water shortage years as compared to the No Action Alternative because of increased water allocations, land preparation and harvesting activities would increase in response to more irrigated acreages. With an increase in the amount of land being irrigated, land preparation and harvesting activities would increase and windblown dust would decrease.

Table 8-14 summarizes the changes in fugitive dust emissions from changes to the irrigated acreages. As shown in the table, there would be a net increase in PM_{10} and $PM_{2.5}$ emissions.

Table 8-14. Alternative 2: Change in Fugitive Dust Emissions from No Action Alternative (tpy) in Sacramento Valley Air Basin

Year Type[1]	PM_{10} Land Prep.	PM_{10} Harvesting	PM_{10} Erosion	PM_{10} Total	$PM_{2.5}$ Land Prep.	$PM_{2.5}$ Harvesting	$PM_{2.5}$ Erosion	$PM_{2.5}$ Total
W	<1	<1	(<1)	<1	<1	<1	(<1)	<1
AN	<1	<1	(<1)	<1	<1	<1	(<1)	<1
BN	7	<1	(2)	5	1	<1	(<1)	1
D	40	4	(4)	41	6	1	(1)	6
C	32	2	(6)	27	5	<1	(1)	4

Note:
[1] Parentheses indicate reduced emissions (beneficial impact).
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; D = dry condition; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; W = Wet condition

8.2.3.2 San Joaquin Valley Air Basin

Equal allocation of available CVP water supplies between agricultural and M&I water service contractors in the San Joaquin Valley Air Basin could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. As described for the Assessment Methods, any changes in groundwater pumping or irrigated acreages that occur within the SWAP San Joaquin River and Tulare Lake regions are assumed to be entirely contained within the San Joaquin Valley Air Basin. Groundwater pumping activities would decrease across all water year types under Alternative 2 (see Table 8-12). As shown in Table 8-15, exhaust emissions from groundwater pumping would decrease during all water years.

Table 8-15. Alternative 2: Change in Groundwater Pumping Emissions from No Action Alternative (tpy) in San Joaquin Valley Air Basin

Year Type[1]	VOC	NOx	CO	SOx	PM_{10}	$PM_{2.5}$
W	(2)	(38)	(49)	(12)	(3)	(3)
AN	(3)	(54)	(71)	(18)	(4)	(4)
BN	(2)	(47)	(62)	(15)	(4)	(4)
D	(2)	(46)	(60)	(15)	(4)	(4)
C	(3)	(53)	(69)	(17)	(4)	(4)

Note:
[1] Parentheses indicate reduced emissions (beneficial impact)
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; CO = carbon monoxide; D = dry condition; NOx = nitrogen oxides; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; SOx = sulfur oxides; VOC = volatile organic compound; W = wet condition;

Equal allocation of available CVP water supplies between agricultural and M&I water service contractors in the San Joaquin Valley Air Basin could affect agricultural production, leading to changes in fugitive dust emissions from land preparation and harvesting activities from agricultural contractors, as well as changes to windblown dust erosion. As more surface water is available to agricultural contractors during water shortage years as compared to the No Action Alternative, land preparation and harvesting activities would increase in response to more irrigated acreages. With an increase in the amount of land being irrigated, land preparation and harvesting activities would increase and windblown dust would decrease.

Table 8-16 summarizes the changes in fugitive dust emissions from changes to the irrigated acreages. PM_{10} and $PM_{2.5}$ emissions would decrease during all water type years because the decrease in windblown dust from more land being irrigated would counteract any increases from land preparation and harvesting.

Table 8-16. Alternative 2: Change in Fugitive Dust Emissions from No Action Alternative (tpy) in San Joaquin Valley Air Basin

Year Type[1]	PM_{10} Land Prep.	PM_{10} Harvesting	PM_{10} Erosion	PM_{10} Total	$PM_{2.5}$ Land Prep.	$PM_{2.5}$ Harvesting	$PM_{2.5}$ Erosion	$PM_{2.5}$ Total
W	<1	<1	(<1)	(<1)	<1	<1	(<1)	(<1)
AN	<1	<1	(<1)	(<1)	<1	<1	(<1)	(<1)
BN	18	2	(36)	(16)	3	<1	(7)	(4)
D	98	24	(152)	(31)	15	4	(30)	(12)
C	118	29	(183)	(36)	18	4	(37)	(15)

Note:
[1] Parentheses indicate reduced emissions (beneficial impact).
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; D = dry condition; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; W = Wet condition

8.2.3.3 General Conformity

Changes in emissions that would occur from groundwater pumping and differences in irrigated acreages could exceed the general conformity de minimis thresholds. The general conformity regulations apply to proposed federal actions in nonattainment or maintenance areas if the relevant criteria pollutants and precursor pollutants caused by the action equal or exceed certain de minimis thresholds (see Table 8-2). Combined emissions from groundwater pumping and from irrigated acreages were compared to the general conformity de minimis thresholds to determine if a general conformity determination would need to be prepared. Table 8-17 summarizes the results of the general conformity applicability evaluation for Alternative 2.

Table 8-17. Alternative 2: General Conformity Applicability Evaluation for Alternative (tpy)

Designated Area	VOC	NOx	CO	SOx	PM_{10}	$PM_{2.5}$
Sacramento Metro[3]	(<1)	(1)	(1)	(<1)	<1	(<1)
San Joaquin Valley	(2)	(38)	(49)	(12)	(3)	(3)

Note:
[1] Parentheses indicate reduced emissions (beneficial impact).
[2] Emissions included in table represent the worst-case (maximum) emissions from all five water years.
[3] Sacramento County is the only portion of the Sacramento Valley Air Basin designated maintenance for PM_{10} (see Table 8-5). As a result, only emissions from Region 9 in the SWAP model was included in the general conformity applicability evaluation for the Sacramento region.
Key:
CO = carbon monoxide; NOx = nitrogen oxides; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; SOx = sulfur oxides; tpy = tons per year; VOC = volatile organic compound

As shown in the table, emissions from all pollutants except for PM_{10} in the Sacramento region would decrease in Alternative 2 when compared to the No Action Alternative. Although PM_{10} emissions would increase, the increase is less than 100 tons per year; therefore, general conformity is not applicable to this alternative and no future action is required.

8.2.3.4 Indirect Effects

Implementation of Alternative 2 could cause indirect effects from actions contractors would take from future water shortages. Because agricultural contractors would have a larger allocation of water during water shortages compared to the No Action Alternative, no additional actions to supplement water are expected to occur. As a result, there would be no indirect effects from implementation of Alternative 2.

8.2.4 Alternative 3: Full M&I Allocation Preference

Under Alternative 3, M&I water service contractors would generally receive the highest deliveries as compared to the No Action and other action alternatives. Under this alternative Reclamation would attempt to provide 100 percent allocations to M&I water service contractors during water shortage conditions. This would be achieved by reducing the allocations to agricultural water service contractors as needed to maximize the frequency of 100 percent allocations to the M&I water service contractors.

Table 8-18 summarizes the SWAP model results for changes in agricultural production that would occur under Alternative 3. Specific impacts in the Sacramento Valley Air Basin and in the San Joaquin Valley Air Basin are summarized below.

Table 8-18. SWAP Output for Alternative 3 (Change from No Action Alternative Agricultural Water Use)

Location	Year Type	Groundwater Pumping (TAF/year)[1]	Irrigated Acreage (thousand acres/year)[1]
Sacramento Valley Air Basin	Wet	0.4	(<1)
	Above Normal	2.0	(<1)
	Below Normal	0.6	(1)
	Dry	(0.3)	(3)
	Critical	1.2	(4)
San Joaquin Valley Air Basin	Wet	14.4	(<1)
	Above Normal	18.8	(<1)
	Below Normal	13.0	(7)
	Dry	29.1	(18)
	Critical	25.7	(23)

Note:
[1] Parentheses indicate a decrease in agricultural production compare to No Action Alternative.
Key:
TAF = thousand acre-feet

Use of the Full M&I Allocation Preference under Alternative 3 could result in a change in emissions if more pumping is necessary to deliver water. As discussed in Chapter 4, Surface Water, M&I deliveries to north of Delta contractors would be increased by 5,000 AF in wet water years to 76,000 AF in dry water years when compared to the No Action Alternative. Additionally, M&I deliveries would be increased by 17,000 AF in wet years to 49,000 AF in dry years when compared to the No Action Alternative. Because this alternative would give a greater preference to M&I users when compared to the No Action Alternative, M&I users would see a corresponding increase in water deliveries.

Although it is expected that additional pumping would be required to transfer the increased water supplies through the CVP system, the conveyance pumps are anticipated to be largely electrically-driven. As a result, there would be no localized air quality impacts from water delivery to M&I contractors, but emissions at the powerplants servicing the electric grid could increase compared to the No Action Alternative. Although there could be a net increase in emissions, combustion equipment operating at the powerplants would be permitted by the local air districts and there would be emissions would be accounted for in the SIP.

8.2.4.1 Sacramento Valley Air Basin

Use of the Full M&I Allocation Preference under Alternative 3 in the Sacramento Valley Air Basin could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. As described for the Assessment Methods, any changes in groundwater pumping or irrigated acreages that occur within the SWAP Sacramento Valley Region are assumed to be entirely contained within the Sacramento Valley Air Basin. Groundwater pumping activities would increase across all water year types (see Table 8-18) because of the decreased availability of CVP water to agricultural contractors. As shown in Table 8-19, exhaust emissions from groundwater pumping would increase across all water year types except for dry years for agricultural contractors in the Sacramento Valley Air Basin.

Table 8-19. Alternative 3: Change in Groundwater Pumping Emissions from No Action Alternative (tpy) in Sacramento Valley Air Basin

Year Type[1]	VOC	NOx	CO	SOx	PM_{10}	$PM_{2.5}$
W	<1	<1	1	<1	<1	<1
AN	<1	2	3	1	<1	<1
BN	<1	1	1	<1	<1	<1
D	(<1)	(<1)	(<1)	(<1)	(<1)	(<1)
C	<1	1	2	<1	<1	<1

Note:
[1] Parentheses indicate reduced emissions (beneficial impact)
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; CO = carbon monoxide; D = dry condition; NOx = nitrogen oxides; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; SOx = sulfur oxides; VOC = volatile organic compound; W = wet condition;

Use of the Full M&I Allocation Preference under Alternative 3 in the Sacramento Valley Air Basin could affect agricultural production, leading to changes in fugitive dust emissions from land preparation and harvesting activities from agricultural contractors, as well as changes to windblown dust erosion. As less surface water is available to agricultural contractors during water shortage years as compared to the No Action Alternative, land preparation and harvesting activities would decrease in response to more irrigated acreages. With a decrease in the amount of land being irrigated, land preparation and harvesting activities would decrease and windblown dust would increase.

Table 8-20 summarizes the changes in fugitive dust emissions from changes to the irrigated acreages. As shown in Table 8-20, there would be a net decrease in PM_{10} and $PM_{2.5}$ emissions.

Table 8-20. Alternative 3: Change in Fugitive Dust Emissions from No Action Alternative (tpy) in Sacramento Valley Air Basin

Year Type[1]	PM_{10} Land Prep.	PM_{10} Harvesting	PM_{10} Erosion	PM_{10} Total	$PM_{2.5}$ Land Prep.	$PM_{2.5}$ Harvesting	$PM_{2.5}$ Erosion	$PM_{2.5}$ Total
W	(<1)	(<1)	<1	(<1)	(<1)	(<1)	<1	(<1)
AN	(<1)	(<1)	<1	(<1)	(<1)	(<1)	<1	(<1)
BN	(6)	(1)	1	(6)	(1)	(<1)	<1	(1)
D	(25)	(3)	2	(26)	(4)	(<1)	<1	(4)
C	(7)	(<1)	3	(5)	(1)	(<1)	1	(1)

Note:
[1] Parentheses indicate reduced emissions (beneficial impact).
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; D = dry condition; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; W = Wet condition

8.2.4.2 San Joaquin Valley Air Basin

Use of the Full M&I Allocation Preference under Alternative 3 in the Sacramento Valley Air Basin in the San Joaquin Valley Air Basin could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. As described for the Assessment Methods, any changes in groundwater pumping or irrigated acreages that occur within the SWAP San Joaquin River and Tulare Lake regions are assumed to be entirely contained within the San Joaquin Valley Air Basin. Groundwater pumping activities would increase across all water years (see Table 8-18). As shown in Table 8-21, exhaust emissions from groundwater pumping would increase during all water years because of the increased reliance on groundwater supplies from decreased allocations of CVP water to agricultural water service contractors.

Table 8-21. Alternative 3: Change in Groundwater Pumping Emissions from No Action Alternative (tpy) in San Joaquin Valley Air Basin

Year Type[1]	VOC	NOx	CO	SOx	PM_{10}	$PM_{2.5}$
W	1	16	21	5	1	1
AN	1	20	27	7	2	2
BN	1	14	19	5	1	1
D	2	32	42	10	2	2
C	1	28	37	9	2	2
General Conformity De Minimis Threshold	10	10	n/a	100	100	100

Note:
[1] Parentheses indicate reduced emissions (beneficial impact)
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; CO = carbon monoxide; D = dry condition; NOx = nitrogen oxides; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; SOx = sulfur oxides; VOC = volatile organic compound; W = wet condition;

Use of the Full M&I Allocation Preference under Alternative 3 in the Sacramento Valley Air Basin in the San Joaquin Valley Air Basin could affect agricultural production, leading to changes in fugitive dust emissions from land preparation and harvesting activities from agricultural contractors, as well as changes to windblown dust erosion. As less surface water is available to agricultural contractors during water shortage years as compared to the No Action Alternative, land preparation and harvesting activities would decrease in response to less irrigated acreages. With a decrease in the amount of land being irrigated, land preparation and harvesting activities would decrease and windblown dust would increase.

Table 8-22 summarizes the changes in fugitive dust emissions from changes to the irrigated acreages. PM_{10} and $PM_{2.5}$ emissions would increase during all water type years because of increased barren land, which would result in more dust erosion. Detailed calculations are provided in Appendix E.

Table 8-22. Alternative 3: Change in Fugitive Dust Emissions from No Action Alternative (tpy) in San Joaquin Valley Air Basin

Year Type[1]	PM_{10} Land Prep.	PM_{10} Harvesting	PM_{10} Erosion	PM_{10} Total	$PM_{2.5}$ Land Prep.	$PM_{2.5}$ Harvesting	$PM_{2.5}$ Erosion	$PM_{2.5}$ Total
W	(<1)	(<1)	<1	<1	(<1)	(<1)	<1	<1
AN	(<1)	<1	<1	<1	(<1)	<1	<1	<1
BN	(17)	(1)	36	17	(3)	(<1)	7	4
D	(62)	(15)	96	19	(9)	(2)	19	8
C	(72)	(24)	122	26	(11)	(4)	24	10

Note:
[1] Parentheses indicate reduced emissions (beneficial impact).
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; D = dry condition; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; W = Wet condition

8.2.4.3 General Conformity

Changes in emissions that would occur from groundwater pumping and differences in irrigated acreages could exceed the general conformity de minimis thresholds. The general conformity regulations apply to proposed federal actions in nonattainment or maintenance areas if the relevant criteria pollutants and precursor pollutants caused by the action equal or exceed certain de minimis thresholds (see Table 8-2). Combined emissions from groundwater pumping and from irrigated acreages were compared to the general conformity de minimis thresholds to determine if a general conformity determination would need to be prepared. Table 8-23 summarizes the results of the general conformity applicability evaluation for Alternative 3.

Table 8-23. Alternative 3: General Conformity Applicability Evaluation for Alternative (tpy)

Designated Area	VOC	NOx	CO	SOx	PM_{10}	$PM_{2.5}$
Sacramento Metro[3]	<1	2	3	1	<1	<1
San Joaquin Valley	2	32	42	10	28	12

Note:

[1] Parentheses indicate reduced emissions (beneficial impact).

[2] Emissions included in table represent the worst-case (maximum) emissions from all five water years.

[3] Sacramento County is the only portion of the Sacramento Valley Air Basin designated maintenance for PM_{10} (see Table 8-5). As a result, only emissions from Region 9 in the SWAP model was included in the general conformity applicability evaluation for the Sacramento region.

Key:

CO = carbon monoxide; NOx = nitrogen oxides; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; SOx = sulfur oxides; tpy = tons per year; VOC = volatile organic compound

As shown in Table 8-23, emissions from all pollutants would increase in Alternative 3 when compared to the No Action Alternative. Emissions in the Sacramento region would not exceed the general conformity de minimis thresholds summarized in Table 8-2. The San Joaquin Valley is designated as an extreme nonattainment region for the 8-hour O_3 NAAQS (see Table 8-4) and is subject to a de minimis threshold of 10 tons per year for O_3 precursors, namely NOx and VOC. Because NOx emissions would be 32 tons per year under Alternative 3 in the San Joaquin Valley air basin, the general conformity de minimis threshold would be exceeded and the proposed federal action would be subject to general conformity.

A full general conformity determination would need to be developed if Alternative 3 is selected as the preferred alternative before a Record of Decision can be issued for the M&I WSP Environmental Impact Statement. As described in Chapter 8.1.2.1, the general conformity regulations apply to both direct and indirect effects. Although the M&I WSP is a policy, because actions by Reclamation to change the allocation amounts to farmers could cause them to pump more groundwater, the M&I WSP could indirectly affect criteria pollutant emissions, making policy decisions subject to general conformity.

If Alternative 3 is selected as the preferred alternative, then Reclamation would be required to conduct a conformity evaluation in accordance with the criteria and procedures in the implementing regulations, publish a draft determination of general conformity for public review, and then publish the final determination of conformity. As described in Chapter 8.1.2.1, if the increased NOx emissions are not included in the SIP, then it would be necessary to fully offset emissions within the O_3 nonattainment area.

8.2.4.4 Indirect Effects

Implementation of Alternative 3 could cause indirect effects from actions contractors would take from future water shortages. As described previously, agricultural contractor would have reduced allocations of water during shortages because M&I contractors would receive their full allocation when feasible. To supplement reduced water supplies, it is possible that agricultural contractors could participate in water transfers from contractors north of the Delta to receive additional water. Contractors selling water for transfer could use groundwater pumping or cropland idling as methods to increase water supplies to buyers south of the Delta. Indirect effects of these activities could include increased exhaust emissions from groundwater pumping or increased fugitive dust from new barren land.

8.2.5 Alternative 4: Updated M&I WSP

Under Alternative 4, CVP deliveries to agricultural and M&I water service contractors would be the same as those under the No Action Alternative; therefore, impacts would be the same as those discussed for the No Action Alternative.

8.2.6 Alternative 5: M&I Contractor Suggested WSP

Alternative 5 attempts to provide a higher amount of CVP deliveries to the M&I water service contractors to meet unmet public health and safety demands during shortage years. This may mean that the water allocations to agricultural water service contractors would need to be reduced, and may require changing the timing and frequency of releases from the CVP reservoirs.

Table 8-24 summarizes the SWAP model results for changes in agricultural production that would occur under Alternative 5. Specific impacts in the Sacramento Valley Air Basin and in the San Joaquin Valley Air Basin are summarized below.

Table 8-24. SWAP Output for Alternative 5 (Change from No Action Alternative Agricultural Water Use)

Location	Year Type	Groundwater Pumping (TAF/year)[1]	Irrigated Acreage (thousand acres/year)[1]
Sacramento Valley Air Basin	Wet	(<0.1)	(<0.1)
	Above Normal	<0.1	(<0.1)
	Below Normal	(<0.1)	<0.1
	Dry	0.1	(<0.1)
	Critical	<0.1	(<0.1)
San Joaquin Valley Air Basin	Wet	0.2	(<0.1)
	Above Normal	0.7	(<0.1)
	Below Normal	0.1	(<0.1)
	Dry	0.1	(<0.1)
	Critical	0.1	(<0.1)

Note:
[1] Parentheses indicate a decrease in agricultural production compare to No Action Alternative.
Key:
TAF = thousand acre-feet

8.2.6.1 Sacramento Valley Air Basin

Implementation of the M&I Contractor Suggested WSP under Alternative 5 in the Sacramento Valley Air Basin could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. As described for the Assessment Methods, any changes in groundwater pumping or irrigated acreages that occur within the SWAP Sacramento Valley Region are assumed to be entirely contained within the Sacramento Valley Air Basin. Because of the similarity to Alternative 4, and consequently the No Action Alternative, changes in groundwater pumping and irrigated acreages would be minor (see Table 8-24). As shown in Table 8-25, exhaust emissions from groundwater pumping would decrease during wet and below normal years, but would increase during above normal, dry, and critical water years.

Table 8-25. Alternative 5: Change in Groundwater Pumping Emissions from No Action Alternative (tpy) in Sacramento Valley Air Basin

Year Type[1]	VOC	NOx	CO	SOx	PM_{10}	$PM_{2.5}$
W	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)
AN	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BN	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)
D	<0.1	0.1	0.2	<0.1	<0.1	<0.1
C	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Note:
[1] Parentheses indicate reduced emissions (beneficial impact)
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; CO = carbon monoxide; D = dry condition; NOx = nitrogen oxides; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; SOx = sulfur oxides; VOC = volatile organic compound; W = wet condition;

Implementation of the M&I Contractor Suggested WSP under Alternative 5 in the Sacramento Valley Air Basin could affect agricultural production, leading to changes in fugitive dust emissions from land preparation and harvesting activities from agricultural contractors, as well as changes to windblown dust erosion. Table 8-26 summarizes the changes in fugitive dust emissions from changes to the irrigated acreages. As shown in the table, net PM_{10} and $PM_{2.5}$ emissions would decrease during all water years except below normal years, when emission would increase.

Table 8-26. Alternative 5: Change in Fugitive Dust Emissions from No Action Alternative (tpy) in Sacramento Valley Air Basin

Year Type[1]	PM_{10} Land Prep.	PM_{10} Harvesting	PM_{10} Erosion	PM_{10} Total	$PM_{2.5}$ Land Prep.	$PM_{2.5}$ Harvesting	$PM_{2.5}$ Erosion	$PM_{2.5}$ Total
W	(<0.1)	(<0.1)	<0.1	(<0.1)	(<0.1)	(<0.1)	<0.1	(<0.1)
AN	(<0.1)	(<0.1)	<0.1	(<0.1)	(<0.1)	(<0.1)	<0.1	(<0.1)
BN	<0.1	(<0.1)	(<0.1)	<0.1	<0.1	(<0.1)	(<0.1)	<0.1
D	(0.1)	(<0.1)	<0.1	(0.1)	(<0.1)	(<0.1)	<0.1	(<0.1)
C	(<0.1)	(<0.1)	<0.1	(<0.1)	(<0.1)	(<0.1)	<0.1	(<0.1)

Note:
[1] Parentheses indicate reduced emissions (beneficial impact).
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; D = dry condition; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; W = Wet condition

8.2.6.2 San Joaquin Valley Air Basin

Implementation of the M&I Contractor Suggested WSP under Alternative 5 in the San Joaquin Valley Air Basin could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. As described for the Assessment Methods, any changes in groundwater pumping or irrigated acreages that occur within the SWAP San Joaquin River and Tulare Lake regions are assumed to be entirely contained within the San Joaquin Valley Air Basin. Groundwater pumping activities would increase across all water years (see Table 8-24). As shown in Table 8-27, exhaust emissions from groundwater pumping would increase during all water years.

Table 8-27. Alternative 5: Change in Groundwater Pumping Emissions from No Action Alternative (tpy) in San Joaquin Valley Air Basin

Year Type[1]	VOC	NOx	CO	SOx	PM_{10}	$PM_{2.5}$
W	<0.1	0.2	0.3	0.1	<0.1	<0.1
AN	<0.1	0.7	0.9	0.2	0.1	0.1
BN	<0.1	0.1	0.1	<0.1	<0.1	<0.1
D	<0.1	0.1	0.2	<0.1	<0.1	<0.1
C	<0.1	0.1	0.1	<0.1	<0.1	<0.1

Note:
[1] Parentheses indicate reduced emissions (beneficial impact)
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; CO = carbon monoxide; D = dry condition; NOx = nitrogen oxides; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; SOx = sulfur oxides; VOC = volatile organic compound; W = wet condition;

Implementation of the M&I Contractor Suggested WSP under Alternative 5 in the San Joaquin Valley Air Basin could affect agricultural production, leading to changes in fugitive dust emissions from land preparation and harvesting activities from agricultural contractors, as well as changes to windblown dust erosion. Table 8-28 summarizes the changes in fugitive dust emissions from changes to the irrigated acreages. PM_{10} and $PM_{2.5}$ emissions would increase during all water years. Detailed calculations are provided in Appendix E.

Table 8-28. Alternative 5: Change in Fugitive Dust Emissions from No Action Alternative (tpy) in San Joaquin Valley Air Basin

Year Type[1]	PM_{10} Land Prep.	PM_{10} Harvesting	PM_{10} Erosion	PM_{10} Total	$PM_{2.5}$ Land Prep.	$PM_{2.5}$ Harvesting	$PM_{2.5}$ Erosion	$PM_{2.5}$ Total
W	(<0.1)	(<0.1)	<0.1	<0.1	(<0.1)	(<0.1)	<0.1	<0.1
AN	(<0.1)	(<0.1)	<0.1	<0.1	(<0.1)	(<0.1)	<0.1	<0.1
BN	(<0.1)	<0.1	<0.1	<0.1	(<0.1)	<0.1	<0.1	<0.1
D	(0.3)	(0.1)	0.5	0.1	(0.1)	(<0.1)	0.1	<0.1
C	(0.2)	(<0.1)	0.3	<0.1	(<0.1)	(<0.1)	0.1	<0.1

Note:
[1] Parentheses indicate reduced emissions (beneficial impact).
Key:
AN = above normal condition; BN = below normal condition; C = critical condition; D = dry condition; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; W = Wet condition

8.2.6.3 General Conformity

Changes in emissions that would occur from groundwater pumping and differences in irrigated acreages could exceed the general conformity de minimis thresholds. The general conformity regulations apply to proposed federal actions in nonattainment or maintenance areas if the relevant criteria pollutants and precursor pollutants caused by the action equal or exceed certain de minimis thresholds (see Table 8-2). Combined emissions from groundwater pumping and from irrigated acreages were compared to the general conformity de minimis thresholds to determine if a general conformity determination would need to be prepared. Table 8-29 summarizes the results of the general conformity applicability evaluation for Alternative 5.

Table 8-29. Alternative 5: General Conformity Applicability Evaluation for Alternative (tpy)

Designated Area	VOC	NOx	CO	SOx	PM_{10}	$PM_{2.5}$
Sacramento Metro[3]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
San Joaquin Valley	<0.1	0.7	0.9	0.2	0.1	0.1

Note:
[1] Parentheses indicate reduced emissions (beneficial impact).
[2] Emissions included in table represent the worst-case (maximum) emissions from all five water years.
[3] Sacramento County is the only portion of the Sacramento Valley Air Basin designated maintenance for PM_{10} (see Table 8-5). As a result, only emissions from Region 9 in the SWAP model was included in the general conformity applicability evaluation for the Sacramento region.

Key:
CO = carbon monoxide; NOx = nitrogen oxides; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; SOx = sulfur oxides; tpy = tons per year; VOC = volatile organic compound

As shown Table 8-29, emissions for all criteria pollutants would increase in both air basins; however, the emission increases would be minimal (less than one ton per year). As a result, the general conformity de minimis thresholds would not be exceeded and a general conformity determination would be required.

8.2.6.4 Indirect Effects

Implementation of Alternative 5 could cause indirect effects from actions contractors would take from future water shortages. As described previously, agricultural contractors would have reduced allocations of water during shortages because M&I contractors would additional water for unmet public health and safety needs when feasible. To supplement reduced water supplies, it is possible that agricultural contractors could participate in water transfers from contractors north of the Delta to receive additional water. Contractors selling water for transfer could use groundwater pumping or cropland idling as methods to increase water supplies to buyers south of the Delta. Indirect effects of these activities could include increased exhaust emissions from groundwater pumping or increased fugitive dust from new barren land.

8.3 Mitigation Measures

There are no mitigation measures to reduce the severity of the air quality effects described in this chapter.

8.4 Unavoidable Adverse Impacts

None of the action alternatives would result in unavoidable adverse impacts on air quality. Although Alternative 3 could result in NOx emissions that would exceed the general conformity de minimis thresholds, it would be necessary to demonstrate that Alternative 3's emissions are accounted for in the SIP through a general conformity determination if Alternative 3 is selected as the preferred alternative. By demonstrating that emissions would conform with the SIP, Alternative 3 would not result in any adverse effects to air quality.

8.5 Cumulative Effects

The timeline for the air quality cumulative effects analysis extends from 2010 through 2030, a 20-year period. The relevant geographic study area for the cumulative effects analysis is the same area of analysis as shown in Figure 8-1. The following section analyzes the cumulative effects using the project method, which is further described in Chapter 20, Cumulative Effects Methodology. Chapter 20 describes the projects included in the cumulative condition.

The cumulative analysis considers projects and conditions that could affect air quality within the area of analysis.

8.5.1 Alternative 2: Equal Agricultural and M&I Allocation

Continued allocation of available CVP water supplies between M&I and Agricultural water service contractors under Alternative 2 would result in a change in water supply deliveries to M&I contractors. CVP deliveries to M&I contractors would decrease under Alternative 2. As a result, there would be less demand at the regional powerplants to provide power to operate the electric pumps and regional criteria pollutant emissions could decrease. As a result, there would not be a cumulatively significant impact to air quality.

Equal allocation of available CVP water supplies between agricultural and M&I water service contractors in the Sacramento and San Joaquin Valley Air Basins could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. Because of the increased availability of CVP water to agricultural contractors, groundwater pumping activities would decrease, which would translate to a decrease in criteria pollutant emissions under the No Action Alternative. As a result, there would not be a cumulatively significant impact to air quality.

Equal allocation of available CVP water supplies between agricultural and M&I water service contractors in the Sacramento and San Joaquin Valley Air Basins could affect agricultural production, leading to changes in fugitive dust emissions from land preparation and harvesting activities from agricultural contractors, as well as changes to windblown dust erosion. Because of the increased CVP deliveries to agricultural contractors, land preparation and harvesting activities would increase, but windblown dust erosion would decrease because there would be less barren land from increased irrigated acreages. The reduction in windblown dust erosion would be sufficient to counteract any increases from new land preparation and harvesting activities, resulting in a net decrease in fugitive dust emissions under Alternative 2. As a result, there would not be a cumulatively significant impact to air quality.

8.5.2 Alternative 3: Full M&I Allocation Preference

Use of the Full M&I Allocation Preference under Alternative 3 would result in a change in water supply deliveries to M&I contractors. CVP deliveries to M&I contractors would increase under Alternative 3. As a result, there would be more demand at the regional powerplants to provide power to operate the electric pumps and regional criteria pollutant emissions could increase. Although emissions could increase, the powerplants would continue to operate within their permitted capacity and there would not be a cumulatively significant impact to air quality.

Use of the Full M&I Allocation Preference under Alternative 3 in the Sacramento and San Joaquin Valley Air Basins could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. Because of the decreased CVP deliveries to agricultural contractors, groundwater pumping activities would increase, which would translate to an increase in criteria pollutant emissions under the No Action Alternative. NOx emissions could exceed the general conformity de minimis threshold, which could result in an adverse impact to air quality. If Alternative 3 is selected as the preferred alternative, then it would be necessary to demonstrate that project-related emissions are included in the SIP emission budgets for agriculture. If the general conformity determination is completed and approved then there would not be cumulatively significant impacts to air quality.

Use of the Full M&I Allocation Preference under Alternative 3 in the Sacramento and San Joaquin Valley Air Basins could affect agricultural production, leading to changes in fugitive dust emissions from land preparation and harvesting activities from agricultural contractors, as well as changes to windblown dust erosion. Because of the decreased CVP deliveries to agricultural contractors, land preparation and harvesting activities would decrease, but windblown dust erosion would increase from more barren land. Increased fugitive dust emissions could be compounded by construction projects in the region, such as the Bay Delta Conservation Plan, the Los Vaqueros Reservoir Expansion Project, and the San Luis Reservoir Low Point Improvement Project. If Alternative 3 is selected as the preferred alternative, then it would be necessary to demonstrate that project-related emissions are included in the SIP emission budgets for agriculture. If the general conformity determination is completed and approved then there would not be cumulatively significant impacts to air quality.

8.5.3 Alternative 4: Updated M&I WSP

Implementation of the Updated M&I WSP under Alternative 4 would not change water supply deliveries to M&I contractors. CVP deliveries to M&I contractors would remain the same under Alternative 4 as the No Action Alternative. As a result, there would not be a cumulatively significant impact to air quality.

Implementation of the Updated M&I WSP under Alternative 4 in the Sacramento and San Joaquin Valley Air Basins could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. No changes to groundwater pumping would occur under Alternative 4 as compared to the No Action Alterative. As a result, there would not be a cumulatively significant impact to air quality.

Implementation of the Updated M&I WSP under Alternative 4 in the Sacramento and San Joaquin Valley Air Basins could affect agricultural production, leading to changes in fugitive dust emissions from land preparation and harvesting activities from agricultural contractors, as well as changes to windblown dust erosion. No changes to land preparation, harvesting, or windblown erosion would occur under Alternative 4 as compared to the No Action Alterative. As a result, there would not be a cumulatively significant impact to air quality.

8.5.4 Alternative 5: M&I Contractor Suggested WSP

Implementation of the M&I Contractor Suggested WSP under Alternative 5 would result in a change in water supply deliveries to M&I contractors. CVP deliveries to M&I contractors would remain the same under Alternative 5 as the No Action Alternative. As a result, there would not be a cumulatively significant impact to air quality.

Implementation of the M&I Contractor Suggested WSP under Alternative 5 in the Sacramento and San Joaquin Valley Air Basins could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. Although minor emissions of air quality pollutants could occur under Alternative 5, there would be minor and would be within normal expected fluctuations in agricultural emissions in the region. As a result, there would not be cumulatively significant air quality impacts.

Implementation of the M&I Contractor Suggested WSP under Alternative 5 in the Sacramento and San Joaquin Valley Air Basins could affect agricultural production, leading to changes in fugitive dust emissions from land preparation and harvesting activities from agricultural contractors, as well as changes to windblown dust erosion. Although minor emissions of air quality pollutants could occur under Alternative 5, there would be minor and would be within normal expected fluctuations in agricultural emissions in the region. As a result, there would not be cumulatively significant air quality impacts.

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Chapter 9
Greenhouse Gases and Climate Change

This chapter presents the existing greenhouse gas (GHG) emissions within the area of analysis and discusses potential effects on climate change from the proposed alternatives. Appendix F, Climate Change Analysis Emission Calculations, provides detailed emission calculations.

GHG emissions associated with changes in groundwater pumping activities are evaluated in relation to climate change in the area of analysis. The effects of climate change on the alternatives were also analyzed.

9.1 Affected Environment

The United Nations Intergovernmental Panel on Climate Change (IPCC) predicts that changes in the earth's climate will continue through the 21st century and that the rate of change may increase significantly in the future because of human activity (IPCC 2013). Many researchers studying the State of California's (State's) climate believe that changes in the earth's climate have already affected California and will continue to do so in the future. Climate change may seriously affect the State's water resources. Temperature increases could affect water demand and aquatic ecosystems. Changes in the timing and amount of precipitation and runoff could occur. Sea level rise could adversely affect the Sacramento-San Joaquin River Delta (Delta) and coastal areas of the State.

Climate change is identified in the 2009 update of the California Water Plan (Bulletin 160-09) as a key consideration in planning for the State's future water management (California Department of Water Resources [DWR] 2009). The 2009 Water Plan update qualitatively describes the effects that climate change may have on the State's water supply. It also describes efforts that should be taken to evaluate climate change effects quantitatively for the next Water Plan update.

9.1.1 Area of Analysis

The GHG and climate change impact analysis evaluates the existing conditions and impacts in the areas with Central Valley Project (CVP) contractors subject to the Municipal & Industrial Water Shortage Policy (M&I WSP). Chapter 1 identifies the M&I water service contractors affected by the proposed alternatives.

9.1.2 Regulatory Setting

GHGs and global climate change are governed by several federal and state laws and policies, which are described below.

9.1.2.1 Federal

Department of the Interior In 2009, the Department of Interior (DOI) issued a Secretarial Order on climate change that expands DOI bureaus' responsibilities in addressing climate change (amended on February 22, 2010). The purpose of Secretarial Order No. 3289 is to provide guidance to bureaus and offices within the DOI on how to provide leadership by developing timely responses to emerging climate change issues. This Order replaces Secretarial Order No. 3226, signed on January 19, 2001, entitled "Evaluating Climate Change Impacts in Management Planning." It reaffirms efforts within DOI that are ongoing with respect to climate change. Among the requirements of the Order is one that requires each bureau and office of DOI to "consider and analyze potential climate change impacts when undertaking long-range planning exercises, setting priorities for scientific research and investigations, and/or when making major decisions affecting DOI resources."

The Bureau of Reclamation (Reclamation) *National Environmental Policy Act (NEPA) Handbook* (2012) recommends that climate change be considered, as applicable, in every NEPA analysis. The *NEPA Handbook* acknowledges that there are two interpretations of climate change in regards to Reclamation actions: 1) Reclamation's action is a potentially significant contributor to climate change; and 2) climate change could affect a Reclamation proposed action. The *NEPA Handbook* recommends considering different aspects of climate change (e.g., relevance of climate change to the proposed action, timeframe for analysis, etc.) to determine the extent to which it should be discussed under NEPA.

The Omnibus Public Land Management of 2009 (Public Law 111-11) Subtitle F – SECURE Water requires Reclamation to evaluate and report on the risks associated with climate change and to identify appropriate adaptation and mitigation strategies. Section 9503 of the SECURE Water Act identifies the following key elements that need to be assessed by Reclamation:

- (c)(1) – each effect of, and risk resulting from, global climate change with respect to the quantity of water resources located in each major Reclamation river basin;

- (c)(2) – the impact of global climate change with respect to the operations of the Secretary in each major Reclamation river basin;

- (c)(3) – each mitigation and adaptation strategy considered and implemented by the Secretary of the Interior to address each effect of global climate change; and

- (c)(4) – each coordination activity conducted by the Secretary with the United States (U.S.) Geological Survey, National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Agriculture, or any appropriate State water resource agency.

Additionally, DOI Department Manual 523 (effective December 20, 2012) states that it is DOI policy to use best available science in decision-making water management planning including integrating adaptation strategies. It also states that climate change be considered in developing or revising management plans. Section B further states that "the Department will promote existing processes and when necessary, institute new processes to: 1) Conduct assessments of vulnerability to anticipated or current climate impacts, 2) Develop and implement comprehensive climate change adaptation strategies based on vulnerability and other factors, and 3) Include measurable goals and performance metrics."

NEPA While there is currently no federal regulation in place to govern the effects of climate change and GHG emissions, the Council on Environmental Quality (CEQ) provided a draft memorandum in February 2010 that outlines how Federal agencies may better consider the effects of GHG emissions and climate change in their evaluation of NEPA documents. In that draft guidance, CEQ proposes the consideration of opportunities to reduce GHG emissions and adapt the actions to climate change impacts throughout the NEPA process.

In the context of NEPA, CEQ proposes that the following climate change issues be considered:

1. The GHG emissions effects of a proposed action and alternative actions; and

2. The relationship of climate change effects to a proposed action or alternatives, including the relationship to proposal design, environmental impacts, mitigation and adaptation measures.

For the GHG emission analysis, the CEQ draft guidance outlines when to evaluate GHG emissions and offers a protocol on how to evaluate GHG emissions. The draft NEPA guidance states that if a proposed action causes direct emissions of 25,000 metric tons or more of carbon dioxide equivalent ($MTCO_2e$) emissions on an annual basis, then a quantitative and qualitative assessment should be completed in an Environmental Impact Statement. The draft CEQ guidance suggests that the following steps be taken to evaluate the effects of GHG emissions:

- Quantify cumulative emissions over the life of the project

- Discuss measures to reduce GHG emissions, including consideration of reasonable alternatives

- Qualitatively discuss the link between such GHG emissions and climate change

In the draft memorandum, CEQ recognizes that the discussion of climate change effects in NEPA documents may be discussed in varying detail depending on available data.

9.1.2.2 State

California Executive Order S-3-05 On June 1, 2005, former California Governor Arnold Schwarzenegger signed Executive Order S-3-05. This executive order established the following GHG emission reduction targets for California:

- By 2010, reduce GHG emissions to 2000 levels.
- By 2020, reduce GHG emissions to 1990 levels.
- By 2050, reduce GHG emissions to 80 percent below 1990 levels.

The order also requires the Secretary of the California Environmental Protection Agency (Cal/EPA) to report to the Governor and the State Legislature biannually on progress made toward meeting the GHG emission targets, commencing in January 2006. The Secretary of the Cal/EPA is also required to report about climate change impacts on water supply, public health, agriculture, the coastline, and forestry; mitigation and adaptation plans to combat these impacts must also be developed.

California GHG emissions were estimated to be 453.06 million $MTCO_2e$ in 2010, compared to 466.32 million $MTCO_2e$ in 2000 (California Air Resources Board [CARB] 2014a). The GHG emissions inventory indicates that emissions decreased by over 13 million $MTCO_2e$ over the decade, representing a 3 percent decrease in statewide emissions. As a result, the State was successful in meeting the first milestone of S-3-05.

California Assembly Bill (AB) 32 California AB 32, the Global Warming Solutions Act of 2006, codifies the state's GHG emissions targets by requiring the state's global warming emissions to be reduced to 1990 levels by 2020 and directs the CARB to enforce the statewide cap that would begin phasing in by 2012. Former Governor Schwarzenegger signed and passed AB 32 into law on September 27, 2006. Key AB 32 milestones are as follows (CARB n.d.):

- January 1, 2009 – Scoping Plan adopted indicating how emissions will be achieved from significant sources of GHGs via regulations, market mechanisms, and other actions.

- During 2009 – CARB staff drafted rule language to implement its plan and held a series of public workshops on each measure (including market mechanisms).

- January 1, 2010 – Early action measures took effect.
- During 2010 – CARB conducted series of rulemakings, after workshops and public hearings, to adopt GHG regulations including rules governing market mechanisms.
- January 1, 2011 – Completion of major rulemakings for reducing GHGs including market mechanisms.
- January 1, 2012 – GHG rules and market mechanisms (e.g., cap-and-trade regulation) adopted by CARB took effect and are legally enforceable.
- December 31, 2020 – Deadline for achieving 2020 GHG emissions cap.

CARB has been proactive in its implementation of AB 32 and has met each of the milestones identified above that have already passed and is on track to meet the last milestone.

9.1.2.3 Regional/Local

The following air pollution control districts (APCDs) and air quality management districts (AQMDs) regulate air quality within the area of analysis:

- Shasta County AQMD;
- Tehama County APCD;
- Glenn County APCD;
- Colusa County APCD;
- Feather River AQMD[1];
- Placer County APCD;
- Yolo-Solano AQMD;
- Sacramento Metropolitan AQMD;
- Bay Area AQMD[2];
- San Joaquin Valley APCD[3]; and
- Monterey Bay Unified APCD[4].

Chapter 8, Air Quality, depicts the location of CVP contractors subject to the M&I WSP in the various air districts.

[1] Includes contractors located in Sutter and Yuba counties.
[2] Includes contractors located in Contra Costa, Alameda, and Santa Clara counties.
[3] Includes contractors located in San Joaquin, Stanislaus, Merced, Fresno, Kings, and Tulare counties and the western portion of Kern County.
[4] Includes contractors located in Santa Cruz, Monterey, and San Benito counties.

9.1.3 Existing Conditions

This section presents projections of the foreseeable affected environment for use as the basis against which the incremental effects of the alternatives are compared in Chapter 9.2 and to indicate the likely effect of climate change on the alternatives.

9.1.3.1 California Climate Trends and Associated Impacts

This discussion describes the data sources used for the analysis, the projected climate changes, and the associated impacts of those changes for the state of California and the study area.

Data Sources Four reports were used as the main data sources for projected changes in climate for this evaluation. Each report is based on different global climate models (GCMs) and emission scenarios, as described below. Because each GCM/emission scenario pair has related uncertainty, it is important to consider results from various models to understand the possible outcomes (California Climate Change Center [CCCC] 2009a). For this analysis, the ranges of projected changes published in each report are presented.

- "Climate Change Scenarios and Sea Level Rise Estimates for the California 2009 Climate Change Scenarios Assessment" (CCCC 2009a) – This report provides projected climate data for California, including monthly temperature data, monthly precipitation data and snow water equivalent (the amount of water contained in snowpack). In addition to the report, the data is available through a series of interactive, web-based tools provided by the California Energy Commission (CEC). Four GCMs were used in the report; the National Center for Atmospheric Research (NCAR) Parallel Climate Model (PCM), the NOAA Geophysical Fluids Dynamics Laboratory (GFDL) model (Version 2.1), the NCAR Community Climate System Model (CCSM), and the French Centre National de Recherches Meteorologiques (CNRM) models. Two emission scenarios from the IPCC Fourth Assessment were used: a low emissions scenario involving substantial reductions in emissions after 2050 (B1) and a medium-high emissions scenario assuming continued increased in emissions (A2). Two downscaling methods were used: 1) constructed analogues; and 2) bias correction and spatial downscaling.

- "Climate Change Impacts on Water Supply and Agricultural Water Management in California's Western San Joaquin Valley, and Potential Adaptation Strategies" (CCCC 2009b) – This report provides estimated watershed runoff and agricultural and urban water demand projections for the Sacramento River basin and the Delta export region of the San Joaquin Valley. The Water Evaluation and Planning modeling system was used in conjunction with six GCMs: CNRM, GFDL, PCM, CCSM, the Center for Climate System Research, and the Max Planck Institute. Two emissions scenarios, B1 and A2, were evaluated.

- **"Climate Change Impacts in the United States: The Third National Climate Assessment" (Melillo, Richmond, and Yohe 2014)** – This report assesses current scientific findings about observed and projected impacts of climate change in the United States. The report draws from a large body of scientific peer-reviewed research published or in press by March 1, 2012.

- **"Global Climate Change Impacts in the United States" (Karl, Melillo, and Peterson 2009)** – This report was prepared by the United States Global Change Research Program, a consortium of 13 federal departments and agencies authorized by Congress in 1989 through the Global Change Research Act of 1990 (Pub. L. 101-606, 104 Stat. 3096, codified as amended at 15 U.S. Code 2921), and serves as the basis for "The Second National Climate Assessment." The foundation for this report is a set of 21 Synthesis and Assessment Products, as well as other peer-reviewed scientific assessments, including those of the IPCC, the U.S. Climate Change Science Program, the U.S. National Assessment of the Consequences of Climate Variability and Change, the Arctic Climate Impact Assessment, the National Research Council's Transportation Research Board report on the Potential Impacts of Climate Change on United States Transportation, and a variety of regional climate impact assessments.

- **"SECURE Water Act Section 9503(c) - Reclamation Climate Change and Water 2011" (Reclamation 2011)** – This report was prepared by Reclamation for Congress to assess climate change risks and how these risks could impact water operations, hydropower, flood control, and fish and wildlife in the Western U.S. The report analyzes potential impacts across eight major Reclamation river basins including the Sacramento and San Joaquin River Basin.

- **"Central Valley Project Integrated Resource Plan Summary Report" (Reclamation 2013)** – The Central Valley Project Integrated Resource Plan (CVP IRP) study addresses future uncertainties in climate and changing socioeconomic conditions. The study analyzes various portfolios of system wide and local water management action that could be used to adapt to adverse effects from climate change.

Projected Changes in Climate The projected changes in climate conditions are expected to result in a wide variety of impacts in the State and San Joaquin River area. In general, estimated future climate conditions include changes to:

- Annual temperature
- Extreme heat
- Precipitation

- Sea level and storm surge
- Snowpack and streamflow

These projected changes are discussed in detail in the following paragraphs.

Annual Temperature. GCM data exhibit warming across California under both a low emission scenario and medium-high emission scenario (CCCC 2009a). While the data contain variability, there is a steady, linear increase over the 21st century (CCCC 2009a). Projected increases are shown in Table 9-1.

Table 9-1. Projected Changes in Temperature Compared to the Historical Average (1961 to 1990)

Region	Mid-21st Century	End of 21st Century
California	+1.8 to 5.4°F	+3.6 to 9.0°F
Sacramento Area, California	---	+3.6 to 6.3°F
Sacramento and San Joaquin River Basin[1]	+3.0 to 3.3°F	+4.2 to 4.5°F

Sources: CCCC 2009a, CEC 2011.

Notes:

[1] Data for Sacramento and San Joaquin River Basin only available through 2070 (Reclamation 2011; page 150); therefore, data is not representative of conditions at the end of the 21st century.

Key:

--- = no data available

°F = degrees Fahrenheit

On a seasonal basis, the models project substantial warming in the spring and greater warming in the summer than in the winter. Summer (July to September) temperature changes range from 2.7 to 10.8 °F and winter (January to March) temperature changes range from 1.8 to 7.2 °F at the end of the 21st century when compared to the historical average (1961 to 1990) (CCCC 2009a). In addition, the models suggest that, during the summer, warming of interior land surfaces will be greater than that observed along the coast (CCCC 2009a). Temperature changes are predicted to be uniform over the Sacramento River and San Joaquin River subbasins and would steadily increase over time; changes are predicted to be highest in the eastern portion of the basins (Reclamation 2011). Annual average temperatures are projected to increase in excess of 3° Celsius in the late 21st century (Reclamation 2014).

Extreme Heat. The climate model results consistently show increases in frequency, magnitude and duration of heat waves when compared to historical averages (1961 to 1990). Historically, extreme temperatures typically occur in July and August. With climate change, these occurrences are likely to begin in June and continue through September (CCCC 2009a). Occurrences lasting five days or longer are projected to become 20 times or more prevalent in the last 30 years of the 21st century (CCCC 2009a).

For Sacramento, the closest area to the San Joaquin River for which data is available, GCM results show a more-than-threefold increase in the frequency of extreme heat and a significant increase in the intensity of hot days (CCCC 2009a). By 2100, the data show as many as 100 days per year with temperatures greater than 95°F in Sacramento (CEC 2011).

*Precipitation***.** On average, the climate model projections show little change in total annual precipitation in California (CCCC 2009a). Specifically, the Mediterranean seasonal precipitation pattern is expected to continue, with most precipitation falling between November and March from North Pacific storms and the prevalence of hot, dry summers (CCCC 2009a). In addition, past trends show a large amount of variability from month to month, year to year, and decade to decade. This high degree of variability is expected to continue in the next century (CCCC 2009a).

For Sacramento, several model simulations indicate a drying trend when compared to the historical average (1961 – 1990). Under the low emissions scenario, the 30-year mean precipitation is projected to be more than five percent drier by mid-21st century and 10 percent drier by late-21st century (CCCC 2009a). The model results showing the drying trend indicate a decline in the frequency of precipitation events, but do not show a clear correlation in the precipitation intensity (CCCC 2009a).

In the western San Joaquin Valley, model simulations suggest that there is a generally decreasing trend in precipitation as the 21st century progresses (CCCC 2009b). In addition, model results indicate that water shortages may be felt more acutely in the western San Joaquin Valley as Delta exports become more constrained (CCCC 2009b).

In the Sacramento and San Joaquin River subbasins, precipitation is expected to remain relatively unchanged during the 21st century, with perhaps a slight increase in the northern portion of the Central Valley and a slight decrease within the southern portion. Projected changes in average annual precipitation in the Central Valley have a clear north to south trend, with a slight increase in precipitation predicted in the northern part of the Sacramento Valley and a slight decrease in precipitation predicted in the San Joaquin and Tulare Lake basins. Reductions are projected to increase throughout the 21st century to nearly 10 percent in the southern parts of the Central Valley (Reclamation 2014).

Sea Level and Storm Surge. By 2050, sea level rise is projected to be between 30 and 45 centimeters (cm) (12 to 18 inches), compared to 2000 levels (CCCC 2009a). Global models indicate that California may see up to a 140 cm (55 inch) rise in sea level by the end of the 21st century (CEC 2011). Combined with high tides and winter storms, sea level rise is projected to result in an increased rate of extreme high sea level events (CCCC 2009a).

Snowpack and Streamflow. Snowpack and streamflow amounts are projected to decline because of less late winter precipitation falling as snow and earlier snowmelt (Melillo, Richmond, and Yohe 2014). In California, snow water equivalent (the amount of water held in a volume of snow) is projected to decrease by 16 percent by 2035, 34 percent by 2070, and 57 percent by 2099, as compared to measurements between 1971 and 2000 (Melillo, Richmond, and Yohe 2014). By the end of the century, late spring streamflow could decline by up to 30 percent (CEC 2011).

Associated Impacts The combined changes in climate result in various impacts for California and the study area. Potential impacts include changes to wildfire hazards, water supply and demand, natural resources, infrastructure, agriculture and livestock, human health, and hydropower. Descriptions of the associated impacts are included below.

Wildfire Hazards. Prolonged periods of higher temperatures combined with associated drought will drive larger and more frequent wildfires in California (Melillo, Richmond, and Yohe 2014). The wildfires are projected to start earlier in the summer and last longer into the fall. In California, the risk of wildfire is projected to increase by up to 55 percent, depending on the level of emission reductions that can be achieved globally (CEC 2011). Changes to temperature and precipitation are also projected to change vegetation types and increase the spread of invasive species that are more fire-prone that, when coupled with more frequent and prolonged periods of drought, increase the risk of fires and reduce the capacity of native species to recover (CEC 2011).

Water Supply and Demand. The projected changes in climate will increase pressure on California's water resources, which are already fully utilized by the demands of a growing economy and population (CEC 2011). Although significant changes in annual precipitation are not projected, increasing temperatures, decreasing snowmelt and changes to spring streamflows will decrease the reliability of water supplies and increase the likelihood of more frequent short-term and long-term droughts and water shortages (Melillo, Richmond, and Yohe 2014). Water is also an important resource for creating hydroelectric power, which may be impacted by decreased supply (Karl, Melillo, and Peterson 2009).

Increasing temperatures will result in increased competition for water among agricultural, municipal, and environmental uses. Larger agricultural demands may lead to increased stress on the management of surface water resources and, potentially, the over exploitation of groundwater aquifers (CCCC 2009b). Agricultural areas could be significantly affected, with California farmers losing as much as 25 percent of the water supply they need (CEC 2011).

Water supplies are also at risk from rising sea levels. An influx of saltwater would degrade California's estuaries, wetlands, and groundwater aquifers. In particular, saltwater intrusion would threaten the quality and reliability of the major state fresh water supply that is pumped from the southern edge of the Delta (CEC 2011). In addition, the entire Delta region is now below sea level, protected by more than a thousand miles of levees and dams, and catastrophic failure of those dams from an extreme high sea level event would greatly affect this resource (Karl, Melillo, and Peterson 2009).

Projected changes in the timing and amount of river flow, particularly in winter and spring, is estimated to more than double the risk of Delta flooding events by mid-century, and result in an eight-fold increase before the end of the century (Karl, Melillo, and Peterson 2009). Taking into account the additional risk of a major seismic event and increases in sea level due to climate change over this century, the California Bay–Delta Authority has concluded that the Delta and Suisun Marsh are not sustainable under current practices (Karl, Melillo, and Peterson 2009).

The Sacramento and San Joaquin Climate Impact Assessment analyzed 18 climate projections:

- **No Climate Change (NoCC) Scenario** – Included simulations of hydroclimatic conditions under historical climate.
- **Future Climate – Ensemble-Information (EI) Scenario** – Used five ensemble-informed (EI5) scenarios that were developed by the CVP IRP based on downscaled GCM projections.
- **Future Climate – Downscaled Climate Projections** – Used the 12 specific GCM projections identified by California's Climate Action Team (CAT) for use in climate studies performed by DWR for the 2009 California Water Plan Update.

The EI5 scenario projections for the overall average unmet demands in the 21st century ranged from 3.7 to 10.5 million acre-feet (MAF) per year. The projected unmet demands increase through the mid-century as both urban and agricultural demands increase, but tend to decrease towards the end of the century as agricultural demands are reduced. The 12 CAT projections for the overall 21st century average annual unmet demands ranged from 4.7 to 13.1 MAF per year (Reclamation 2014).

Natural Resources. Climate change will continue to affect natural ecosystems, including changes to biodiversity, location of species and the capacity of ecosystems to moderate the consequences of climate disturbances such as droughts (Melillo, Richmond, and Yohe 2014). In particular, species and habitats that are already facing challenges will be the most impacted by climate change (Melillo, Richmond, and Yohe 2014). Other impacts to natural resources include:

- Changing water quality of natural surficial water bodies, including higher water temperatures, decreased and fluctuating dissolved oxygen content, increased cycling of detritus, more frequent algal blooms, increased turbidity, increased organic content, color changes, and alkalinity changes (Karl, Melillo, and Peterson 2009).

- Decreased tree growth and habitat change in low- and mid-elevation forests from increased temperature and drought (Karl, Melillo, and Peterson 2009).

- Increased frequency and intensity of insect attacks due to increased temperatures and shorter winters (Melillo, Richmond, and Yohe 2014).

- Disruption of the coordination between predator-prey or plant-pollinator life cycles that may lead to declining populations of many native species (Karl, Melillo, and Peterson 2009).

- Changes in the tree canopy that affect rainfall interception, evapotranspiration, and infiltration of precipitation, affecting the quantity of runoff (Karl, Melillo, and Peterson 2009).

- Reduced ability to respond to flooding and increased stress on species populations due to changes in wetland and riparian zone plant communities and hydraulic roughness (Karl, Melillo, and Peterson 2009).

- Shifting distribution of plant and animal species on land, with some species becoming more or less abundant (Karl, Melillo, and Peterson 2009).

- Rare or endangered species may become less abundant or extinct (Melillo, Richmond, and Yohe 2014).

- Decreased recreation and tourism opportunities from ecosystems degradation (Karl, Melillo, and Peterson 2009).

Infrastructure. Existing infrastructure were designed based on past, stable climate trends and may not have the capacity to respond to rapid changes in climate that are projected for the future (Melillo, Richmond, and Yohe 2014). Impacts to infrastructure include:

- Changes to soil moisture (Karl, Melillo, and Peterson 2009), which may led to soil subsidence under structures.

- Increased energy demand for cooling, refrigeration and water transport (Karl, Melillo, and Peterson 2009).

- Buckling of pavement or concrete structures (Karl, Melillo, and Peterson 2009).

- Decreased lifecycle of equipment or increased frequency of equipment failure (Karl, Melillo, and Peterson 2009).

- Accelerated erosion when stormwater infrastructure capacity is exceeded (Melillo, Richmond, and Yohe 2014).

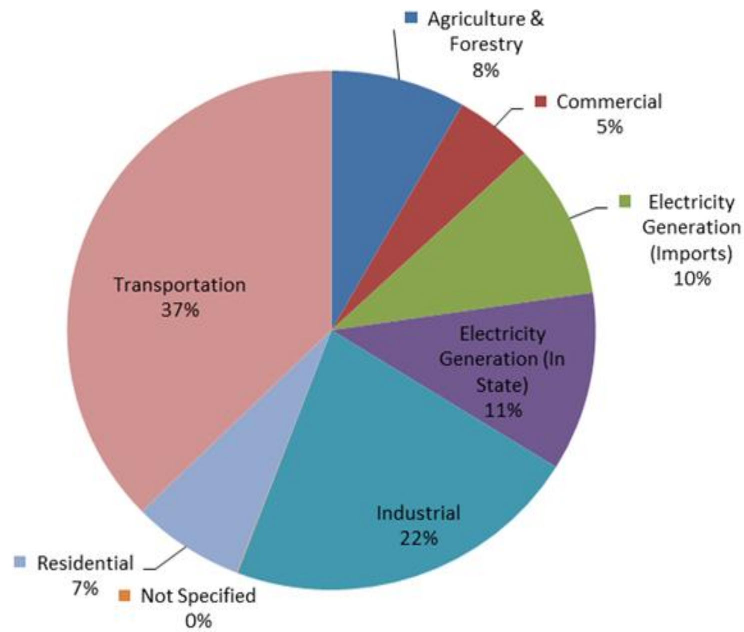
Agriculture and Livestock. Increased temperatures are projected to lengthen the growing season, although disruptions from extreme heat, drought, and changes to insects are also expected (Melillo, Richmond, and Yohe 2014). With adaptive actions, agriculture in the United States is expected to be resilient in the near-term, but yields of crops are expected to decline mid-century and late-century due to increased extremes in the climate (Melillo, Richmond, and Yohe 2014). However, increased CO_2 emissions can also stimulate crop growth and reduce transpiration, thereby increasing a crop's water use efficiency. As a result, some crops could have higher yields until a crop's optimum temperature range is exceeded (Reclamation 2013). California produces a large portion of the nation's high-value specialty crops, which are irrigation dependent and vulnerable to extreme changes in temperature and moisture (Melillo, Richmond, and Yohe 2014). Increased frequency and duration of heat waves would also put stress on livestock.

Human Health. Extreme heat events, increased wildfires, decreased air quality caused by rising temperatures, and diseases transmitted by insects, food and water that are impacted by climate change are a threat to human health and well-being (Melillo, Richmond, and Yohe 2014).

Hydropower. Electricity demand generally correlates with temperature. Hydroelectric generation is sensitive to climate changes that may affect basin precipitation, river discharge, and reservoir water levels. Changes that result in decreased reservoir inflow could adversely affect hydropower generation. Conversely, increases in runoff could increase hydropower production (Reclamation 2011).

9.1.3.2 GHG Emissions Sources and Inventory

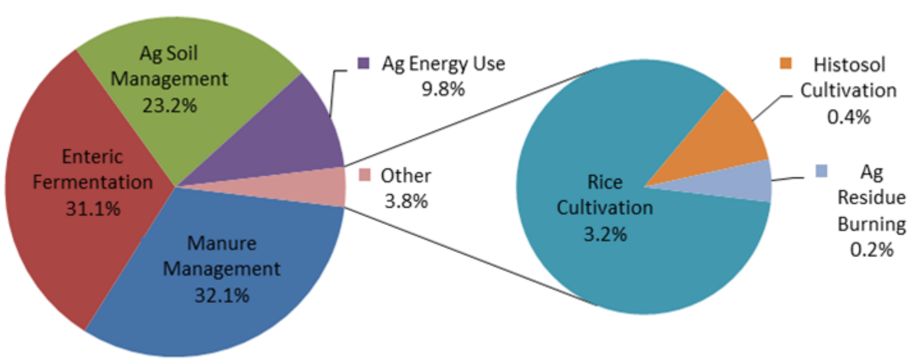
California is the second highest emitter of GHG emissions in the U.S., only behind Texas; however, from a per capita standpoint, California has the 45th lowest GHG emissions among the states. Worldwide, California is the 20th largest emitter of CO_2 if it were a country; on a per capita basis, California would be ranked 38th in the world (CARB 2014a). As shown in Figure 9-1, transportation is responsible for 37 percent of the State's GHG emissions, followed by the industrial sector (22 percent), electricity generation (21 percent), commercial and residential (12 percent), agriculture and forestry (8 percent) and other sources (0.04 percent). Emissions of CO_2 and nitrous oxide (N_2O) are largely byproducts of fossil fuel combustion. Methane (CH_4), a highly potent GHG, results largely from off-gassing associated with agricultural practices and landfills. California gross GHG emissions in 2012 (the last year inventoried) totaled approximately 459 million $MTCO_2e$ (CARB 2014b).



Source: CARB 2014b.

Figure 9-1. California GHG Emissions in 2012

Agricultural emissions represented approximately 8 percent of California's emissions in 2012. Agricultural emissions represent the sum of emissions from agricultural energy use (from pumping and farm equipment), agricultural residue burning, agricultural soil management (the practice of using fertilizers, soil amendments, and irrigation to optimize crop yield), enteric fermentation (fermentation that takes place in the digestive system of animals), histosols (soils that are composed mainly of organic matter) cultivation, manure management, and rice cultivation. Agricultural emissions are shown in Figure 9-2.



Source: CARB 2014b.

Figure 9-2. California Agricultural GHG Emissions in 2012

9.2 Environmental Consequences

These sections describe the environmental consequences associated with each alternative.

9.2.1 Assessment Methods

This analysis estimates CO_2, CH_4, and N_2O emissions that would occur from groundwater substitution transfers and cropland idling transfers. The other two pollutant groups commonly evaluated in various GHG reporting protocols, hydrofluorocarbons and perfluorocarbons, are not expected to be emitted in large quantities as a result of the alternatives and are not discussed further in this chapter.

Groundwater pumping activities could change air emissions in the area of analysis if the amount of annual groundwater pumped in an action alternative changed compared to the No Action Alternative. For this analysis, it was conservatively assumed that only diesel-fueled pumps would be used during any groundwater pumping activities. While a range of fuel types (including electric engines, engine sizes (horsepower) would be used in the area of analysis, average values were used to provide a high-level analysis. Existing emissions data used in the analysis includes:

- CalSim II model results for changes in CVP deliveries to M&I water service contractors. CalSim II is a planning model used by Reclamation and DWR designed to simulate operations of CVP and State Water Project (SWP) reservoirs and water delivery systems, including CVP allocations and deliveries to water service contractors. CalSim II simulates flood control operating criteria, water delivery policies, in-stream flow, and Delta outflow requirements. CalSim II is the best available tool for modeling CVP and SWP operations and is the primary system-wide operations model used by Reclamation and DWR to conduct planning and impact analyses of potential projects. The model simulates operation of the CVP and SWP for defined physical conditions and a set of regulatory requirements using 82 years of historical hydrology from water year 1922 through 2003. Baseline CalSim II simulations at both existing and future levels of development were developed by Reclamation in January 2012. See Appendix B, Water Operations Model Documentation, for more detail on the CalSim II model assumptions and results.

- Statewide Agricultural Production (SWAP) model results for changes in agricultural groundwater pumping in the Sacramento Valley, San Joaquin River, and Tulare Lake regions. The SWAP model incorporates project water supplies (CVP and SWP), other local water supplies, and groundwater. As conditions change within a SWAP region (e.g., the quantity of available project water supply increases or the cost of groundwater pumping increases), the model optimizes production by adjusting the crop mix, water sources and quantities used, and other inputs. It also fallows land when that appears to be the most cost-effective response to resource conditions. The SWAP model is used to compare the long-run response of agriculture to potential changes in SWP and CVP irrigation water delivery, other surface or groundwater conditions, or other economic values or restrictions. CalSim II output for the five alternative and existing conditions were used as inputs into the SWAP model. For each alternative and water year type, the CalSim II model provides the SWAP model with CVP and SWP deliveries for each SWAP model region. For more information on the SWAP model assumptions, inputs, and results, please see Appendix D, Statewide Agricultural Production Model Documentation.

- Diesel fuel emission factors from The Climate Registry (2014)

Each GHG contributes to climate change differently, as expressed by its global warming potential (GWP). GHG emissions are discussed in terms of CO_2e emissions, which express, for a given mixture of GHG, the amount of CO_2 that would have the same GWP over a specific timescale. CO_2e is determined by multiplying the mass of each GHG by its GWP.

This analysis uses the GWP from the IPCC Fourth Assessment Report (Forster et al. 2007) for a 100-year time period to estimate CO_2e. This approach is consistent with the federal GHG Reporting Rule (40 Code of Federal Regulations 98), as effective on January 1, 2014 (78 Federal Register 71904) and California's 2000-2012 GHG Inventory Report (CARB 2014a). The GWPs used in this analysis are 25 for CH_4 and 298 for N_2O.

Detailed calculations are provided in Appendix F, Climate Change Analysis Emission Calculations.

9.2.2 Alternative 1: No Action

Maintaining the current water shortage allocations to agricultural and M&I water service contractors could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. The SWAP model simulates adjustments made by farmers to maximize economic profit. Groundwater pumping costs are expected to increase by 17 percent between existing conditions and 2030. In response to this increased cost, farmers would substitute away from groundwater pumping to minimize costs by either obtaining additional surface water by intra- or inter- regional transfers or by irrigating only those crops which produce the greatest return on investment, subject to resource, technical, and market constraints.

As a result, farmers are expected to decrease the amount of groundwater pumping by 46.0 thousand acre-feet (TAF) in critical years to 150.4 TAF in above normal years over the entire study area. As shown in Table 9-2, exhaust emissions from groundwater pumping would decrease across all water year types for agricultural contractors in three SWAP regions.

Table 9-2. No Action Alternative: Change in Groundwater Pumping GHG Emissions from Existing Conditions ($MTCO_2e$ per year [$MTCO_2e/yr$])

Water Year	Annual Groundwater Pumped (TAF)	CO_2	CH_4	N_2O	Total
W	-137.8	-27,438	-28	-66	-27,532
AN	-150.4	-29,941	-30	-72	-30,044
BN	-94.1	-18,727	-19	-45	-18,791
D	-98.8	-19,675	-20	-48	-19,742
C	-46.0	-9,156	-9	-22	-9,187

Key:
AN = above normal condition; BN = below normal condition; C = critical condition; D = dry condition; W = wet condition

Changes to the environment from climate change could affect the No Action Alternative. As described in the Chapter 9.1.3, changes to annual temperatures, extreme heat, precipitation, sea level rise and storm surge, and snowpack and streamflow are expected to occur in the future because of climate change. Recent climate change modeling evaluated the projected average annual total CVP exports at the Jones Pumping Plant under the NoCC, EI5, and CAT scenarios. Compared to the NoCC scenario, total CVP exports would be reduced in the central tendency EI scenario (CT_Q5) by three percent by 2040, which is the period during which the M&I WSP would be in place. Conversely, the average of the 12 CAT scenarios indicated that total CVP exports at the Jones Pumping Plant could increase by five percent (Reclamation 2014). As a result, depending on future conditions, it is possible that less water would be available for export to water users in the San Joaquin River and Tulare Lake regions. Because groundwater pumping is expected to decrease under the No Action Alternative, any effects from climate change are expected to be minor.

The No Action Alternative could cause indirect effects from actions contractors would take from future water shortages. Because CVP deliveries to agricultural contractors would be larger compared to existing conditions in 2010, no additional actions to supplement water are expected to occur. As a result, there would be no indirect effects from the No Action Alternative.

9.2.3 Alternative 2: Equal Agricultural and M&I Allocation

Equal allocation of available CVP water supplies between agricultural and M&I water service contractors in the area of analysis could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. As shown in Table 9-3, groundwater pumping decreases would range from 37.6 TAF in wet years to 54.5 TAF in above normal years. This is reflective of the increased water deliveries to agricultural contractors as shown in the CalSim II modeling results (see Appendix B). Exhaust emissions from groundwater pumping would decrease during all water years for agricultural contractors in the area of analysis.

Table 9-3. Alternative 2: Change in Groundwater Pumping GHG Emissions from No Action Alternative ($MTCO_2e/yr$)

Water Year	Annual Groundwater Pumped (TAF)	CO_2	CH_4	N_2O	Total
W	-37.6	-7,480	-8	-18	-7,506
AN	-54.5	-10,857	-11	-26	-10,894
BN	-44.4	-8,838	-9	-21	-8,869
D	-43.5	-8,664	-9	-21	-8,694
C	-51.5	-10,243	-10	-25	-10,279

Key:
AN = above normal condition; BN = below normal condition; C = critical condition; D = dry condition; W = wet condition

Changes to the environment from climate change could affect Alternative 2. As described in the Chapter 9.1.3, changes to annual temperatures, extreme heat, precipitation, sea level rise and storm surge, and snowpack and streamflow are expected to occur in the future because of climate change. As described for the No Action Alternative, available water available for export to the San Joaquin River and Tulare Lake region CVP water service contractors could increase or decrease depending on the climate change scenario. Because groundwater pumping is expected to decrease under the No Action Alternative, any effects from climate change are expected to be minor.

Implementation of Alternative 2 could cause indirect effects from actions contractors would take from future water shortages. Because CVP deliveries to agricultural contractors would be larger compared to the No Action Alternative, no additional actions to supplement water are expected to occur. As a result, there would be no indirect effects from implementation of Alternative 2.

9.2.4 Alternative 3: Full M&I Allocation Preference

Use of the Full M&I Allocation Preference under Alternative 3 in the area of analysis could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. Because of the increased allocation to M&I water service contractors compared to the No Action Alternative, agricultural contractors would see a decrease in water available for delivery (see Appendix B). With less water available from the CVP, agricultural contractors would increase their groundwater pumping maintain their crops. As shown in Table 9-4, groundwater pumping increases would range from 13.6 TAF in below normal water years to 28.8 TAF in dry water years and GHG emissions from groundwater pumping would increase as a result.

Table 9-4. Alternative 3: Change in Groundwater Pumping GHG Emissions from No Action Alternative ($MTCO_2e$/yr)

Water Year	Annual Groundwater Pumped (TAF)	CO_2	CH_4	N_2O	Total
W	14.8	2,949	3	7	2,959
AN	20.8	4,136	4	10	4,150
BN	13.6	2,706	3	7	2,715
D	28.8	5,733	6	14	5,753
C	27.0	5,367	5	13	5,386

Key:
AN = above normal condition; BN = below normal condition; C = critical condition; D = dry condition; W = wet condition

Changes to the environment from climate change could affect Alternative 3. As described in the Chapter 9.1.3, changes to annual temperatures, extreme heat, precipitation, sea level rise and storm surge, and snowpack and streamflow are expected to occur in the future because of climate change. As described for the No Action Alternative, available water available for export to the San Joaquin River and Tulare Lake region CVP water service contractors could increase or decrease depending on the climate change scenario. It is projected that groundwater pumping could increase during this alternative and reduced water exports could place additional demand on the system. Impacts from climate change could potentially be adverse because if CVP exports decrease, then more pumping than currently predicted could be necessary.

Implementation of Alternative 3 could cause indirect effects from actions contractors would take from future water shortages. As described previously, agricultural contractor would have reduced allocations of water during shortages because M&I contractors would receive 100 percent allocations when feasible. To supplement reduced water supplies, it is possible that agricultural contractors could participate in water transfers from contractors north of the Delta to receive additional water. Contractors selling water for transfer could use groundwater pumping or cropland idling as methods to increase water supplies to buyers south of the Delta. An indirect effect of these activities could include increased exhaust emissions from groundwater pumping.

9.2.5 Alternative 4: Updated M&I WSP

Under Alternative 4, CVP deliveries to agricultural and M&I water service contractors would be the same as those under the No Action Alternative; therefore, impacts would be the same as those discussed for the No Action Alternative.

9.2.6 Alternative 5: M&I Contractor Suggested WSP

Implementation of the M&I Contractor Suggested WSP under Alternative 5 in the area of analysis could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. Although the allocations to agricultural contractors would remain the same, M&I contractors would receive higher deliveries during water shortage conditions because of the increased frequency that Reclamation would supply the unmet portion of the public health and safety demands. As a result, agricultural contractors would increase their groundwater pumping to counteract the slight reduction of CVP deliveries. As shown in Table 9-5, the annual amount of groundwater pumped would increase from 0.1 TAF in dry and critical water years to 0.7 TAF in above normal water years. Exhaust emissions from groundwater pumping would also slightly increase.

Table 9-5. Alternative 5: Change in Groundwater Pumping GHG Emissions from No Action Alternative ($MTCO_2e/yr$)

Water Year	Annual Groundwater Pumped (TAF)	CO_2	CH_4	N_2O	Total
W	0.2	42	<1	<1	42
AN	0.7	135	<1	<1	136
BN	0.1	15	<1	<1	15
D	0.2	43	<1	<1	43
C	0.1	15	<1	<1	15

Key:
AN = above normal condition; BN = below normal condition; C = critical condition; D = dry condition; W = wet condition

Changes to the environment from climate change could affect Alternative 5. As described in the Chapter 9.1.3, changes to annual temperatures, extreme heat, precipitation, sea level rise and storm surge, and snowpack and streamflow are expected to occur in the future because of climate change. As described for the No Action Alternative, available water available for export to the San Joaquin River and Tulare Lake region CVP water service contractors could increase or decrease depending on the climate change scenario. It is projected that groundwater pumping could increase during this alternative and reduced water exports could place additional demand on the system. However, any effects from climate change are expected to be minimal because the change in pumping for this alternative is predicted to be minor when compared to the No Action Alternative. As a result, impacts from climate change would be minor.

Implementation of Alternative 5 could cause indirect effects from actions contractors would take from future water shortages. To supplement reduced water supplies, it is possible that agricultural contractors could participate in water transfers from contractors north of the Delta to receive additional water. Contractors selling water for transfer could use groundwater pumping or cropland idling as methods to increase water supplies to buyers south of the Delta. An indirect effect of these activities could include increased exhaust emissions from groundwater pumping.

Additionally, transfers of water from north of the Delta to south of the Delta would involve export pumping at hydropower stations. Any reductions in hydropower from climate change could indirectly increase GHG emissions from the expected increased use of fossil fuels (Reclamation 2013). As a result, GHG emissions from increased export pumping could cause an increase in GHG emissions because of shifts in the State's electricity portfolio.

9.3 Mitigation Measures

There are no mitigation measures to reduce the severity of the climate change effects described in this chapter.

9.4 Unavoidable Adverse Impacts

Alternatives 3 and 5 could increase GHG emissions when compared to the No Action Alternative, which would be an adverse impact to climate change.

9.5 Cumulative Effects

The timeline for the climate change cumulative effects analysis extends from 2010 through 2030, a 20-year period. The relevant geographic study area for the cumulative effects analysis is the same area of analysis shown in Figure 1-2 in Chapter 1, Introduction. The following section analyzes the cumulative effects using the project method, which is further described in Chapter 20, Cumulative Effects Methodology. Chapter 20 describes the projects included in the cumulative condition. The cumulative analysis for climate change considers projects and conditions that could affect water supply deliveries within the area of analysis.

9.5.1 Alternative 2: Equal Agricultural and M&I Allocation

Equal allocation of available CVP water supplies between agricultural and M&I water service contractors in the area of analysis could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. Alternative 2 would result in a decrease in GHG emissions compared to the No Action Alternative because agricultural water service contractors are expected to receive lower water deliveries because of reduced allocations during water shortages. Since GHG emissions would decrease there would be no cumulative impacts.

9.5.2 Alternative 3: Full M&I Allocation Preference

Use of the Full M&I Allocation Preference under Alternative 3 in the area of analysis could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. By its very nature, climate change is a cumulative impact from various global sources of activities that incrementally contribute to global GHG concentrations. Individual projects provide a small addition to total concentrations, but contribute cumulatively to a global phenomenon. Cumulative GHG and climate change impacts should be analyzed from the perspective of whether they would impede the state's ability to meet its emission reduction goals. Because AB 32 requires the State to decrease its GHG emissions, any increase in GHG emissions from a project could be seen as a cumulative impact because it would impede the State's ability to meet its GHG emissions reduction goals.

Alternative 3 would increase GHG emissions compared to the No Action Alternative and would result in a cumulative impact when combined with other proposed projects in the region described in Chapter 20. Climate change therefore represents a cumulative effect for the entire State and could have a variety of meteorological and hydrologic implications.

9.5.3 Alternative 4: Updated M&I WSP

Implementation of the Updated M&I WSP under Alternative 4 in the area of analysis could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. No changes to groundwater pumping would occur under Alternative 4 as compared to the No Action Alterative. As a result, there would not be a cumulative impact to climate change.

9.5.4 Alternative 5: M&I Contractor Suggested WSP

Implementation of the M&I Contractor Suggested WSP under Alternative 5 in the area of analysis could affect agricultural production, leading to changes in emissions from groundwater pumping from agricultural contractors. As described for Alternative 3, any increase in GHG emissions from an alternative would be a cumulative impact because it would impede the State's ability to meet its GHG emissions reduction goals when combined with other projects.

Alternative 5 would increase GHG emissions compared to the No Action Alternative and would result in a cumulative impact when combined with other proposed projects in the region described in Chapter 20. Climate change therefore represents a cumulative effect for the entire State and could have a variety of meteorological and hydrologic implications.

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Chapter 10
Aquatic Resources

This chapter presents the existing aquatic resources within the area of analysis and discusses potential effects on aquatic resources from the proposed alternatives.

10.1 Affected Environment

The following section defines the area of analysis for assessing impacts from the Central Valley Project (CVP) Municipal and Industrial Water Shortage Policy (M&I WSP) alternatives. Additionally, a description of the existing biological conditions of each region identified within the area of analysis is provided, including a discussion of special status fish species with the potential to be affected by the alternatives. Also presented here is an overview of the regulatory setting associated with aquatic biological resources standards and a description of the habitat types and fish species with the potential to be affected.

Special status species, for the purpose of this document, are either: 1) protected, or proposed for protection, under the federal Endangered Species Act (ESA); 2) protected, or proposed for protection, under the California Endangered Species Act (CESA); 3) managed as part of a Federal Fishery Management Plan under the Magnuson-Stevens Fishery Conservation and Management Act; or 4) considered a species of concern by California Department of Fish and Wildlife (CDFW), United States (U.S.) Fish and Wildlife Service (USFWS), and/or National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries). Additionally, both Critical Habitat and Essential Fish Habitat (discussed under Chapter 10.1.2, below) are designated within the project area for various special-status species. Both of these habitat types are important components in considering potential project-related impacts as part of this assessment.

10.1.1 Area of Analysis

The area of analysis for the aquatic resources potentially affected by the alternatives encompasses the main waterways and water bodies within five major geographic areas or regions of California: the Sacramento Valley region; the American River region; the Sacramento-San Joaquin River Delta (Delta) region; the San Joaquin Valley region; and the San Francisco Bay Area region (see Figure 10-1). An overview description of the five areas is provided below, while a more detailed discussion of the sub-regions within the area of analysis is provided in Chapter 10.1.3.

Figure 10-1. Aquatic Resources Area of Analysis

Sacramento Valley region is the largest of the five regions and encompasses 11 counties, including Butte, Colusa, El Dorado, Glenn, Placer, Sacramento, Shasta, Sutter, Tehama, Trinity, and Yolo. Major water bodies and drainages in this portion of the area of analysis include Trinity Lake, Shasta Lake, the Sacramento River from Keswick Dam to the Delta, and Lake Oroville.

The American River region includes Folsom Lake and the Lower American River from Nimbus Dam to its confluence with the Sacramento River. Counties included in this portion of the area of analysis include El Dorado, Placer, and Sacramento.

The Delta region includes waterways throughout the Delta and service areas associated with the eastern San Francisco Bay and the traditional Delta boundaries. Counties included in this portion of the area of analysis include Alameda and Contra Costa.

The San Joaquin region is the second largest region and covers seven counties: Fresno; Kern; Kings; Madera; Merced; San Joaquin; Stanislaus; and Tulare. This region’s hydrology has been severely altered and man-made drainages have displaced many previously natural creeks and rivers that carried this region’s water. The major water body evaluated in the area is the San Luis Reservoir.

The San Francisco Bay Area region consists of four counties: Alameda; Contra Costa; Santa Clara; and San Benito.

As discussed in Chapter 3, Resources Introduction, there are only relatively small changes to Shasta and Trinity lakes, Lake Oroville, and San Luis Reservoir as a result of the different agricultural and municipal and industrial water service contractor allocations in the alternatives. The changes in storage are a reasonable response of a complex system to different CVP allocation procedures and may not necessarily be specific responses to the different allocation schemes of one alternative versus another. The differences between all Alternatives for CalSim II modeled water storage in Shasta Lake, Trinity Lake, Lake Oroville, and San Luis Reservoir are very small and range from zero to one percent. This is further discussed in Appendix B, Water Operations Model Documentation. These changes are relatively small and are within the range of existing operational variability. Because of the small changes in water surface elevation and storage, potential differences between alternatives to Shasta Lake, Trinity Lake, Lake Oroville, and San Luis Reservoir will not be discussed further in this chapter.

10.1.2 Regulatory Setting

10.1.2.1 Federal

Endangered Species Act Under ESA, the Secretary of the Interior and the Secretary of Commerce have joint authority to list a species as threatened or endangered (United States Code [USC], Title 16, Section 1533[c]). ESA prohibits the “take” of endangered or threatened fish and wildlife species, the take of endangered or threatened plants in areas under federal jurisdiction or in violation of state law, or adverse modifications to their critical habitat. Under ESA, the definition of “take” is to “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.” USFWS and NOAA Fisheries also interpret the definition of “harm” to include significant habitat modification that could result in the take of a species.

If an activity would result in the take of a federally-listed species, one of the following is required: an incidental take permit (ITP) under Section 10(a) of ESA or an incidental take statement issued pursuant to federal interagency consultation under Section 7 of ESA. Such authorization typically requires various measures to avoid and minimize species take, and to protect the species and avoid jeopardy to the species' continued existence.

Pursuant to the requirements of Section 7 of ESA, a federal agency reviewing a proposed project which it may authorize, fund, or carry out must determine whether any federally-listed threatened or endangered species, or species proposed for federal listing, may be present in the project area and determine whether implementation of the proposed project is likely to affect the species. In addition, the federal agency is required to determine whether a proposed project is likely to jeopardize the continued existence of a listed species or any species proposed to be listed under ESA or result in the destruction or adverse modification of critical habitat proposed or designated for such species (16 USC 1536[3], [4]).

NOAA Fisheries administers ESA for marine fish species, including anadromous salmonids such as Central Valley steelhead (*Oncorhynchus mykiss*), winter-run and spring-run Chinook salmon (*O. tshawytscha*), and green sturgeon (*Acipenser medirostris*). USFWS administers ESA for non-anadromous and non-marine fish species such as delta smelt (*Hypomesus transpacificus*), and longfin smelt (*Spirinchus thaleichthys*), which has been recently proposed for listing and warrants consideration for protection under the ESA. In 2012, the USFWS acknowledged that the San Francisco Bay-Delta Distinct Population Segment (DPS) of the longfin smelt warrants listing but was precluded from listing at that time because of other higher priorities and consequently will be treated as a candidate species. Projects for which a federally-listed species is present and likely to be affected by an existing or proposed project must receive authorization from USFWS and/or NOAA Fisheries. Authorization may involve a letter of concurrence that the project will not result in the potential take of a listed species, or may result in the issuance of a Biological Opinion (BO) that describes measures that must be undertaken to minimize the likelihood of an incidental take of a listed species. A project that is determined by NOAA Fisheries or USFWS to jeopardize the continued existence of a listed species cannot be approved under a BO.

Where a federal agency is not authorizing, funding, or carrying out a project, take that is incidental to the lawful operation of a project may be permitted pursuant to Section 10(a) of ESA through approval of a habitat conservation plan (HCP).

ESA requires the federal government to designate "critical habitat" for any species it lists under the Endangered Species Act. "Critical habitat" is defined as: 1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to the species conservation, and those features that may require special management considerations or protection; and 2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation.

Biological Opinions As described above, BOs are prepared through formal consultation under Section 7 of the ESA (described above) by either NOAA Fisheries or USFWS in response to a federal action affecting a listed species.

In 2004 and 2005, both NOAA Fisheries and USFWS issued new BOs following formal consultation with the Bureau of Reclamation (Reclamation). Both BOs were subsequently sued. In response to further litigation, the 2004 and 2005 BOs were remanded to USFWS and NOAA Fisheries for revision, but were not vacated. USFWS and NOAA Fisheries released revised BOs in 2008 and 2009, respectively.

Actions were brought challenging the NOAA Fisheries and USFWS BOs under ESA and the Administrative Procedure Act (APA) concerning the effects of the CVP and State Water Project (SWP) on endangered fish species. The cases arose out of continuing efforts to protect several species listed under ESA. Plaintiffs moved for summary judgment on their claims that the NOAA Fisheries and USFWS BO addressing the impacts of the coordinated operations of the CVP and SWP and its Reasonable and Prudent Alternative (RPA) violate the ESA and APA and are arbitrary, capricious, and unlawful.

In September 2011, the court remanded the 2009 BO to NOAA Fisheries, in a mixed ruling, finding in favor of the federal government on some counts, and in favor of water contractor plaintiffs on other counts. On December 12, 2011, the court ordered NOAA Fisheries to submit a revised draft BO to Reclamation on October 1, 2014, and submit a final BO on February 1, 2016. Reclamation must issue final National Environmental Policy Act (NEPA) documentation by February 1, 2016, and a Record of Decision by April 29, 2016.

On December 27, 2010, the Court entered an "Amended Order on Cross-Motions for Summary Judgment" (Doc. 761). The Amended Order remanded the BO to the USFWS without vacatur (annulled or set aside) for further consideration.

On March 13, 2014, the United States Court of Appeals for the Ninth Circuit affirmed in part and reversed in part the finding from the District Court on the USFWS BO. The Court of Appeals upheld the determination that Reclamation must complete NEPA analysis, but it reversed the finding that the scientific basis for the BO was arbitrary and capricious. The NOAA Fisheries BO is the subject of a future review from the Court of Appeals. Until the legal issues are resolved and new biological opinions are completed (if necessary), the 2008 USFWS and 2009 NOAA Fisheries BOs will guide operations of an M&I WSP.

Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat The Pacific Fishery Management Council (PFMC) has designated the Delta, San Francisco Bay, and Suisun Bay as Essential Fish Habitat (EFH) to protect and enhance habitat for coastal marine fish and macroinvertebrate species that support commercial fisheries such as Pacific salmon. The amended Magnuson-Stevens Fishery Conservation and Management Act, also known as the Sustainable Fisheries Act (Public Law 104-297), requires that all federal agencies consult with NOAA Fisheries on activities or proposed activities authorized, funded, or undertaken by that agency that may adversely affect EFH of commercially managed marine and anadromous fish species.

As part of the Biological Assessment on the Coordinated Long-Term Operations of the CVP and SWP, Reclamation and the California Department of Water Resources (DWR) have addressed anticipated effects of SWP and CVP operations on EFH within the Delta estuary for use in the re-consultation for compliance with the Act. The EFH provisions of the Sustainable Fisheries Act are designed to protect fishery habitat from being lost due to disturbance and degradation.

Real-Time Decision-Making to Assist Fishery Management Reclamation and DWR work closely with USFWS, NOAA Fisheries, CDFW, and other agencies to coordinate the operation of the CVP and SWP with fishery needs. This coordination is facilitated through several forums, as discussed below.

CALFED Water Operations Management Team The Water Operations Management Team (WOMT) was established to facilitate decision making at the appropriate levels and provide timely support of decisions. This team, which first met in 1999, consists of management-level participants from Reclamation, DWR, USFWS, NOAA Fisheries, and CDFW. The WOMT meets frequently to provide oversight and decision making that must routinely occur within the CALFED Ops Group process. The WOMT relies heavily on other teams and work groups for recommendations on fishery actions. It also uses the CALFED Ops Group (see below) to communicate with stakeholders about its decisions. Although the goal of the WOMT is to achieve consensus on decisions, the agencies retain their authorized roles and responsibilities.

CALFED Ops Group The CALFED Ops Group consists of participants from Reclamation, DWR, USFWS, NOAA Fisheries, CDFW, the State Water Resources Control Board (SWRCB), and the U.S. Environmental Protection Agency. The CALFED Ops Group generally meets 11 times a year in a public setting to discuss CVP and SWP operations, Central Valley Project Improvement Act (CVPIA) implementation, and coordination with efforts to protect endangered species. The CALFED Ops Group held its first public meeting in January 1995, and during the next six years the group developed and refined its process. The CALFED Ops Group is recognized within D-1641 and elsewhere as a forum where agencies can consult and achieve consensus on coordinating CVP and SWP operations with endangered species, water quality, and CVPIA requirements.

Decisions made by the CALFED Ops Group have been incorporated into the Delta standards to protect beneficial uses of water (e.g., export/inflow ratios and some closures of DCC gates).

Several teams were established as part of the CALFED Ops Group. These teams are described below.

Operations and Fishery Forum The stakeholder-driven Operations and Fishery Forum disseminates information about recommendations and decisions regarding CVP and SWP operations. Forum members are considered the contact people for their respective agencies or interest groups when the CALFED Ops Group needs to provide information about take of listed species or address other topics or urgent issues. Alternatively, the CALFED Ops Group may direct the Operations and Fishery Forum to recommend operational responses to issues of concern raised by member agencies.

Data Assessment Team The Data Assessment Team consists of technical staff members from the agencies and stakeholders. The team meets frequently during the fall, winter, and spring to review and interpret data relating to fish movement, location, and behavior. Based on its assessments and information about CVP and SWP operations, the Data Assessment Team recommends potential changes in operations to protect fish.

B2 Interagency Team The B2 Interagency Team was established in 1999 and consists of technical staff members from the agencies within the CALFED Ops group. The team meets weekly to discuss implementation of Section 3406(b)(2) of the CVPIA, which defines the dedication of CVP water supply for environmental purposes. It communicates with the WOMT to ensure coordination with the other operational programs or resource-related aspects of project operations.

Fisheries Technical Teams Several fisheries-specific teams have been established to provide guidance on resource management issues. These teams are described below.

The Sacramento River Temperature Task Group The Sacramento River Temperature Task Group (SRTTG) is a multiagency group formed pursuant to SWRCB Water Right Orders 90-5 and 91-1 to help improve and stabilize the Chinook salmon population in the Sacramento River. Reclamation develops temperature operation plans each year for the Shasta and Trinity divisions of the CVP. These plans consider impacts of CVP operations on winter-run and other races of Chinook salmon. The SRTTG meets in the spring to discuss biological and operational information, objectives, and alternative operations plans for temperature control, then recommends an operations plan for temperature control. Reclamation then submits a report to the SWRCB, generally on or before June 1 each year.

After the operations plan is implemented, the SRTTG may perform additional studies and hold meetings to revise the plan based on updated biological data, reservoir temperature profiles, and operations data. Updated plans may be needed for summer operations to protect winter-run Chinook salmon, or in fall for the fall-run spawning season. If any changes are made to the plan, Reclamation submits a supplemental report to the SWRCB.

Delta Operations for Salmonids and Sturgeon Group The Delta Operations for Salmonids and Sturgeon (DOSS) group was established from Action IV.5 in the RPA in the NOAA Fisheries BO. Their responsibilities are to advise the WOMT and NOAA Fisheries on measures to reduce adverse effects from Delta operations of the CVP and the SWP to salmonids and green sturgeon. DOSS coordinates the work of other technical teams to provide expertise on issues pertinent to Delta water quality, hydrology, and environmental parameters. The DOSS is responsible to: 1) provide recommendations for real-time management of operations to WOMT and NOAA Fisheries, consistent with implementation procedures provided in the RPA; 2) track and evaluate the effectiveness of the implementation of Actions IV.1 through IV.4 (Delta Cross Channel operations, Delta flow management, entrainment reductions, and infrastructure/operations modifications at the CVP/SWP fish facilities); 3) conduct annual reviews of Delta operations and data collection from ongoing monitoring programs; 4) oversee the implementation of the acoustic tag experiment for San Joaquin fish; 5) coordinate with the Delta Smelt Working Group to maximize benefits to all special-status fishes; and, 6) coordinate with the other technical teams identified in the RPA to ensure consistent implementation of the RPA.

Delta Smelt Working Group The Delta Smelt Working Group was established in 1995 to resolve biological and technical issues regarding delta smelt and to develop recommendations for consideration by USFWS. The working group generally acts when Reclamation and DWR seek consultation with USFWS on delta smelt or when unusual salvage of delta smelt occurs. It also has assisted in developing strategies to improve habitat conditions for delta smelt.

The Delta Smelt Working Group employs a delta smelt decision tree when forming recommendations to send to the WOMT. The working group does not decide what actions will be taken and does not supplant the Data Assessment Team, but merely provides additional advice to the WOMT. The group may propose operations modifications that it believes will protect delta smelt, either by reducing take at the export facilities or by preserving smelt habitat. The decision tree is adapted by the working group as new knowledge becomes available.

American River Operations Work Group In 1996, Reclamation established an operational working group for the lower American River, known as the American River Operations Work Group. Although open to anyone, the work group's meetings generally include representatives from several agencies and organizations with ongoing concerns about management of the lower American River: Reclamation, USFWS, NOAA Fisheries, CDFW, the Sacramento Area

Flood Control Agency, the Water Forum, the City of Sacramento, Sacramento County, the Western Area Power Administration, and the Save the American River Association. The American River Operations Work Group convenes at least monthly to provide fisheries updates and reports to enable Reclamation to better manage Folsom Lake for fish resources in the lower American River.

10.1.2.2 State

California Endangered Species Act Pursuant to CESA and Section 2081 of the California Fish and Game Code, a permit from the CDFW is required for activities that could result in the take of a state-listed threatened or endangered species (i.e., species listed under CESA). The definition of "take" is to hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill (Fish and Game Code Section 86).

The state definition does not include "harm" or "harass," as the federal definition does. As a result, the threshold for take under CESA is typically higher than that under ESA. Section 2080 of the Fish and Game Code prohibits the taking of plants and animals listed under the authority of CESA, except as otherwise permitted under Fish and Game Code Sections 2080.1, 2081, and 2835. Under CESA, the California Fish and Game Commission maintain a list of threatened species and endangered species (Fish and Game Code Section 2070). The California Fish and Game Commission also maintain two additional lists:

- Candidate species
- Species of special concern, which serves as a watch list

Consistent with the requirements of CESA, a lead agency reviewing a proposed project within its jurisdiction must determine whether any state-listed endangered or threatened species may be present in a proposed project area and determine whether the proposed project may take a listed species. If a take would occur, an ITP would be required from the CDFW, including a mitigation plan that provides measures to minimize and fully mitigate the impacts of the take. The measures must be roughly proportional in extent to the impact of the taking and must be capable of successful implementation. Issuance of an ITP may not jeopardize the continued existence of a state-listed species. For species that are also listed as threatened or endangered under the ESA, CDFW may rely on a federal incidental take statement or incidental take permit to authorize an incidental take under CESA.

10.1.3 Existing Conditions

The following section describes the existing physical conditions associated with riverine, lacustrine, or estuarine habitats supporting biologic resources within the area of analysis. Most of the species addressed occur throughout the area of analysis, but a few are more restricted to one or more regions within the area of analysis. Table 10-1 provides information on species status, preferred habitats, and occurrence within the five different regions in the area of analysis. The habitat types are described to provide a general overview of aquatic resources within the area of analysis. The regions defined in the Area of Analysis are then further sub-divided into the rivers, reservoirs, or other water bodies to better describe the aquatic habitats within the regions that were evaluated in the effects analysis. Finally, the special status fisheries resources that could potentially be affected by the proposed project and alternatives are described.

10.1.3.1 Aquatic Habitat Types in the Area of Analysis

Aquatic habitats in the area of analysis fall into several broad types: riverine; lacustrine; and estuarine. These are characterized here and information on associated assemblages of fish species occurring within each habitat is provided below.

Riverine Habitat Riverine habitat is aquatic habitat characterized by moving water. The nature and characteristics of riverine habitat can vary considerably. Depending on the size of the drainage basin and topography, riverine habitats can consist of large, slow-moving water to small, fast-moving water found in higher elevation drainages.

Historically in the Central Valley, smaller streams and rivers typically were dry in the late summer. Only the larger rivers or spring fed streams were consistently perennial. With construction of reservoirs on most of the larger streams and rivers in the Central Valley, most flows have been regulated resulting in less variable flows supporting aquatic habitat within and among years. Aquatic and emergent vegetation is typically sparse in riverine habitats and limited to slower moving shallow areas of the channel. Emergent vegetation is restricted to the margins and backwaters of the river in areas of shallow, slow-moving water.

Fish assemblages in the riverine habitats of the area of analysis include native and non-native species. More than 30 species of fish are known to use riverine habitats in the area of analysis. Anadromous species include native species of Chinook salmon, steelhead, green sturgeon, white sturgeon (*Acipenser transmontanus*), and non-native species such as American shad (*Alosa sapidissima*) and striped bass (*Morone saxatilis*). Resident species include rainbow trout (*O. mykiss*), brown trout (*Salmo trutta*), largemouth (*Micropterus punctulatus*) and smallmouth bass (*M. dolomieu*), channel catfish (*Ictalurus punctatus*), sculpin (*Cottus* sp.), carp (*Cyprinus carpio*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker (*Catostomus occidentalis*), and hardhead (*Mylopharodon conocephalus*). The distribution and abundance of these species in riverine habitat within the area of analysis varies depending on the location and specific conditions of the riverine habitat such as water temperature, gradient, turbidity and substrate composition, among others.

Table 10-1. State- and Federally-listed, Proposed, and Candidate Fish Species Potentially Occurring in the Area of Analysis

Common Name	Scientific Name	Status (Federal/ State)	Primary Habitat and Critical Seasonal Periods	Occurrence in Area of Analysis
Salmonids				
Central Valley Steelhead	*Oncorhynchus mykiss*	T/—	Anadromous species using riverine, estuarine, and saltwater habitat. Migration potentially occurs year-round.	Sacramento River, American River, San Joaquin Valley, Delta
California Central Coast/South-Central Coast	*Oncorhynchus mykiss*	T/—	Anadromous species using riverine, estuarine, and saltwater habitat. Migration potentially occurs year-round.	Coastal Mountains, San Francisco Bay Area
Central Valley Chinook salmon, fall/late fall-run	*Oncorhynchus tshawytscha*	SC/SSC	Anadromous species using riverine, estuarine, and saltwater habitat. Adult migration occurs mainly from September through December but has been observed as late as June. Primary juvenile outmigration occurs from January through June.	Sacramento River, American River, Delta, San Francisco Bay Area, San Joaquin Valley
Central Valley spring-run Chinook salmon	*Oncorhynchus tshawytscha*	T/T	Anadromous species using riverine, estuarine, and saltwater habitat. Adult migration potentially occurs from March through May. Juvenile outmigration occurs from November through April.	Sacramento River, Delta, San Joaquin Valley
Sacramento River winter-run Chinook salmon	*Oncorhynchus tshawytscha*	E/E	Anadromous species using riverine, estuarine, and saltwater habitat. Adult migration potentially occurs from January through May. Juvenile outmigration occurs from November through mid-March.	Sacramento River, Delta
Non-Salmonids				
Hardhead	*Mylopharodon conocephalus*	—/SSC	Clear, high-quality streams with large, deep, rock or sand-bottom pools. Clean gravel riffles for spawning.	Sacramento River, American River, San Joaquin Valley, Bay-Delta
Sacramento splittail	*Pogonichthys macrolepidotus*	—/SSC	Sloughs and other slow-moving waters of San Pablo Bay and Delta tributaries.	Sacramento River, American River, San Francisco Bay Area, San Joaquin Valley, Delta
River lamprey	*Lampetra ayresii*	—/SSC	Cool, high-quality perennial streams for spawning and larval rearing. Clean, well-aerated gravel beds for spawning. Soft-bottom pools with abundant silt and detritus for larval rearing.	Sacramento River, American River, San Francisco Bay Area, Delta, San Joaquin River

Common Name	Scientific Name	Status (Federal/ State)	Primary Habitat and Critical Seasonal Periods	Occurrence in Area of Analysis
Delta smelt	*Hypomesus transpacificus*	T/E	Spends most of its life in the Sacramento–San Joaquin estuary. Spawns in shallow, fresh or slightly brackish water upriver from the mixing zone, including in the Sacramento River, Mokelumne River system, Cache Slough region, San Francisco Bay Delta, and Montezuma Slough area.	Sacramento River, American River, Delta
California / San Joaquin Roach	*Lavinia symmetricus* ssp. 1	—/SSC	Occurs in small, warm tributaries, to larger streams that flowed through open foothill woodlands of oak and foothill pine. Located in the foothills in much of the same region that contains the pikeminnow- hardhead-sucker assemblage.	Occurs upstream of large reservoir or in tributary streams that would not be affected by the project.
Green sturgeon	*Acipenser medirostris*	T/SSC	Green sturgeon are an anadromous species, migrating from the ocean to freshwater to spawn. They exist in the Sacramento River system, as well as in the Eel, Mad, Klamath, and Smith rivers in the northwest portion of California.	Sacramento River, American River, San Francisco Bay Area, Delta, San Joaquin Valley
Longfin smelt	*Spirinchus thaleichthys*	—/T	The longfin smelt is an anadromous species that spawns in the Delta and rears in the brackish areas of the San Francisco Bay and Delta.	Delta, San Francisco Bay Area
Sacramento perch	*Archoplites interruptus*	—/SSC	Historically found in the sloughs, slow moving rivers, and lakes of the central valley. Prefer warm water. Aquatic vegetation is essential for young. (Within native range only)	Found in isolated quarry lakes in the Livermore Valley and would not be affected by the Project.

Sources:
CDFW 2012; Moyle 2002; Brown 2000

Key to Status Codes:

Federal Status:
SC: Species of Concern
E: Endangered
T: Threatened

State Status:
E: Endangered
T: Threatened
SSC: Species of Special Concern

Lacustrine Habitat Lacustrine habitats in the area of analysis are represented by artificial impoundments. Lakes and ponds also occur in inland depressions containing standing water and can vary in size and characteristics, but there are no lakes in the area of analysis that would be affected by the proposed project. Lacustrine habitat includes the lake bed and shoreline areas (benthic) and also the open water (pelagic) habitat. Large reservoirs like Shasta and Folsom lakes and Lake Oroville typically maintain both a cold and warm water fishery. These deep lakes stratify during the warm summer months into warm water body in the top 20 to 30 feet of the water column and a cold water portion of the reservoir in waters deeper than about 80 to 100 feet. The transitional zone that separates the two water bodies is called as the thermocline. Management of the cold water pool is an important consideration to successfully manage for cold water fishes downstream of these large dams. Shallow lacustrine habitats may support rooted plants. Permanent, shallow waters can support emergent and aquatic plants in shallow areas and along the margins of the water body. Most reservoirs, because of their seasonally fluctuating water levels, do not support emergent or submerged aquatic vegetation.

Fish associated with lacustrine habitat vary substantially depending on the size and characteristics of the habitat and whether species have been intentionally or unintentionally introduced. Larger reservoirs in the area of analysis thermally stratify in the summer and can support warm and cold water fish assemblages. Warm water fish assemblages consist of sportfish such as largemouth bass, smallmouth bass, spotted bass (*M. punctulatus*), bluegill (*Lepomis machrochirus*), crappie (*Pomoxis* spp.), and catfish (*Ictalurus* spp.). Native warm water fish that inhabit lacustrine habitats include Sacramento sucker and hardhead Cold water sport species include brown trout, rainbow trout, and Kokanee salmon (*O. nerka*) where these species have been introduced.

Estuarine Habitat Estuarine communities occur in tidal areas where fresh and salt meet. Estuaries are composed of subtidal and intertidal areas and substrates are typically composed of fine sediments. In large estuaries, the mix of fresh and ocean waters usually forms a horizontal salinity gradient that varies by area and location, with seasonal variations in freshwater inflow and lunar driven changes in tidal strength. Aquatic plants include free floating phytoplankton, green and blue-green algae. Pacific eelgrass (*Zostera marina*) grows in dense stands in many sub-tidal estuarine communities with clear water. Salinity and water clarity determine plant species distribution in estuarine communities.

Fish species that use estuarine habitats are primarily marine in origin but anadromous species also use this habitat. Many marine species breed in estuarine habitats, and juvenile fish rear in this habitat until moving into marine environments as adults. Anadromous fish pass through estuarine areas during their migrations to and from the sea. Juveniles of anadromous species may rear in estuarine habitats before moving to the ocean (e.g., salmon and steelhead) or may continue to use estuarine habitats for much of their life (e.g., striped bass, splittail (*Pogonichthys macrolepidotus*). A few species such as delta smelt are found almost exclusively in estuarine habitats. Crustaceans such as shrimp, crabs and mollusks, including gastropods and bivalves also occur in estuarine habitats.

10.1.3.2 Sacramento River Division

Within Sacramento River Region riverine habitat occurs as large, perennial rivers; small, perennial streams and small, intermittent streams. The Sacramento River is the main feature in this region. Other perennial rivers and streams in the area of analysis include Clear Creek, Cottonwood Creek, Butte Creek, Battle Creek, Deer, Antelope, Mill, the Feather and Yuba rivers and Bear Creek. Intermittent streams include Stony and Thomes creeks. These intermittent and perennial streams are tributaries to the Sacramento River. These streams would not be affected by the project and therefore are not analyzed.

The Lower Sacramento River (below Shasta Dam) supports native and non-native resident and anadromous fish. The Sacramento River serves as an important migration corridor and spawning and rearing habitat for anadromous salmon, steelhead and sturgeon. Aquatic habitat in the lower Sacramento River is characterized by large flows and cold water conveyed through large-scale pools, riffles and runs from Keswick Dam to about Red Bluff. Downstream of Red Bluff, riverine habitat is still high quality but the river gradient is slightly less and average channel velocities are slower. The river enters a more confined leveed reach at about Colusa and is more typical of a lowland river comprised of deep runs and pools but without pools and riffles. The river is overall, depositional in nature, and as the distance downstream from Shasta Dam increases, water has a reduced clarity and habitat diversity, relative to the upper portion of the river. More than 30 species of fish are known to use the Sacramento River. Of these, a number of native and introduced species are anadromous. Anadromous species include four races or runs of Chinook salmon, steelhead, green and white sturgeon, striped bass, and American shad.

The Sacramento River between Keswick Dam and Red Bluff is of primary importance to native anadromous fishes and currently is used for spawning and early lifestage rearing by all four runs of Chinook salmon (fall, late-fall, winter, and spring) and steelhead. Other tributary rivers and streams also provide habitat for one or more runs of Chinook salmon and steelhead.

10.1.3.3 American River Division

The American River watershed supports all three types of aquatic habitat. Lacustrine habitat is found in Folsom Lake, and Lake Natoma. Riverine habitat occurs in the lower American River. Folsom Lake has a capacity of 977,000 acre-feet (AF) and has 75 miles of shoreline when full. The lake supports both cold and warm water fisheries. Native species that occur in the reservoir include hardhead and Sacramento pikeminnow. However, introduced largemouth bass, smallmouth bass, spotted bass, bluegill, crappie, and catfish constitute the primary warm-water sport fisheries of Folsom Lake. The reservoir's cold water sport species include brown trout, rainbow, Kokanee salmon, and Chinook salmon.

Lake Natoma is an afterbay for Folsom Dam and serves as the intake for the Folsom South Canal. The lake's capacity is 8,760 AF and has about 10 miles of shoreline when full. The lake is heavily used for recreation such as rowing and sailing, and has a marginal fishery, mostly because of the cold water inflow from Folsom Dam and high rate of turnover.

The Lower American River includes 23 miles of river (below Nimbus Dam) to the confluence with the Sacramento River. The river from Nimbus Dam to about Watt Avenue is a rock bottomed, cool water river with riffles runs and pools. Fall-run Chinook salmon and steelhead spawn and rear in the river, primarily upstream of Sunrise Boulevard, but rearing can extend as far downstream as Watt Avenue. Habitat includes backwaters and dredged ponds and overall supports more than 40 fish species, half of which are game fish. Other common species include American shad, striped bass, largemouth bass, carp, Sacramento pikeminnow, Sacramento sucker, and hardhead.

10.1.3.4 Delta Division

The Delta Region includes the Delta which is comprised of the channels of the Sacramento and San Joaquin rivers including from about the I-Street Bridge in Sacramento on the Sacramento River and Vernalis on the San Joaquin River, west to Martinez and includes Suisun Bay and the Suisun Marsh. The Delta is tidally influenced and is also the diversion point for both the CVP and SWP. The Delta is comprised of tidal river channels and sloughs and many constructed features. The constructed features include the Sacramento and Stockton deepwater ship channels, the Delta Cross Channel and Clifton Court Forebay. Other habitats include shallow water habitats and tidally active open waters in Sherman Island, Franks Tract and Mildred Island. The Delta contains the diversion intakes and fish screens for the CVP and SWP located in the southwest side of the Delta. Suisun Bay provides shallow water, estuarine habitat that is important for many fish species. More than 120 fish species rely on the Delta and San Francisco Bay as important areas to complete one or more lifestages. Channels and sloughs of the Delta and Suisun Bay provide important migration and rearing habitats for anadromous salmonids, delta smelt, longfin smelt and splittail.

West of Martinez is the Carquinez Straits, San Pablo and San Francisco Bays. Estuarine areas occur from the Delta to San Francisco Bay depending on season of the year and outflow conditions. The interface of freshwater and saltwater is generally productive and highly dynamic biotic zones. Juvenile fishes are attracted to these areas because of the abundance of small prey-sized fishes feeding on plankton. This mixing area is also important as a staging ground for anadromous fishes as they pass between, and acclimatize to the freshwater and saltwater environments.

Freshwater lacustrine habitat is provided in local reservoirs in Contra Costa and Alameda counties. Riverine habitat is found in numerous permanent and intermittent streams that flow into the reservoirs or directly into Suisun Bay or San Francisco Bay.

10.1.3.5 Cross Valley Canal Unit

The Cross Valley Unit is not included in the effects analysis for Aquatic Resources because there are no natural water courses that would be affected by change in operation for agricultural and M&I allocations.

10.1.3.6 West San Joaquin Division

The West San Joaquin Division is the western part of the southern portion of the Central Valley which lies south of the Delta. It stretches from San Joaquin County down to Kern County. Most of the streamflow in the valley enters from the east side of the valley and the West San Joaquin Division includes most of the CVP including San Luis Reservoir. Water pumped from the Delta is delivered to contractors along the CVP Delta-Mendota Canal or from Mendota Pool. The San Joaquin River flows west from Friant Dam to Mendota Pool where it turns in a northerly direction to flow to the Delta.

The primary aquatic feature in the West San Joaquin Division is San Luis Reservoir, a large and intensively reservoir site that contains of warm water fishes exported from the Delta such as bluegill, largemouth bass, crappie, catfish, and carp. Because San Luis is an artificial environment that does not support life history requirements of special-status fish species, it is not analyzed further.

10.1.3.7 Description of Fish Resources in the Area of Analysis

Fish resources of the area of analysis include native and non-native anadromous and resident species. Several native anadromous and resident species have been listed as threatened or endangered under ESA or CESA or are candidates for listing. Six fish species or Evolutionarily Significant Units (ESU) listed under ESA or CESA have the potential to occur in the watercourses in the area of analysis, as shown in Table 10-1. One of these species, longfin smelt, is a candidate for federal listing in addition to its current CESA listing. Additionally, six species have the potential to occur in the watercourses in the area of analysis that are listed as either federal or State species of concern (Table 10-1).

Federal and State Listed Salmonids

General Pacific Salmonid Life Cycle Anadromous salmonids share similar life cycle patterns. Anadromous fish live in the oceans as adults, growing and maturing in the food-abundant environment. After reaching maturity in the ocean, salmonids immigrate[1] to their natal (place of hatching) streams to spawn. Spawning generally takes place in the tails of pools and riffles. Substrate size and quality is important for successful spawning. The suitable substrate is free of silt and size varies from small gravel to cobble (0.5 to 6 inches in diameter), depending on the fish species. Eggs are deposited in a gravel nest, called a redd, and hatch in 30 to 60 days depending on the temperature of the water and the species. Juvenile salmonids typically spend between two months (Chinook salmon) and two years (steelhead) growing in the freshwater habitat before

[1] Migrate into the freshwater environment/watershed from the marine environment.

emigrating[2] to the ocean. Prior to emigration, juvenile salmonids go through a physiological process that allows them to adapt from a freshwater environment to a marine environment (smoltification). The emigrating fish, called smolts, leave the freshwater environment for the ocean during the spring. Due to this anadromous life cycle, salmonids encounter a range of distinct habitat types throughout their life history.

During emigration, juvenile salmonids typically enter estuarine habitats, which can vary widely in their physical characteristics. Salmonid use of estuarine habitats has been well documented, and the time spent in an estuary and the benefits received from estuarine habitat can vary widely among species and watersheds (Bond et al. 2008; Smith 1990). Some salmonids move through estuaries in days, whereas other species remain for many months (described in more detail by species, below).

Central Valley Steelhead NOAA Fisheries has divided steelhead into six distinct groups, called DPS, based on genetic testing and life history patterns. Recognition of these groups helps conserve diversity in the various life history adaptations. The Central Valley DPS includes all naturally spawned populations of steelhead in the Sacramento and San Joaquin rivers and their tributaries, excluding steelhead from the San Francisco and San Pablo Bays and their tributaries (NOAA Fisheries 2007). Designated critical habitat includes 2,308 miles of stream habitat within the Central Valley as well as estuary habitat within the San Francisco-San Pablo-Suisun Bay complex (NOAA Fisheries 2007).

Central Valley steelhead historically migrated upstream into the high gradient upper reaches of Central Valley streams and rivers for spawning and juvenile rearing. Construction of dams and impoundments on the majority of Central Valley rivers has created impassable barriers to upstream migration and substantially reduced the geographic distribution of steelhead. Although quantitative estimates of the number of adult steelhead returning to Central Valley streams to spawn are not available, anecdotal information and observations indicate that population abundance is low. Steelhead distribution is currently restricted to the mainstem Sacramento River downstream of Keswick Dam, the Feather River downstream of Oroville Dam, the American River downstream of Nimbus Dam, the Mokelumne River downstream of Comanche Dam, and a number of smaller tributaries to the Sacramento River system, Delta, and San Francisco Bay. Low numbers of steelhead have also been reported from the San Joaquin River tributaries. The Central Valley steelhead population is composed of both naturally spawning steelhead and steelhead produced in hatcheries. NOAA Fisheries recently released the Central Valley Chinook Salmon and Steelhead Recovery Plan (NOAA Fisheries 2014).

Central Valley steelhead have a similar life history as described for other Pacific salmonids (above). The steelhead life cycle is characterized by a high degree of

[2] Migrate out of the freshwater environment/watershed to the marine environment.

flexibility (plasticity) in the duration of both their freshwater and marine rearing phases. The steelhead life cycle is adapted to respond to environmental variability in stream hydrology and other environmental conditions. Unlike Chinook salmon that die after spawning, adult steelhead may migrate downstream after spawning and return to spawn in subsequent years. Steelhead that do not migrate to the ocean, but spend their entire life in freshwater, are known as resident rainbow trout. Adult steelhead migrate upstream during the fall and winter (September through approximately February) with steelhead migration into the upper Sacramento River typically occurring during the fall and adults migrating into lower tributaries typically during the late fall and winter. Spawning typically occurs during the winter and spring (December - April) with the majority of spawning activity occurring during January and March. Downstream migration of steelhead smolts typically occurs during the late winter and early spring (January - May). The seasonal timing of downstream migration of steelhead smolts may vary in response to a variety of environmental and physiological factors including changes in water temperature, and in changes in stream flow and increased turbidity, resulting from stormwater runoff. Juvenile steelhead rear within the coastal marine waters for approximately two to three years before returning to their natal stream as spawning adults.

Central Valley steelhead are listed as a threatened species under the Federal Endangered Species Act. Steelhead are not listed for protection under the California Endangered Species Act but are identified as a species of concern.

South-Central and Central California Coast Steelhead The current range of Central California Coast (CCC) steelhead includes all naturally spawned populations of steelhead in coastal streams from the Russian River to Aptos Creek, and the drainages of San Francisco, San Pablo, and Suisun Bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin Rivers; and tributary streams to Suisun Marsh including Suisun Creek, Green Valley Creek, and an unnamed tributary to Cordelia Slough (commonly referred to as Red Top Creek), exclusive of the Sacramento-San Joaquin River Basin of the California Central Valley. The South-Central California coast steelhead includes winter steelhead found in three tributaries of Monterey Bay: the Pajaro, Salinas, and Carmel Rivers. Also included are small streams of the Big Sur Coast and small intermittent streams of San Luis Obispo County, south to Point Conception (Moyle 2002). Designated critical habitat for CCC steelhead includes 1,465 miles of stream habitat in central coastal California as well as estuarine habitat in San Pablo and San Francisco Bays. Designated critical habitat for South-Central California coast steelhead includes 1,250 miles of stream habitat within the 30 watersheds this DPS occupies as well as 3 square miles of estuarine habitat associated with these watersheds.

South-Central and Central California Coast steelhead have a similar life history as described for other Pacific salmonids (above). The primary habitat requirements for coastal steelhead consists of shaded pools of small, cool, low-flow upstream reaches typical of the original steelhead habitat in the region. In addition, they can use warm water habitats below some dams or pipeline outfalls, where summer releases provide high summer flows and fast-water feeding habitat. Steelhead along the California coast enter coastal streams to spawn when winter storm events raise streamflows and breach the sandbars that form at the mouths of many streams during summer months. Increased streamflow during these large events also seems to provide cues that stimulate migration and allow better conditions for upstream fish passage (Moyle 2002). The complete season for potential upstream migration lasts from late October through the end of May, but the majority of the population (as observed in Waddell Creek) typically migrates between mid-December and mid-April (Shapovalov and Taft 1954). In Central California streams, steelhead typically rear for one or two years. Shapovalov and Taft (1954) observed that trout of all different ages migrated out of Waddell Creek throughout the year, but the majority migrated from April through June. This behavior is thought to be consistent for most coastal California populations native to other creek reaches as well.

Information on abundance and productivity trends for the naturally spawning component of the CCC steelhead DPS is extremely limited. Estimates of steelhead statewide show a reduction in numbers from 603,000 in the early 1960s to 240,000 to 275,000 in the 1980s (McEwan and Jackson 1996). It has been federally listed as Threatened since August 18, 1997 and was reaffirmed January 5, 2006.

Populations of South-Central California coast steelhead have declined from annual runs of approximately 25,000 spawning adults to fewer than 500 (NOAA Fisheries 2013). It has been federally listed as Threatened since August 18, 1997, and following a five-year review issued by NOAA Fisheries on December 7, 2011, it was concluded that this DPS should remain listed as Threatened. Critical habitat has been designated by NOAA Fisheries for this species.

Central Valley Fall/late Fall-Run Chinook Salmon Fall-run Chinook salmon are the most abundant species of Pacific Salmon inhabiting the Sacramento and San Joaquin river systems. Fall-run Chinook salmon are not listed for protection under either CESA or ESA. In addition to fall-run Chinook salmon the group of Pacific Salmon is comprised of late fall-run Chinook salmon (which are not listed under either ESA or CESA), spring-run Chinook salmon and winter-run Chinook salmon, which are discussed below. Although fall-run and late fall-run Chinook salmon are not listed for protection under ESA they are included in this analysis since the area of analysis includes habitat identified as EFH for Pacific salmon.

Although fall-run and late fall-run Chinook salmon inhabit a number of watersheds within the Central Valley for spawning and juvenile rearing, the largest populations occur within the mainstem Sacramento, Feather, Yuba, American, Mokelumne, Merced, Tuolumne, and Stanislaus rivers. Fall-run Chinook salmon, in addition to spawning in these river systems, are also produced in fish hatcheries located on the Sacramento, Feather, American, Mokelumne, and Merced rivers. Hatchery operations are intended to mitigate for the loss of access to upstream spawning and juvenile rearing habitat resulting from construction of dams and reservoirs within the Central Valley in addition to producing fall-run Chinook salmon as part of the ocean salmon enhancement program to support commercial and recreational ocean salmon fisheries. Fall-run Chinook salmon also support an inland recreational fishery.

Fall-run and late fall-run Chinook salmon have a similar life history as described for other Pacific salmon (above). Adult fall-run Chinook salmon migrate from the coastal marine waters upstream through San Francisco Bay, Suisun Bay, and the Delta during late summer and early fall (approximately late July to early December). Fall-run Chinook salmon spawning occurs between October and December with the greatest spawning activity occurring typically in November and early December. The success of fall-run Chinook salmon spawning is dependent, in part, on seasonal water temperatures. After incubating and hatching, the young salmon emerge from the gravel redd as fry. A portion of the fry population migrate downstream soon after emergence, where they rear within the lower river channels, Delta, and estuary, during the spring months. The remaining portion of juvenile salmon continue to rear in the upstream stream systems through the spring months, until they are physiologically adapted to migration into saltwater (smolting), which typically takes place between April and early June. A small proportion of the fall-run Chinook salmon juveniles may, in some systems, rear through the summer and fall months migrating downstream during the fall, winter, or early spring as yearlings. Adult Chinook salmon spawn at ages ranging from approximately two to five-years-old with the majority of adult fall-run Chinook salmon returning at age three. Chinook salmon, unlike steelhead, die after spawning.

In 1998 NOAA Fisheries proposed that Central Valley fall-run and late fall-run Chinook salmon be listed under ESA as a threatened species. Based upon further analysis, and public comment, NOAA Fisheries decided that fall-run and late fall-run Chinook salmon did not warrant listing but rather remain as a candidate species for further analysis and evaluation.

Central Valley Spring-Run Chinook Salmon Spring-run Chinook salmon were historically widely distributed and abundant within the Sacramento and San Joaquin river systems (Yoshiyama *et al.* 1998). The Central Valley spring-run Chinook salmon ESU has been reduced from an estimated 17 historical populations to only three extant natural populations with consistent spawning runs (on Mill, Deer, and Butte Creeks), which are tributaries to the Sacramento River. The ESU includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries in California, including the Feather River, as well as the Feather River Hatchery spring-run Chinook program. Designated critical habitat includes 1,158 miles of stream habitat within the Sacramento River basin as well as estuary habitat within the San Francisco-San Pablo-Suisun Bay complex (NOAA Fisheries 2007).

Spring-run Chinook salmon historically migrated upstream into the upper reaches of the mainstem rivers and tributaries for spawning and juvenile rearing. Construction of major dams and reservoirs on these river systems eliminated access to the upper reaches for spawning and juvenile rearing and completely eliminated the spring-run salmon population from the San Joaquin River system. Spring-run Chinook salmon abundance has declined substantially and the geographic distribution of the species within the Central Valley has also declined substantially. Spring-run spawning and juvenile rearing currently occurs on a consistent basis within only a small fraction of their previous geographic distribution, including populations inhabiting Deer, Mill, and Butte creeks, the mainstem Sacramento River, several other local tributaries on an intermittent basis, and the lower Feather River.

Spring-run Chinook salmon have a similar life history as described for other Pacific salmon (above). Adult and juvenile spring-run Chinook salmon primarily migrate upstream and downstream within the mainstem Sacramento River. Adult spring-run Chinook salmon migrate upstream into the Sacramento River system during the spring months, but are sexually immature. Although the majority of adult spring-run Chinook salmon migrate upstream within the mainstem Sacramento River, there is a probability, although low, that adults may migrate into the Delta. Adult spring-run Chinook salmon hold in deep cold pools within the rivers and tributaries over the summer months prior to spawning. Spawning occurs during the late summer and early fall (late August through October) in areas characterized by suitable spawning gravels, water temperatures, and water velocities. Eggs incubate within the redds, emerging as fry during the late fall and winter. A portion of fry appear to migrate downstream soon after emerging where they rear within the lower river channels, and potentially within the Delta estuary, during winter and spring months. After emergence a portion of the spring-run Chinook salmon fry remain as residents in the creeks and rear for a period of approximately one year. The juvenile spring-run Chinook salmon that remain in the creeks migrate downstream as yearlings primarily during the late fall, winter and early spring with a peak yearling migration occurring in November (Hill and Weber 1999). Juvenile spring-run Chinook salmon may migrate from the Sacramento River into the interior Delta during their downstream migration and may occur within the central Delta, including the lower San Joaquin River, during the winter and early spring migration period. The downstream migration of both spring-run Chinook salmon fry and yearlings during the late fall and winter typically coincides with increased flow and turbidity associated with winter stormwater runoff.

A variety of environmental and biological factors have been identified that affect the abundance, mortality, and population dynamics of spring-run Chinook salmon. One of the primary factors that have affected population abundance of spring-run Chinook salmon has been the loss of access to historic spawning and juvenile rearing habitat within the upper reaches of the Sacramento River and its tributaries and San Joaquin River as a result of the migration barriers caused by construction of major dams and reservoirs. Operation of the Red Bluff Diversion Dam, which impedes adult upstream migration and vulnerability of juvenile spring-run Chinook salmon to predation mortality, has been identified as a factor affecting mortality within the river. Water temperatures within the rivers and creeks have also been identified as a factor affecting incubating eggs, holding adults, and growth and survival of juvenile spring-run Chinook salmon. Juvenile spring-run Chinook salmon are also vulnerable to entrainment at a large number of unscreened water diversions located along the Sacramento River and within the Delta in addition to entrainment and salvage mortality at the SWP and CVP export facilities. In recent years a number of changes have been made to improve the survival and habitat conditions for spring-run Chinook salmon. Several large previously unscreened water diversions have been equipped with positive barrier fish screens. Changes to ocean salmon fishing regulations, and modifications to SWP and CVP export operations have also been made to improve the survival of both adult and juvenile spring-run Chinook salmon. Improvements in fish passage facilities have also been made to improve migration and access to Butte Creek. These changes and management actions, in combination with favorable hydrologic and oceanographic conditions in recent years, are thought to have contributed to the trend of increasing abundance of adult spring-run Chinook salmon returning to spawn in Butte Creek and other habitats within the upper Sacramento River system in recent years.

Spring-run Chinook salmon are listed as a threatened species under both CESA and ESA. Recent genetics studies have shown that spring-run like Chinook salmon returning to lower Feather River are genetically similar to fall-run Chinook salmon. Hybridization between spring-run and fall-run Chinook salmon, particularly on the Feather River where both stocks are produced within the Feather River hatchery, is a factor affecting the status of the spring-run salmon population. NOAA Fisheries is in the process of developing a recovery plan for Central Valley spring-run Chinook salmon.

Sacramento River Winter-Run Chinook Salmon The Sacramento River winter-run Chinook Salmon ESU includes all naturally spawned populations in the Sacramento River and its tributaries as well as two artificial propagation programs; winter-run Chinook salmon from the Livingston Stone National Fish Hatchery winter-run Chinook salmon in a captive broodstock program maintained at the same hatchery (NOAA Fisheries 2007). Designated critical habitat includes the Sacramento River from Keswick Dam to Chipps Island in the Delta as well as portions of San Francisco Bay.

Winter-run Chinook salmon historically migrated into the upper tributaries of the Sacramento River for spawning and juvenile rearing. With the construction of Shasta and Keswick dams, winter-run salmon no longer had access to historic spawning habitat within the upper watersheds. As a result of migration blockage, spawning and juvenile rearing habitat for winter-run Chinook is limited to the mainstem Sacramento River downstream of Keswick Dam. During the mid-1960s, adult winter-run Chinook salmon returns to the Sacramento River were relatively high (approximately 80,000 returning adults). However, the population declined substantially during the 1970s and 1980s. The population decline continued until

1991 when the adult winter-run Chinook salmon population returning to the Sacramento River was estimated to be less than 200 fish. As a result of the substantial decline in abundance, the species was listed as endangered under both the CESA and ESA. During the mid- and late- 1990s the numbers of adult winter-run salmon returning to the Sacramento River gradually increased and the trend of increasing abundance continues to be present.

Winter-run Chinook salmon have a similar life history as described for other Pacific salmon (above). Adult winter-run salmon migrate upstream through San Francisco Bay, Suisun Bay, and the Delta during the winter and early spring months with peak migration occurring during March (Moyle 2002). Adult winter-run Chinook salmon migrate upstream within the Sacramento River with the majority of adults spawning in the reach upstream of Red Bluff. Winter-run Chinook salmon spawn within the mainstem of the Sacramento River in areas where gravel substrate, water temperatures, and water velocities are suitable. Spawning occurs during the spring and summer (mid-April through August; Moyle 2002). Egg incubation continues through the fall months. Juvenile winter-run Chinook salmon rear within the Sacramento River throughout the year. Juvenile winter-run salmon (smolts) migrate downstream through the lower reaches of the Sacramento River, Delta, Suisun Bay, and San Francisco Bay during the winter and early spring as they migrate from the freshwater spawning and juvenile rearing areas into the coastal marine waters of the Pacific Ocean. The Sacramento River mainstem is the primary upstream and downstream migration corridor for winter-run Chinook salmon. Juvenile winter-run Chinook salmon may migrate from the Sacramento River into the lower reaches of channels within Suisun Marsh during their downstream migration. The migration timing of juvenile winter-run Chinook salmon varies within and among years in response to a variety of factors including increases in river flow and turbidity resulting from winter storms, but generally occurs between early-winter through late-spring months. Environmental and biological factors that affect the abundance, mortality, and population dynamics of winter-run Chinook salmon are similar for those described for spring-run Chinook salmon (above).

Winter-run Chinook salmon are listed as an endangered species under both the CESA and ESA. As with other Chinook salmon stocks, NOAA Fisheries is continuing to evaluate the status of the winter-run Chinook salmon population and the effectiveness of various management actions implemented within the Sacramento River, Delta, and ocean to provide improved protection and reduced mortality for winter-run salmon, in addition to providing enhanced habitat quality and availability for spawning and juvenile rearing. NOAA Fisheries has prepared a draft recovery plan for winter-run Chinook salmon.

Federal and State Listed Non-Salmonids

Delta Smelt Delta smelt are endemic to the Delta estuary and inhabit the freshwater portions of the Delta, lower reaches of the Sacramento and San Joaquin rivers, and the low-salinity portions of Suisun Bay. Critical habitat for delta smelt has been designated by USFWS within the Sacramento–San Joaquin River system.

Delta smelt are a relatively small species (two to four inches long) with an annual life cycle, although some individuals may live two years. Adult delta smelt migrate upstream into channels and sloughs of the Delta (e.g., lower Sacramento River in the vicinity of Decker Island and Rio Vista) during winter to prepare for spawning. Delta smelt live their entire life cycle within the Delta estuary. Juveniles and adults typically inhabit open waters of the Delta. Spawning occurs between February and July; peak spawning occurs during April through mid-May (Moyle 2002). Females deposit adhesive eggs on substrates such as gravel and sand. Eggs hatch, releasing planktonic larvae that are passively dispersed downstream by river flow. Larval and juvenile delta smelt rear within the estuary for a period of about six to nine months before beginning their upstream spawning movement into freshwater areas of the lower Sacramento and San Joaquin rivers. They also have been known to move downstream into Napa River during high flows; sometimes they do not move at all if the western end of Suisun Bay freshens; they have also been known inhabit Suisun Marsh.

Delta smelt experienced a general decline in population abundance over the past several decades leading to their listing as a threatened species under both ESA and CESA. In March 2006, a petition seeking to relist delta smelt as an endangered species was submitted to the USFWS. The proposal to elevate the listing status remains under review and USFWS has, as yet, not acted on the petition. In June 2007, the California Fish and Game Commission accepted a petition to uplist delta smelt from threatened to endangered status under CESA. This action is currently under review.

North American Green Sturgeon North American green sturgeon are large, bottom-dwelling, anadromous fish that are widely distributed along the Pacific coast of North America. These sturgeon are the most broadly distributed, wide ranging, and marine-oriented species of the sturgeon family; however, they are not very abundant in comparison to white sturgeon. San Francisco Bay, San Pablo Bay, Suisun Bay, the Delta, and the Sacramento River support the southernmost reproducing population of green sturgeon. Critical habitat for green sturgeon has not been designated.

Habitat requirements of green sturgeon are poorly understood, but spawning and larval ecologies are probably similar to those of white sturgeon. Indirect evidence indicates that green sturgeon spawn mainly in the upper reaches of Sacramento River (e.g., Colusa to Keswick Dam). They are slow growing and late maturing, spawning every three to five years between March and July. Adult fish spawn in fresh water and then return to estuarine or marine environments. Preferred spawning habitat occurs in large rivers that contain large cobble in deep and cool pools with turbulent water (Moyle 2002; Adams et al. 2002). Larval and juvenile green sturgeon may rear for up to 2 years in fresh water and then migrate to an estuarine environment, primarily during summer and fall.

They remain near estuaries at first, but may migrate considerable distances as they grow larger (Moyle 2002).

Both adult and juvenile North American green sturgeon are known to occur in the lower reaches of the San Joaquin River and in the south Delta. Juveniles have been captured in the vicinity of Santa Clara Shoals and Brannan Island State Recreation Area, and in the channels of the south Delta (NOAA Fisheries 2006). The occurrence of green sturgeon in fishery sampling and CVP/SWP fish salvage is extremely low. As a result, very little information is available on the habitat requirements, geographic distribution, or seasonal distribution of various life history stages of green sturgeon within the estuary. However, adults and juveniles have the potential to occur within the project area throughout the year.

The southern DPS of North American green sturgeon is listed as threatened under ESA and is a California species of special concern.

Longfin Smelt Longfin smelt are small, planktivorous fish species found in several Pacific coast estuaries from San Francisco Bay to Prince William Sound, Alaska. Longfin smelt can tolerate a broad range of salinity concentrations, ranging from fresh water to seawater (The Bay Institute [TBI] 2007). Spawning is believed to occur in the lower reaches of the Sacramento River (downstream of Rio Vista). Spawning is also thought to occur in the eastern portion of Suisun Bay and larger sloughs within Suisun Marsh. Historically, spawning probably occurred in the lower San Joaquin Rivers (TBI 2007). Spawning may take place as early as November and may extend into June. The majority of spawning occurs between January and March (TBI 2007). Adult longfin smelt are found mainly in Suisun, San Pablo, and San Francisco Bays, although their distribution is shifted upstream into the western Delta in years of low outflow (Baxter 1999; Moyle 2002).

Like delta smelt, longfin smelt spawn adhesive eggs in river channels of the eastern estuary, and after hatching their larvae are carried downstream (planktonic drift) to nursery areas by freshwater outflow. In contrast to delta smelt, longfin smelt juveniles and adults are broadly distributed and inhabit the more saline regions of the Delta estuary and nearshore coastal waters. During non-spawning periods longfin smelt are most often concentrated in Suisun, San Pablo, and North San Francisco Bay (Baxter 1999; Moyle 2002). The easternmost catch of longfin smelt in FMWT samples has been at Medford Island in the central Delta. A measurable portion of the longfin smelt population consistently survives into a second year. During the second year of life, the adult longfin smelt inhabit San Francisco Bay and occasionally have been found in nearshore ocean surveys (Rosenfield and Baxter 2007). Therefore, longfin smelt are often considered anadromous (SWRCB 1999).

Longfin smelt is an ESA candidate species for listing and a CESA threatened species.

Other Species of Ecological Concern

Hardhead Hardhead are large cyprinids typically found in undisturbed areas of larger middle- and low-elevation streams between the Pit River in the north and Kern River in the south and are widely distributed in streams of the Sacramento–San Joaquin drainage (Moyle 2002). Generally these fish are bottom feeders that forage for benthic invertebrates and aquatic plant material as well as drifting insects and algae. All life stages are omnivores though the juvenile and adult fish have a slightly different diet and tooth structure for feeding. The young typically feed on mayfly and caddisfly larvae, as well as small snails, while the diets of the older individuals typically includes a higher concentration of aquatic plants, crayfish, and larger invertebrates. In a lake environment, hardhead may also feed on zooplankton. Hardhead mature after their second year and presumably spawn from May through June in Central Valley streams, although the spawning season is thought to extend into August in the foothill streams of the Sacramento–San Joaquin drainage (Moyle 2002).

Within stream habitats, hardhead tend to prefer warmer temperatures than salmonids and they are often found associated with pikeminnows and suckers. Optimal temperatures for hardhead range from 24 to 28 degrees Celsius, though they cannot tolerate low dissolved oxygen levels (Moyle 2002). Therefore the hardhead minnow is usually found in clear deep streams with a slow but present flow.

Most hardhead reach sexual maturity at 3 years and may live up to 9 or 10 years. They generally spawn in the spring between April and May, although could extend into the summer months as late as August. In small drainages hardhead tend to spawn near their resident pools, while fish in larger rivers or lakes often move up to approximately 20 or 50 miles to find suitable spawning grounds. Though spawning may occur in pools, runs, or riffles, the bedding area will typically be characterized by gravel and rocky substrate. Females usually produce 7,000 to 24,000 eggs per year, though some fisheries biologists believe that the eggs may take two years to develop within the female (Moyle 2002). Upon hatching, young larval hardhead remain under vegetative cover along stream or lake margins. As the juveniles grow they may move to deeper water or be swept downstream to larger rivers below.

Hardhead do not currently have an ESA or CESA listing, but are a California species of special concern.

Sacramento Splittail Sacramento splittail are large minnow endemic to the Delta estuary. Once found throughout low-elevation lakes and rivers of the Central Valley from Redding to Fresno, these fish now occur in the lower reaches of the Sacramento and San Joaquin Rivers and tributaries, Suisun and Napa Marshes, the Sutter and Yolo bypasses, and the tributaries of north San Pablo Bay.

Splittail are well adapted for living in estuarine waters with fluctuating salinity conditions. Adults and sub-adults have an unusually high tolerance for saline waters up to 18 parts per thousand (ppt), for a member of the minnow family. The species is relatively long-lived (five to seven years), and matures at the end of the first year (males) or third year (females). As is typical of a fish species evolved in a highly variable riverine system, juvenile abundance fluctuates annually depending on spawning success. Spawning, which seems to be triggered by increasing water temperatures and day length, occurs from February through July in the Delta, upstream tributaries, Napa Marsh, Napa, and Petaluma rivers, Suisun Bay and Marsh, and the Sutter and Yolo bypasses (Baxter et al. 1996; Meng and Moyle 1995; Sommer et al. 1997). Spawning, egg incubation, and juvenile rearing occur primarily in seasonally inundated floodplains on submerged vegetation. Juvenile splittail may occur in shallow and open waters of the Delta and Suisun Bay, but are most abundant in the northern and western Delta (Sommer et al. 2001). Adults migrate upstream to spawn during high flows that inundate floodplain spawning habitat. This habitat consists of vegetation temporarily submerged by flooding of riparian and upland habitats.

Young-of-the-year splittail abundance appears to fluctuate widely from year to year. Young splittail abundance declined substantially during the 1987 to 1992 drought (Baxter et al. 1996). In recent years, indices of juvenile splittail abundance have continued to fluctuate substantially among years (Sommer et al. 1997). In contrast to young splittail, adult abundance showed no obvious decline during the 1987 to 1992 drought (Sommer et al. 1997). The species' long lifespan and multiple year classes moderate adult population variation.

ESA protection for the splittail was petitioned in 1992 and proposed by the USFWS for in 1994, the agency delayed listing until a lawsuit was filed and a court ordered USFWS to take action. In 1999 the splittail was listed as a federally-threatened species. After litigation by water agencies challenging the listing, a court ordered the USFWS to review the status of the splittail. In 2003 the USFWS removed the splittail from the threatened species list, despite a strong consensus by scientists within the agency that the species should retain its protected status. In 2010, a 12-month finding on a petition to list the splittail was issued by USFWS and concluded that the species would not be listed. Currently, Sacramento splittail has no ESA or CESA listing and no delineated critical habitat.

River Lamprey River lamprey is an anadromous species widely distributed along the Pacific coast from Northern California to Alaska. This species been captured mostly in the upper portion of the Sacramento–San Joaquin estuary and its tributaries.

Adults migrate from the ocean upstream into fresh water in fall and spawn during winter or spring in small tributary streams. The lifespan of river lamprey is about six or seven years (Moyle 2002). River lamprey ammocoetes (larvae) are morphologically similar to those of the Pacific lamprey. This similarity, coupled with their overlapping distributions, makes positive identification of ammocoetes very difficult. The ammocoetes, transforming adults, and newly transformed adults have been collected in plankton nets in Suisun Bay, Montezuma Slough, and Delta sloughs. The presence of river lamprey in collections made above dams, such as on upper Sonoma Creek, indicates that some river lamprey may spend their entire life in fresh water.

River lamprey has become uncommon in California, and it is likely that the populations are declining because the Sacramento, San Joaquin, and Russian rivers and their tributaries have been severely altered by dams, diversions, pollution, and other factors. Two tributary streams where spawning has been recorded in the past (Sonoma and Cache Creeks) are both severely altered by channelization, urbanization, and other problems (Moyle 2002).

River lamprey is a federal species of concern and a California species of special concern.

California / San Joaquin Roach California roach are small, thick-bodied fish found throughout the Sacramento-San Joaquin river drainage, including the Pit River and tributaries to Goose Lake in Oregon. In coastal drainages, they are native to the Navarro, Gualala, and Russian rivers; streams tributary to Tomales Bay, Pescadero Creek and, in the Monterey Bay drainage, San Lorenzo, Pajaro, and Salinas rivers (Moyle 2002). The Sacramento-San Joaquin roach, a distinct population within the California roach “complex” (Moyle 2002), is found within the Sacramento and San-Joaquin River drainages, except Pit River, as well as tributaries to San Francisco Bay. They are commonly found in small to medium sized foothill rivers and their present distribution is confined to rivers upstream of large Central Valley reservoirs or tributaries that are not affected by the CVP or SWP operations. Consequently, California roach are not included in the analysis of effects.

Sacramento Perch Sacramento perch are a CDFW Species of Special Concern and were historically abundant predators throughout the Central Valley of California, where they occupied sloughs, lakes, and slow moving rivers. Today they are rare in their native waters, but may still exist in Clear Lake, as well as in some farm ponds and reservoirs (Crain and Moyle 2011). They have been widely introduced throughout California including in Owens Lake, the upper Klamath basin, upper Pit River watershed and Walker River watershed, (Moyle 2002). The only two native populations that were present in the area of analysis were in the Alameda Creek drainage, and are currently thought to be extirpated (Crain and Moyle 2011). These habitats would not be affected by any change in CVP or SWP operations for allocation of agricultural and M&I supplies. Consequently, Sacramento perch are not included in the analysis of effects.

10.2 Environmental Consequences

10.2.1 Assessment Methods

This section describes the assessment methods used to analyze potential effects of the alternatives on biologic aquatic resources, including the No Action Alternative. Detailed information on the alternatives considered for analysis is provided in Chapter 2.

The CalSim II model was used to provide average monthly river flow, monthly reservoir storage and elevation, exports, and Delta parameters (Delta outflow, location of X2, and south of Delta [SOD] exports through the CVP and SWP Delta facilities) for the alternatives. For each parameter, a monthly average by water year type was calculated for each year in the 1922 to 2003 period, including all the years combined (long-term monthly average). Reservoirs were analyzed using end-of-month water surface elevation and storage. River conditions were assessed using average monthly flows while the Delta was evaluated using average monthly outflow and average monthly SOD Diversions. See Appendix B, Water Operations Model Documentation, for details on the CalSim II documentation and model results.

Delta Simulation Model-2 (DSM2) was used to calculate the average monthly location of X2 measured along the mid channel line as kilometers east from the Golden Gate. The CalSim II and DSM2 model results allow for comparisons between the proposed alternatives, and provide a relative description of the changes that would be expected to occur with potential implementation of the alternatives. Additional detail on the parameters used for this analysis is provided below. See Appendix C, Delta Water Quality Model Documentation, for details on the DSM2 documentation and model results.

10.2.1.1 Reservoir Storage and Elevation

The proposed alternatives could alter storage and water surface elevations for the reservoirs within the area of analysis. Changes to storage and elevation in Trinity and Shasta lakes and Lake Oroville are very small and are discussed in Chapter 3. The habitat attributes and fisheries resources of these reservoirs are described above. The timing and duration of storage fluctuation can have an impact on the reproductive success of nearshore spawning fishes. Stable or increasing storage during spring months (March through June) can contribute to increased reproductive success, young-of-year production, and juvenile growth. Reduced or variable storage related to reservoir drawdown during spring spawning months can cause reduced spawning success for warm-water fishes through nest dewatering, egg desiccation, and physical disruption of spawning or nest-guarding activities.

A positive relationship exists between mean water surface elevation and amount of littoral habitat in the reservoirs. For reservoirs, higher mean water surface elevations were assumed to provide more littoral habitat, therefore, more warm water juvenile fish-rearing habitat. Cold water fish habitat occurs in the lower layers of project reservoirs, when they are thermally stratified (generally May through October).

River Flows Flows provide physical habitat for a variety of fish species and migratory corridors for anadromous fish species, including Chinook salmon, steelhead, and striped bass. The effect of flow on habitat is highly variable by stream, due to morphologic and hydrologic differences. The change in magnitude and duration of flows between alternatives could indicate changes in potential fish habitat.

Total Delta Outflow Total Delta outflow is the net amount of water (not including tidal flows) at a given time flowing out of the Delta toward the San Francisco Bay. It provides an indicator of freshwater flow passing through the Delta and habitat conditions farther downstream in the San Pablo Bay and central San Francisco Bay. Delta outflow affects salinity gradients in these downstream aquatic habitats and the geographic distribution and abundance of various fish and macroinvertebrates.

X2 Position X2 is the distance from the Golden Gate Bridge to the 2 ppt near-bottom salinity isohaline. The X2 location has been identified as an important indicator of estuarine habitat conditions in the Delta system. The position of X2 in Suisun Bay during the February through June period (locations less than about 74 kilometers from the Golden Gate) is thought to be directly or indirectly related to the reproductive success and survival of the early life stages of a number of estuarine species. Results of statistical regression analyses suggest that the abundance of several estuarine species is greater when the X2 position during spring occurs in the western portion of Suisun Bay and that abundance is lower in those years when the X2 position is farther to the east, near the confluence between the Sacramento and San Joaquin rivers.

Old and Middle River Reverse Flows Reverse flows in Old and Middle rivers, resulting from low San Joaquin River inflows and increased exports to the CVP and SWP, have been identified as a potential cause of increased delta smelt mortality at the CVP and SWP fish facilities within recent years (Simi and Ruhl 2005, Ruhl et al. 2006; USFWS 2008; NOAA Fisheries 2009). Results of analyses of the relationship between the magnitude of reverse flows in Old and Middle rivers and salvage of adult delta smelt in the late winter shows a substantial increase in salvage as reverse flows exceed approximately -5,000 cubic feet per second (cfs). Concerns regarding reverse flows in Old and Middle rivers have also focused on planktonic egg and larval stages of striped bass, splittail, and on Chinook salmon smolts, in addition to delta smelt, and while these species do not spawn to a significant extent in the south Delta, eggs and larvae may be transported into the area by reverse flows in Old and Middle rivers.

SOD Water Deliveries SOD water deliveries are measured as the amount of water diverted from the south Delta to the CVP and SWP canals for delivery to SOD water contractors. Changes in diversions to achieve the deliveries are an indicator of potential for direct and indirect fish losses. An increase in these deliveries (achieved by exports) would indicate a potential increase in the risk of fish entrainment and salvage mortality at the CVP and SWP export facilities.

10.2.2 Alternative 1: No Action Alternative

The No Action Alternative includes the most likely future conditions in the absence of the project. The No Action Alternative represents continued implementation of the 2001 Draft M&I WSP.

10.2.2.1 Sacramento River Division

Under the No Action Alternative, CVP deliveries would change compared to existing conditions based on population growth and changes in land use. The minor changes in river flow would not have an appreciable or observational effect on aquatic resources as compared to existing conditions.

Sacramento River below Keswick Sacramento River flows below Keswick would experience minor changes in flows under the No Action Alternative when compared to existing conditions. The greatest changes would occur in dry and critical water years, shown in Tables 10-2 and 10-3, respectively.

Table 10-2. Long-term Average Monthly Flow in the Sacramento River below Keswick in Dry Years under the No Action Alternative compared to Existing Conditions

Month	Existing Conditions (cfs)	No Action Alternative (cfs)	Difference	
			cfs	%
Oct	5787	5702	-85	-1
Nov	5668	5442	-246	-4
Dec	4113	3941	-172	-4
Jan	4016	3897	-119	-3
Feb	3702	3753	51	1
Mar	3734	3745	11	0
Apr	5764	5717	-47	-1
May	7292	7333	-41	-1
Jun	11204	11281	77	1
Jul	13473	13398	-75	-1
Aug	9901	9647	-254	-3
Sep	5471	5385	-86	-2

Table 10-3. Long-term Average Monthly Flow in the Sacramento River below Keswick in Critical Years under the No Action Alternative compared to Existing Conditions

Month	Existing Conditions (cfs)	No Action Alternative (cfs)	Difference	
			cfs	%
Oct	5795	5552	-243	-4
Nov	5215	5097	-118	-2
Dec	3766	3683	-83	-2
Jan	3449	3453	4	0
Feb	3883	3881	-2	0
Mar	3467	3482	15	0
Apr	6591	6389	-202	-3
May	6867	6858	-9	0
Jun	10481	10451	-30	0
Jul	12618	12264	-354	-3
Aug	9347	9160	-187	-2
Sep	4698	4619	-79	-2

In dry water years, flows would slightly decrease in November-January and August, but are about the same in all other months. The largest reduction in flow occurs in November and December with a four percent decrease compared to existing conditions. In critical water years, flows slightly decrease in October, April, and July, but are about the same in all other months. The largest reduction is a four percent decrease in October compared to existing conditions. While modeled flows slightly decrease in both dry and critical water year types, this decrease is within normal operational variation and is not likely to result in any discernible biological effect on fish or aquatic habitat. Flows in the Sacramento River would not drop below minimum flow requirements for the protection of winter-run spawning, rearing and migration within the upper Sacramento River, 3,200 cfs at Keswick Dam from October 1 to March 31 (NOAA Fisheries 1993, NOAA Fisheries 2004).

Sacramento River at Wilkins Slough Sacramento River flows at Wilkins Slough would experience minor changes in flows under the No Action Alternative when compared to existing conditions in dry and critical water years. The relative change in flows would be less than five percent in all months except August of dry water years and July of critical years which would have a seven percent decrease in flow. This decrease is within normal operational variation and is not likely to result in any discernible biological effect on fish or aquatic habitat. Flows in the Sacramento River would not drop below minimum flow requirements.

Sacramento River at Hood Sacramento River flows at Hood would experience minor changes in flows under the No Action Alternative when compared to existing conditions in dry and critical water years. The relative change in flows would be less than 5 percent in all months except September of dry water years which would have a 6 percent decrease in flow, and July and August of critical water years, which would have a 6 percent and 10 percent decrease respectively. These decreases are within normal operational variation and are not likely to result in any discernible biological effect on fish or aquatic habitat, especially in July and August in this section of the Sacramento River and would not result in flows dropping below minimum requirements.

10.2.2.2 American River Division

Under the No Action Alternative, CVP deliveries would change compared to existing conditions based on population growth and changes in land use. The changes in reservoir storage and river flow in dry and critical water years could cause storage and river flow impacts to aquatic resources in the American River Division; however, minimum flow requirements protective of aquatic resources would be met.

Folsom Lake Storage and Elevation Folsom Lake would experience minor variations in storage and water surface elevation when compared to existing conditions under the No Action Alternative. The greatest changes would occur in both dry and critical water years, shown in Tables 10-4 and 10-5, respectively.

Table 10-4. Long-term End of Month Average Storage in Dry Water Years in Folsom Lake under the No Action Alternative compared to Existing Conditions

Month	Existing Conditions (thousand acre-feet [TAF])	No Action Alternative	
		Difference (TAF)	% Change
Oct	469	-8	-2
Nov	445	-12	-3
Dec	453	-15	-3
Jan	450	-15	-3
Feb	506	-11	-2
Mar	599	1	0
Apr	704	-1	0
May	771	4	0
Jun	713	-10	-1
Jul	548	-10	-2
Aug	474	-10	-2
Sep	451	-12	-3

Table 10-5. Long-term End of Month Average Storage in Critical Water Years in Folsom Lake under the No Action Alternative compared to Existing Conditions

Month	Existing Conditions (TAF)	No Action Alternative	
		Difference (TAF)	% Change
Oct	421	-7	-2
Nov	371	-2	0
Dec	352	-5	-2
Jan	338	-5	-2
Feb	354	-6	-2
Mar	415	-3	-1
Apr	451	-4	-1
May	464	0	0
Jun	430	-7	-2
Jul	345	-3	-1
Aug	262	27	10
Sep	236	24	10

In dry water years Folsom Lake storage would be about the same compared to existing conditions in all months. In critical water years, storage would be about the same in most months but would increase by 10 percent in August and September compared to existing conditions. During critical years the increase during August and September would result in two percent increase in storage or eight-foot increase in elevation. The changes in modeled reservoir elevation and are within normal operational fluctuations of the reservoir. The relatively small changes are unlikely to have a biological effect on the cold or warm water fishery in the reservoir.

American River Flows below Nimbus   When compared to existing conditions, the No Action Alternative would result in minor changes to flows in the American River as modeled below the Nimbus Dam as compared to existing conditions. The greatest changes would occur in both dry and critical water years, shown in Tables 10-6 and 10-7, respectively.

Table 10-6. Long-term Average Monthly Flow in the American River below Nimbus in Dry Years under the No Action Alternative compared to Existing Conditions

Month	Existing Conditions (cfs)	No Action Alternative	
		Difference (cfs)	% Change
Oct	1553	19	1
Nov	2006	-10	-1
Dec	1745	-34	-2
Jan	1651	-9	-1
Feb	1962	-133	-7
Mar	2252	-229	-10
Apr	1999	-120	-6
May	1945	-226	-12
Jun	2419	-36	-2
Jul	3554	-361	-10
Aug	2317	-275	-12
Sep	1660	-200	-12

Table 10-7. Long-term Average Monthly Flow in the American River below Nimbus in Critical Years under the No Action Alternative compared to Existing Conditions

Month	Existing Conditions (cfs)	No Action Alternative	
		Difference (cfs)	% Change
Oct	1411	72	5
Nov	1953	-140	-7
Dec	1491	2	0
Jan	1308	2	0
Feb	1191	10	1
Mar	964	-53	-6
Apr	1112	-59	-5
May	1234	-110	-9
Jun	1710	-146	-9
Jul	1943	-332	-17
Aug	1937	-761	-39
Sep	1110	-143	-13

In dry water years, flows would be about the same or would decrease. Flows would decrease between 10 and 12 percent in March, May and July through September. In critical water years, flows would decrease between 5 and 9 percent in November and March through June and decrease 17 percent in July, 39 percent in August and 13 percent in September.

Flows in the lower American River are regulated by the Hodge Decision that changed the State Water Rights Board (SWRB Decision 893). The Hodge Decision has been amended by the Lower American River Flow Management Standard (Surface Water Resources Inc. [SWRI] 2004) and established the seasonal minimum flows. For October through May, the required flows could range from 800 to 2,250 cfs, depending on the water year type (SWRI 2004). From June through September, required flows would 800 to 1,750 cfs, but may vary depending on the water year type (SWRI 2004). From October through December, the required flow would be based on an index of the American River Basin carryover storage conditions (SWRI 2004).

Regardless of these modeled flow changes, minimum flow requirements for the protection of fisheries resources would control releases from Folsom Dam into the Lower American River. Under the No Action Alternative the flows would meet the minimum established flow requirements.

10.2.2.3 Delta Division

Under the No Action Alternative, changes to CVP deliveries compared to existing conditions in dry and critical years could cause changes in X2 position, Old and Middle River flows, total Delta outflow, and south of Delta diversions in the Delta Division; however, minimum requirements established to be protective of aquatic resources would be met.

Total Delta Outflow The No Action Alternative would result in changes to total Delta outflow compared to existing conditions. The greatest changes would occur in both dry and critical water years, shown in Tables 10-8 and 10-9, respectively.

Table 10-8. Long-term Average Monthly Total Delta Outflow in Dry Water Years under the No Action Alternative compared to Existing Conditions

Month	Existing Conditions (TAF)	No Action Alternative	
		Difference (TAF)	% Change
Oct	321	1	0
Nov	504	-3	-1
Dec	538	2	0
Jan	871	17	2
Feb	1173	0	0
Mar	1215	-15	-1
Apr	868	-4	0
May	653	-23	-4
Jun	397	3	1
Jul	308	3	1
Aug	246	8	3
Sep	220	-14	-7

Table 10-9. Long-term Monthly Average Total Delta Outflow in Critical Water Years under the No Action Alternative compared to Existing Conditions

Month	Existing Conditions (TAF)	No Action Alternative	
		Difference (TAF)	% Change
Oct	288	-1	0
Nov	375	-9	-2
Dec	342	14	4
Jan	653	34	5
Feb	729	13	2
Mar	726	6	1
Apr	537	-8	-1
May	379	-11	-3
Jun	319	0	0
Jul	249	2	1
Aug	219	11	5
Sep	179	0	0

During dry water years the modeled outflow would be about the same in every month except for September when there would be a seven percent reduction in outflow as compared to existing conditions. During critical water years, the modeled outflow would be about the same in every month. These predicted changes in Delta outflow are unlikely to result in a discernible effect to fish or aquatic habitats in the Delta due to their small changes in (less than five percent change in all months except September of dry water years). September is not a critical time period for sensitive fish in the Delta.

X2 Position When compared to existing conditions, the No Action Alternative would result in changes to the position of X2, as shown in Table 10-10.

Table 10-10. Long-term Average X2 Location in Dry and Critical Water Years under the No Action Alternative compared to Existing Conditions

Month	Dry Water Years		Critical Water Years	
	Existing Conditions (km)	No Action Alternative (change in km)	Existing Conditions (km)	No Action Alternative (change in km)
Oct	84	-0.092	88	-0.078
Nov	85	-0.055	89	0.004
Dec	85	0.015	89	0.174
Jan	83	-0.012	88	-0.100
Feb	78	-0.257	83	-0.683
Mar	70	-0.227	77	-0.561
Apr	67	0.077	75	-0.199
May	70	0.150	78	0.040

Month	Dry Water Years		Critical Water Years	
	Existing Conditions (km)	No Action Alternative (change in km)	Existing Conditions (km)	No Action Alternative (change in km)
Jun	74	0.412	83	0.244
Jul	80	0.205	86	0.135
Aug	85	-0.026	88	-0.015
Sep	88	-0.128	90	-0.188

During dry water years, X2 position would remain similar as compared to existing conditions. The largest shifts are predicted to occur in February and March, where X2 would shift an additional quarter of a kilometer east. In June, X2 would shift about half a kilometer west, and by July, the position would be about a quarter kilometer west compared to its location under existing conditions. During critical water years, changes to the position of X2 show a similar pattern. The largest shifts are predicted to occur in February and March, but X2 would shift an additional half a kilometer east and about a quarter kilometer east in April. In June, X2 would shift about a quarter kilometer west, and by July would be about a tenth of a kilometer west compared to its location under existing conditions. All these movements are relatively small shifts in predicted X2 position. During February of dry years, the X2 location (KM 78) is already east of Chipps Island (KM 74) and an additional quarter mile east would not materially change habitat conditions in the Delta. By March X2 has moved west (KM 70) and an additional quarter mile shift to the east would neither materially change habitat conditions nor move X2 east of Chipps Island. During critical years, X2 is already well east of Chipps Island and the additional minor shift toward the east in February-April or the shifts to the west in June and July would not substantially change habitat conditions in the western Delta. Reclamation and DWR would operate the CVP and SWP to be compliant with regulatory requirements. Changes in operations would need to be in accordance with D-1641 and BO requirements, which require water quality requirements to be met at regulatory compliance points in the Delta and other locations to meet additional requirements for aquatic resources.

Old and Middle River Flows The No Action Alternative would result in changes to Old and Middle River flows compared to existing conditions. The greatest decreases in flows would occur in February (10 percent), March (14 percent), and May (17 percent) of wet water years, May (34 percent) of below normal water years, and April (14 percent) and May (11 percent) of dry water years compared to existing conditions. While some of the modeled decreases in flows are relatively high, all of the changes would be within the range of operational variability and actual changes would not exceed reverse flow criteria developed to be protective of aquatic resources.

SOD Water Deliveries SOD water deliveries, as measured by total Delta exports in CalSim II, are an indicator of the potential for direct and indirect fish losses, with increases in the exports indicating a potential increase in the risk of fish entrainment and salvage mortality at the CVP and SWP export facilities. As compared to existing conditions, the No Action Alternative would result in changes to the total exports through these facilities. The greatest changes would occur during dry and critical water years, shown in Tables 10-11 and 10-12, respectively.

Table 10-11. Long-term Average Total Delta Exports in Dry Water Years under the No Action Alternative compared to Existing Conditions

Month	Existing Conditions (TAF)	No Action Alternative	
		Difference (TAF)	% Change
Oct	395	-11	-3
Nov	382	-4	-1
Dec	567	19	3
Jan	400	2	0
Feb	328	-1	0
Mar	288	-4	-1
Apr	124	-6	-5
May	111	-2	-2
Jun	180	0	0
Jul	676	-37	-5
Aug	474	-42	-9
Sep	567	-37	-6

Table 10-12. Long-term Average Total Delta Exports in Critical Water Years under the No Action Alternative compared to Existing Conditions

Month	Existing Conditions (TAF)	No Action Alternative	
		Difference (TAF)	% Change
Oct	378	-15	-4
Nov	293	1	1
Dec	424	1	0
Jan	348	-5	-1
Feb	271	4	1
Mar	191	4	2
Apr	106	-7	-7
May	105	-10	-10
Jun	64	-3	-5
Jul	379	-49	-13
Aug	246	-62	-25
Sep	261	-14	-5

During dry water years, increased total exports are predicted to slightly increase in December, with little change or no decrease in all other months. During critical water years increased total exports are predicted to increase slightly in November, February, and March, with little change or decreases in all other months. Important periods for entrainment occur during delta smelt and longfin smelt migration, spawning and larval transport periods (January-April or May) and the Chinook salmon and steelhead outmigration (February-May). Other species can be entrained at any time of the year, but entrainment of green sturgeon, salmon and steelhead is limited by operation response to incidental take limits. Should any of the take limits be encroached upon, CDFW, NOAA Fisheries, and USFWS would coordinate with Reclamation on export operations to avoid exceeding take limits. As a result, the predicted changes to water deliveries to SOD contractors are not likely to result in a discernible effect associated with the risk of fish entrainment and salvage mortality at the CVP and SWP export facilities. Decreases in exports modeled in July and August of critical water years could have some beneficial effects on summer fish entrainment and mortality at the export facilities.

10.2.3 Alternative 2: Equal Agricultural and M&I Allocation

10.2.3.1 Sacramento River Division

Providing equal allocations to agricultural and M&I water service contractors would result in very small changes in river flow and would not have an appreciable or observational effect on aquatic resources as compared to the No Action Alternative.

Sacramento River flows below Keswick would experience minor changes in flows under Alternative 2 as compared to the No Action Alternative (Alternative 1). The changes would be greatest in dry and critical water years, shown in Tables 10-13 and 10-14, respectively.

Table 10-13. Long-term Average Monthly Flow in the Sacramento River below Keswick in Dry Years under Alternative 2 compared to the No Action Alternative

Month	No Action Alternative (cfs)	Alternative 2	
		Difference (cfs)	% Change
Oct	5703	-11	0
Nov	5422	-45	-1
Dec	3941	30	1
Jan	3896	26	1
Feb	3753	31	1
Mar	3745	1	0
Apr	5717	83	1
May	7252	117	2

Month	No Action Alternative (cfs)	Alternative 2	
		Difference (cfs)	% Change
Jun	11280	48	0
Jul	13398	-54	0
Aug	9647	332	3
Sep	5385	-91	-2

Table 10-14. Long-term Average Monthly Flow in the Sacramento River below Keswick in Dry Years under Alternative 2 compared to the No Action Alternative

Month	No Action Alternative (cfs)	Alternative 2	
		Difference (cfs)	% Change
Oct	5547	-5	0
Nov	5046	-52	-1
Dec	3673	-9	0
Jan	3501	49	1
Feb	3842	-39	-1
Mar	3485	3	0
Apr	6550	162	3
May	6908	50	1
Jun	10296	-154	-1
Jul	12215	-49	0
Aug	9064	-97	-1
Sep	4513	-105	-2

In dry and critical water years, flows would be about the same in all months as compared to the No Action Alternative. The largest change is a three percent increase in August of dry water years and a three percent increase in April of critical water years. Modeled flows changes are within normal operational variation and are not likely to result in any discernible biological effect on fish or aquatic habitat. Flows in the Sacramento River would not drop below minimum flow requirements for the protection of winter-run spawning, rearing and migration within the upper Sacramento River - 3,200 cfs at Keswick Dam from October 1 to March 31 (NOAA Fisheries 1993, NOAA Fisheries 2004).

Sacramento River at Wilkins Slough Sacramento River flows at Wilkins Slough would experience minor changes in flows under Alternative 2 as compared to the No Action Alternative in dry water years and critical water years. The relative change in flows would be less than five percent in all months except August of dry water years which would have a six percent increase in flow. Some minor beneficial effects on water temperature may occur as a result of this increase in flow.

Sacramento River at Hood Sacramento River flows at Hood would experience the same pattern of flow alteration as described above for the Sacramento River at Wilkins Slough. The relative change in flows would be less than five percent in all months except August of dry water years, which would have a six percent increase in flow.

10.2.3.2 American River Division

Providing equal allocations to agricultural and M&I water service contractors would result in changes in reservoir storage and river flow but would not be expected to have an appreciable or observational effect on aquatic resources as compared to the No Action Alternative.

Folsom Lake Storage and Elevation Folsom Lake would experience increases in storage and elevation as compared to the No Action Alternative under Alternative 2. The changes would be greatest in dry and critical water years, shown in Tables 10-15 and 10-16, respectively.

Table 10-15. Long-term Average Storage in Dry Water Years in Folsom Lake under Alternative 2 compared to No Action Alternative

Month	No Action Alternative (TAF)	Alternative 2	
		Difference (TAF)	% Change
Oct	461	7	1
Nov	432	7	2
Dec	438	7	2
Jan	434	8	2
Feb	495	6	1
Mar	600	3	1
Apr	703	5	1
May	775	8	1
Jun	703	10	1
Jul	538	9	2
Aug	463	0	0
Sep	439	5	1

Table 10-16. Long-term Average Storage in Critical Water Years in Folsom Lake under Alternative 2 compared to No Action Alternative

Month	No Action Alternative (TAF)	Alternative 2	
		Difference (TAF)	% Change
Oct	415	12	3
Nov	369	12	3
Dec	347	10	3
Jan	333	10	3
Feb	348	12	3

Month	No Action Alternative (TAF)	Alternative 2	
		Difference (TAF)	% Change
Mar	411	15	4
Apr	447	20	5
May	464	25	5
Jun	423	33	8
Jul	342	31	9
Aug	289	24	8
Sep	260	25	10

In dry and critical water years under Alternative 2, storage would slightly increase as compared to the No Action Alternative in all months. The modeled changes in reservoir storage may have slight positive effects on warm water fisheries although the effect is likely to be very small or indiscernible because the relative increase in elevation would be small (maximum six-foot increase during September of critical water year), and is within the normal range of operational variability of the reservoir elevation. The minor increases are not likely have a measurable effect on the cold pool storage.

American River Flows below Nimbus Compared to the No Action Alternative, Alternative 2 would result in relatively small changes to average monthly flows in the American River as modeled below the Nimbus Dam. The changes would be greatest in dry and critical water years, shown in Tables 10-17 and 10-18, respectively.

Table 10-17. Long-term Average Monthly Flow in the American River below Nimbus in Dry Years under Alternative 2 compared to the No Action Alternative

Month	No Action Alternative (cfs)	Alternative 2	
		Difference (cfs)	% Change
Oct	1572	-7	0
Nov	1996	21	1
Dec	1711	18	1
Jan	1642	10	1
Feb	1829	65	4
Mar	2022	70	3
Apr	1878	49	3
May	1719	22	1
Jun	2382	51	2
Jul	3192	118	4
Aug	2042	225	11
Sep	1461	-16	-1

Table 10-18. Long-term Average Monthly Flow in the American River below Nimbus in Critical Years under Alternative 2 compared to the No Action Alternative

Month	No Action Alternative (cfs)	Alternative 2	
		Difference (cfs)	% Change
Oct	1483	15	1
Nov	1812	34	2
Dec	1493	60	4
Jan	1309	41	3
Feb	1201	1	0
Mar	911	2	0
Apr	1052	3	0
May	1123	5	0
Jun	1564	-25	-2
Jul	1611	149	9
Aug	1177	203	17
Sep	968	51	5

In both dry and critical water years flows would slightly increase under Alternative 2 in most months of the year as compared to the No Action Alternative. In general, the relative changes are small and are unlikely to have a measureable effect on habitat conditions within the river. In July and August during both dry and critical water years the increases are greater (up to 17 percent in August of critical water years), and there may be a positive effect when compared to the No Action Alternative. Changes to flows under Alternative 2 are within the normal operational variations of the river and would also be managed to meet the flow and temperature requirements for operating the Lower American River.

10.2.2.3 Delta Division

Providing equal allocations to agricultural and M&I water service contractors in dry and critical years could cause changes in X2 position, Old and Middle River flows, total Delta outflow and south of Delta diversions in the Delta Division; however, minimum requirements established to be protective of aquatic resources would be met.

X2 Position The X2 position would be altered by less than 0.02 kilometer (200 meters) in any given month for both dry and critical water years when compared to the No Action Alternative. This difference would not have measurable effects on Delta habitat conditions. The X2 position would be essentially the same as for the No Action Alternative.

Old and Middle River Flows Alternative 2 would result in changes to Old and Middle River flows as compared to the No Action Alternative. The greatest decreases would occur in August of dry water years (eight percent) and July and August of critical water years (seven percent and eight percent, respectively) as compared to the No Action Alternative. Changes in all other months and water years would be less than five percent. All of these changes would be within the range of operational variability and actual changes would not exceed criteria developed to be protective of aquatic resources.

Total Delta Outflow Alternative 2 would result in changes to total Delta outflow as compared to the No Action Alternative. The changes would be greatest in dry and critical water years, shown in Tables 10-19 and 10-20, respectively.

Table 10-19. Long-term Average Monthly Total Delta Outflow in Dry Water Years under Alternative 2 compared to the No Action Alternative

Month	No Action Alternative (TAF)	Alternative 2	
		Difference (TAF)	% Change
Oct	322	1	0
Nov	501	-5	-1
Dec	540	3	1
Jan	888	2	0
Feb	1173	4	0
Mar	1199	3	0
Apr	864	6	1
May	630	6	1
Jun	400	0	0
Jul	310	1	0
Aug	254	9	3
Sep	206	7	4

Table 10-20. Long-term Average Total Delta Outflow in Critical Water Years under Alternative 2 compared to the No Action Alternative

Month	No Action Alternative (TAF)	Alternative 2	
		Difference (TAF)	% Change
Oct	287	5	2
Nov	366	-1	0
Dec	356	3	1
Jan	687	8	1
Feb	742	2	0
Mar	732	1	0
Apr	529	10	2
May	368	12	3
Jun	320	3	1
Jul	251	-2	-1
Aug	231	-12	-5
Sep	179	1	0

In both dry and critical water years total Delta outflow would change only slightly under Alternative 2 in most months of the year as compared to the No Action Alternative. The predicted changes in Delta outflow are small, and are not likely to have a measurable effect on fish or aquatic habitats in the Delta.

SOD Water Deliveries SOD water deliveries, as measured by total delta exports, are an indicator of the potential for direct and indirect fish losses, with increases in the exports indicating a potential increase in the risk of fish entrainment and salvage mortality at the CVP and SWP export facilities. The changes would be greatest in dry and critical water years, shown in Tables 10-21 and 10-22, respectively.

Table 10-21. Long-term Average Total Delta Exports in Dry Water Years under Alternative 2 compared to the No Action Alternative

Month	No Action Alternative (TAF)	Alternative 2	
		Difference (TAF)	% Change
Oct	384	1	0
Nov	378	7	2
Dec	585	0	0
Jan	401	0	0
Feb	327	2	1
Mar	284	0	0
Apr	118	0	0
May	109	0	0
Jun	180	0	0
Jul	639	11	2
Aug	431	40	9
Sep	530	11	2

Table 10-22. Long-term Average Total Delta Exports in Critical Water Years under Alternative 2 compared to the No Action Alternative

Month	No Action Alternative (TAF)	Alternative 2	
		Difference (TAF)	% Change
Oct	363	1	0
Nov	294	5	2
Dec	425	12	3
Jan	342	1	0
Feb	275	0	0
Mar	195	-1	-1
Apr	99	0	0
May	95	0	-1

Month	No Action Alternative (TAF)	Alternative 2	
		Difference (TAF)	% Change
Jun	60	0	0
Jul	330	28	8
Aug	184	17	9
Sep	247	5	2

Minor changes to SOD deliveries are predicted to occur in 11 of 12 months for dry water years and 10 of 12 months for critical water years. In August of dry water years, SOD deliveries would increase by nine percent. In August and September of critical water years, SOD deliveries would increase by eight and nine percent, respectively. These predicted changes in water deliveries to SOD contractors are relatively small in relation to the total exports for any given month and may not actually occur in practice due to SWP and CVP operational criteria to protect fish. For most of the months the differences are unlikely to result in a discernible effect associated with the risk of fish entrainment and salvage mortality at the CVP and SWP export facilities. Under Alternative 2, in August of both dry and critical water years and in September of critical water years, total Delta exports are predicted to increase by up to nine percent, an increase of this magnitude could lead to a small increase in fish entrainment and salvage mortality, when compared to the No Action Alternative; however, August and September are not critical periods for fish entrainment and actual operations would be informed by real-time decision making to comply with standards and criteria developed for fish protection.

10.2.4 Alternative 3: Full M&I Allocation Preference

10.2.4.1 Sacramento River Division

Providing increased CVP deliveries to M&I water service contractors under Alternative 3 would result in very small changes in river flow and would not have an appreciable or observational effect on aquatic resources as compared to the No Action Alternative.

Sacramento River flows below Keswick, at Wilkins Slough, and at Hood would experience minor changes in flows under Alternative 3 when compared to the No Action Alternative. The greatest changes would occur in dry and critical water years. The relative changes would be less than four percent in all months in both water year types, would not likely to result in a discernible effect on fish or aquatic habitat, and would not result in flows dropping below minimum flow requirements.

10.2.4.2 American River Division

Providing increased CVP deliveries to M&I water service contractors under Alternative 3 would result in changes in reservoir storage and river flow, but would not be expected to have an appreciable effect on aquatic resources as compared to the No Action Alternative because actual operations would be required to meet operational criteria to protect fish and aquatic habitat.

Folsom Lake Storage and Elevation Folsom Lake would experience decreases in storage and elevation compared to the No Action Alternative as increased M&I water service contractor deliveries are being met by the reservoir. The changes would be greatest in critical water years, shown in Table 10-23. During dry water years, storage and elevation are similar under Alternative 3 when compared to the No Action Alternative with predicted changes less than one percent in all months.

Table 10-23. Long-term Average Storage in Critical Water Years in Folsom Lake under Alternative 3 compared to No Action Alternative

		Alternative 3	
Month	No Action Alternative (TAF)	Difference (TAF)	% Change
Oct	461	-7	-2
Nov	432	-10	-3
Dec	438	-11	-3
Jan	434	-13	-4
Feb	495	-12	-3
Mar	600	-8	-2
Apr	703	-8	-2
May	775	-6	-1
Jun	703	-6	-1
Jul	538	-9	-3
Aug	463	-7	-3
Sep	439	-9	-3

In critical water years, storage would be slightly less as compared to the No Action Alternative in all months. The modeled changes in reservoir storage would not be expected to have measurable effects on warm water fisheries because the relative decreases in elevation are small and would have a small effect on aquatic habitat (less than one percent decreases in elevation). Likewise, these decreases are not likely have a measurable effect on the cold pool storage. Changes to flows under Alternative 2 are within the normal operational variations of the river and would also need to meet the flow and temperature requirements for operating the Lower American River.

American River Flows below Nimbus As compared to the No Action Alternative (Alternative 1), Alternative 3 would result in changes to flows in the American River as modeled below the Nimbus Dam. The changes would be greatest in dry and critical water years, shown in Tables 10-24 and 10-25, respectively.

Table 10-24. Long-term Average Monthly Flow in the American River below Nimbus in Dry Years under Alternative 3 compared to the No Action Alternative

Month	No Action Alternative (cfs)	Alternative 3	
		Difference (cfs)	% Change
Oct	1572	-2	0
Nov	1996	13	1
Dec	1711	-3	0
Jan	1642	0	0
Feb	1829	-33	-2
Mar	2022	-56	-3
Apr	1878	-30	-2
May	1719	-32	-2
Jun	2382	-75	-3
Jul	3192	23	1
Aug	2042	-199	-10
Sep	1461	-64	-4

Table 10-25. Long-term Average Monthly Flow in the American River below Nimbus in Critical Years under Alternative 3 compared to the No Action Alternative

Month	No Action Alternative (cfs)	Alternative 3	
		Difference (cfs)	% Change
Oct	1483	30	2
Nov	1812	31	2
Dec	1493	2	0
Jan	1309	4	0
Feb	1201	-31	-3
Mar	911	-78	-9
Apr	1052	-59	-6
May	1123	-74	-7
Jun	1564	-51	-3
Jul	1611	3	0
Aug	1177	-75	-6
Sep	968	19	2

In both dry water years and critical water years flows are about the same for all months except for August when flows would be about 10 percent less. For critical years, flows are about the same in all months except they would decrease six to nine percent in March through May and August. Regardless of predicted operations, the system would be operated to maintain flows and temperatures that would meet required criteria and standards developed to be protective of fish. Flows and temperatures within the lower American River are regulated and managed by Reclamation between June 1 and October 15 for steelhead over-summer rearing (SWRI 2004).

10.2.4.3 Delta Division

Providing increased CVP deliveries to M&I water service contractors under Alternative 3 in dry and critical years could cause changes in X2 position, Old and Middle River flows, total Delta outflow and south of Delta diversions in the Delta Division; however, minimum requirements established to be protective of aquatic resources would be met.

X2 Location The X2 position would be changed by less than 0.25 km in any given month for both dry and critical water years when compared to the No Action Alternative and are within normal operational variations. This difference would not have measurable effects on fish or aquatic habitats in the Delta and effects on X2 position are essentially the same as compared to the No Action Alternative.

Old and Middle River Flows Alternative 3 would result in small changes to Old and Middle River flows as compared to the No Action Alternative. Changes in all months and water years would be less than five percent. All of the changes would be within the range of operational variability and actual changes would not exceed criteria developed to be protective of aquatic resources.

Total Delta Outflow Alternative 3 would result in changes to total Delta outflow compared to the No Action Alternative in both dry and critical water years. The predicted changes in Delta outflow are small (less than five percent in all months), and are within normal operational variations and are not likely to have a measurable effect on fish or aquatic habitats in the Delta.

SOD Water Deliveries Alternative 3 would result in minor changes to SOD water deliveries, as measured by total Delta exports. As compared to the No Action Alternative, changes in the total exports through these facilities during dry and critical water years are small (less than five percent in all months), and are within normal operational variability and are unlikely to result in a discernible effect associated with the risk of fish entrainment and salvage mortality at the CVP and SWP export facilities.

10.2.5 Alternative 4: Updated M&I WSP

Implementation of the Updated M&I WSP would not change effects to aquatic resources. CVP deliveries to both agricultural and M&I water service contractors would be the same as under the No Action Alternative; therefore, aquatic resources effects generated by Alternative 4 would be identical to the aquatic resources effects of the No Action Alternative.

10.2.6 Alternative 5: M&I Contractor Suggested WSP

10.2.6.1 Sacramento River Division

Implementation of Alternative 5 would result in very small changes in river flow and would not have an appreciable or observational effect on aquatic resources as compared to the No Action Alternative.

Sacramento River flows below Keswick, at Wilkins Slough, and at Hood would experience minor changes in flows under Alternative 5 when compared to the No Action Alternative in all water years. The relative increases or decreases are predicted to be less than one percent in all months in all water year types, would not likely to result in a discernible effect on fish or aquatic habitat, and would not result in flows dropping below minimum flow requirements.

10.2.6.2 American River Division

Implementation of Alternative 5 would result in very small changes in reservoir storage and river flow and would not have an appreciable or observational effect on aquatic resources as compared to the No Action Alternative.

Folsom Lake Storage and Elevation During all water years, storage and elevation are similar under Alternative 5 as compared to the No Action Alternative with predicted changes of less than one percent in all months.

American River Flows below Nimbus During all water years flows in the American River are similar under Alternative 5 as compared to the No Action Alternative with predicted changes less than one percent in all months.

10.2.6.3 Delta Division

Implementation of Alternative 5 would result in very small changes in X2 position, total Delta outflow and south of Delta diversions and would not have an appreciable or observational effect on aquatic resources as compared to the No Action Alternative.

X2 Location The position of X2 would be changed by less than 0.01 kilometer (10 meters) in any given month for both all water years when compared to the No Action Alternative. This difference would not have measurable effects on fish or habitats in the Delta and effects on X2 position are essentially the same as compared to the No Action Alternative.

Old and Middle River Flows Alternative 5 would result in small changes to Old and Middle River flows as compared to the No Action Alternative. Changes in all months and water years would be less than one percent. All of the changes would be within the range of operational variability and actual changes would not exceed criteria developed to be protective of aquatic resources.

Total Delta Outflow Alternative 5 would have similar total Delta outflow compared to the No Action Alternative in all water years. The predicted changes in Delta outflow are small (less than one percent in all months), and are not likely to have a measurable effect on fish or aquatic habitats in the Delta.

SOD Water Deliveries Alternative 5 would have similar total Delta exports as compared to the No Action Alternative with predicted changes in the total exports through these facilities during dry and critical water years less than one percent in all months. Any difference would be unlikely to result in a discernible effect associated with the risk of fish entrainment and salvage mortality at the CVP and SWP export facilities.

10.3 Mitigation Measures

Mitigation measures are not necessary because the minor changes in reservoir storage, river flow, and Delta conditions that would result from the alternatives would not have an appreciable or observational effect on aquatic resources.

10.4 Unavoidable Adverse Impacts

None of the action alternatives would result in unavoidable adverse impacts to aquatic resources.

10.5 Cumulative Effects

The timeframe for this cumulative effects analysis extends to 2030. Any alternative selected for implementation may be in place until 2030; therefore, any effects of the M&I WSP that would contribute to cumulative impacts would occur within this timeframe. Any cumulative projects or actions that would not occur until after 2030 are not considered in this cumulative effects analysis. The following section analyzes the cumulative effects using the project method, which is further described in Chapter 20, Cumulative Effects Methodology. Chapter 20 describes the projects included in the cumulative condition. The cumulative analysis considers projects and conditions that could affect aquatic resources within the area of analysis.

Several cumulative actions are in the preliminary stages of planning and have not completed environmental documents. While it can be argued that these actions are reasonably foreseeable because they have issued notices in the Federal Register and may have completed scoping meetings, some do not have sufficient information available to determine potential effects. These actions are described in Chapter 10.6.1 below but may not be included in the cumulative impact analysis if there is not enough information to determine potential environmental effects and how they would combine with effects of the M&I WSP.

The analysis of every past action that may have affected aquatic resource is not possible or required. Past projects were mainly identified as part of the affected environment for aquatic resources and are considered as part of the cumulative condition.

Changes associated with CVP deliveries to agricultural and M&I water service contractors under Alternatives 2, 3, 4 and 5 would have little to no effect on aquatic resources in Trinity and Shasta lakes and Lake Oroville. The average monthly reservoir storage levels in these lakes would vary from zero to two percent across dry and critical water year types for all months and all alternatives. The other projects identified with the potential to contribute to the cumulative condition, including the Bay Delta Conservation Plan (BDCP) and the Shasta Lake Water Resources Investigation, have the potential to impact reservoir levels in Shasta Lake. The BDCP could potentially result in reduced average storage elevations with increased south-of-Delta export for all the reservoirs. The Shasta Lake Water Resources Investigation could generate the opposite effect on Shasta Lake with increased storage capacity and increase storage elevations as a result of a dam raise action. The additional storage could also result is reduced agricultural and M&I demand from Trinity Lake and Lake Oroville. Therefore, implementation of Alternative 2, 3, 4 or 5 in combination with these cumulative projects would not generate an adverse cumulative effect on the aquatic resources within these reservoirs.

10.5.1 Alternative 2: Equal Agricultural and M&I Allocation

Changes associated with Alternative 2 to Sacramento River flows downstream of Shasta Lake to the Delta would have little effect on aquatic resources in the Sacramento River. Impacts to Sacramento River from changes in flow would be minimal with changes ranging across dry and critical water year types for all months and range from decreases of up to two percent to increase of three percent when compared to the No Action Alternative. Cumulative projects identified with the potential to impact river flows include the Shasta Lake Water Resources Investigation. Under the Shasta Lake Water Resources Investigation project there could be increases or decreases in flow at certain times of the year. It is unlikely that a project would be approved that would substantially adversely affect flows along the Sacramento River because there are already policies in place to maintain specific river flow rates for fish and water supply concerns. Future projects along the river that could substantially affect flows are also unlikely to be approved due to the policies in place to manage specific river flows. Therefore, the effect of equal allocation of agricultural and M&I supplies on Sacramento River flows under Alternative 2 in combination would not generate an adverse cumulative effect on aquatic resources in the Sacramento River.

Changes associated with Alternative 2 to surface water storage in Folsom Lake would have little to no effect on aquatic resources. The average monthly reservoir levels in Folsom Lake would vary from no change to an increase of 10 percent when compared across dry and critical water year types for all months to the No Action Alternative. Cumulative projects identified with the potential to contribute to the cumulative condition under Alternative 2 include the BDCP, the Folsom Dam Safety and Flood Damage Reduction Project and Folsom Water Control Manual Update, the Remanded BOs on the Coordinated Long-Term Operations of the CVP and SWP, and Long Term Water Transfers. Under the Folsom Dam Safety and Flood Damage Reduction Project, there could be new rules developed for operating Folsom Lake that allow storage to encroach on the historical flood control space in the reservoir. BDCP and Remanded BOs could allocate more water from Folsom Lake to manage Delta conditions thereby reducing storage levels under certain conditions. Under the combined operating rules, inflows, storage levels, flood control, power production, downstream fish flows, and Delta conditions would need to be in compliance with permits and operating criteria governing the CVP and SWP. Consequently, substantial changes to storage in Folsom Lake are unlikely to occur solely from implementation of Alternative 2. Therefore, the impacts of Alternative 2 in combination would not generate an adverse cumulative effect on aquatic resources in Folsom Lake.

Changes associated with Alternative 2 in Lower American River flows downstream of Folsom Lake to the Sacramento River could affect aquatic resources in the Lower American River. Under Alternative 2, impacts to the Lower American River average monthly flows ranging across dry and critical water year types for all months ranged from a decrease of 2 percent to an increase of approximately 17 percent when compared to the No Action Alternative. Projects identified with the potential to contribute to the cumulative condition under Alternative 2 include the BDCP, the Folsom Dam Safety and Flood Damage Reduction Project and Folsom Water Control Manual Update, the Remanded BOs on the Coordinated Long-Term Operations of the CVP and SWP and Long Term Water Transfers. Under the Folsom Dam Safety and Flood Damage Reduction Project, there could be new rules developed for operating Folsom Lake that could allow more storage earlier in the winter and a reduced flood pool in the reservoir. This could affect flows into the Lower American River. BDCP and the Remanded BOs could allocate more water from Folsom to manage Delta conditions. Future projects that could substantially affect flows in the Lower American River would need to be consistent with the permit conditions and operating rules influencing management of Folsom Lake. Therefore Alternative 2 in combination would not generate an adverse cumulative effect on aquatic resources in the Lower American River.

Changes associated with Alternative 2 in the Delta Outflow, X2 position and South of Delta Exports could affect aquatic resources in the Delta. Under Alternative 2, impacts to X2 location are minimal a maximum shift of 0.02 km compared to the No Action Alternative in dry and critical years for all months. Under Alternative 2, impacts to average monthly Delta Outflow range from a decrease of 5 percent to an increase of 4 percent with six months showing no change and the remaining months ranging from -1 to 2 percent. The largest percent changes occur in the August and September which is not a critical time for listed species in the Delta. Under Alternative 2, impacts to average monthly South of Delta exports ranges from a decrease of one percent to an increase of nine percent. The largest increases of eight and nine percent occur in the months of July and August and neither month is an important time for listed fishes in the Delta. Projects identified with the potential to contribute to the cumulative condition under Alternative 2 include nearly every project listed in Chapter 21 as they all affect either flows into the Delta, habitat conditions in the Delta or SWRCB water quality objectives. The BDCP, North and South of Delta storage projects, the In-Delta Storage project, and other projects would affect the amount of water flowing into the Delta, flowing through the Delta or being diverted from the Delta. Under any of these projects there could be new rules developed for operating the CVP and SWP that could affect flows in the Delta. BDCP and the Remanded BOs could allocate more water to manage Delta conditions thereby reducing exports under certain conditions. Future projects that could substantially affect flows into or through the Delta would need to be consistent with the permit conditions and operating rules for flows, fishery protection, and water quality objectives in the Delta and Central Valley rivers. Therefore Alternative 2 in combination would not generate an adverse cumulative effect on aquatic resources in the Delta.

10.5.2 Alternative 3: Full M&I Allocation Preference

Changes associated with Alternative 3 to Sacramento River flows downstream of Shasta Lake to the Delta could affect aquatic resources in the Sacramento River. Under Alternative 3, impacts to Sacramento River from changes in flow include decreases of up to 10 percent to increases of one percent in dry and critical year types for all months when compared to the No Action Alternative. Cumulative projects identified with the potential to impact river flows are the same as for Alternative 2. These projects would be implemented to increase water for agriculture and municipal supplies. As storage projects are being planned and developed, these projects would need to go through an environmental analysis related to fisheries. It is unlikely that a project would be approved that would substantially affect flows along the Sacramento River because there are already policies in place to manage specific river flow rates for fish and water supply concerns. Future projects along the river that could substantially affect flows are also unlikely to be approved due to the policies in place to manage specific river flows. Therefore Alternative 3 in combination would not generate an adverse cumulative effect on aquatic resources in the Sacramento River.

Changes associated with Alternative 3 to surface water storage in Folsom Lake could affect aquatic resources. The average monthly reservoir levels in Folsom Lake would vary from a decrease of up to nine percent and an increase of up to two percent when compared to the No Action Alternative for dry and critical water year types for all months. Cumulative projects identified with the potential to contribute to the cumulative condition under Alternative 3 include the BDCP, the Folsom Dam Safety and Flood Damage Reduction Project and Folsom Water Control Manual Update, the Remanded BOs on the Coordinated Long-Term Operations of the CVP and SWP, and Long Term Water Transfers. Under the Folsom Dam Safety and Flood Damage Reduction Project, there could be new rules developed for operating Folsom Lake that allow storage to encroach on the historical flood control space in the reservoir. BDCP and Remanded BOs could allocate more water from Folsom Lake to manage Delta conditions thereby reducing storage levels under certain conditions. Future projects that could substantially affect storage in Folsom Lake are also unlikely to be approved due to the policies in place to manage storage volumes in the reservoir. Therefore Alternative 3 in combination would not generate an adverse cumulative effect on aquatic resources in Folsom Lake.

Changes associated with Alternative 3 in Lower American River flows downstream of Folsom Lake to the Sacramento River could affect aquatic resources in the Lower American River. Under Alternative 3, impacts to the Lower American River average monthly flows across dry and critical water year types for all months ranged from a decrease of 10 percent to an increase of approximately 2 percent when compared to the No Action Alternative. Projects identified with the potential to contribute to the cumulative condition are the same as for Alternative 2. Under the Folsom Dam Safety and Flood Damage Reduction Project, there could be new rules developed for operating Folsom Lake that could allow more storage earlier in the winter and a reduced flood pool in the reservoir. This could affect flows into the Lower American River. BDCP and the Remanded BOs could allocate more water from Folsom to manage Delta conditions thereby reducing storage levels under certain conditions. Future projects that could substantially affect storage in Folsom Lake are unlikely to be approved due to the policies in place to manage storage volumes in Folsom Lake. Therefore the effect of Alternative 3 in combination would not generate an adverse cumulative effect on aquatic resources in the Lower America River.

Changes associated with Alternative 3 in Delta Outflow, X2 position and South of Delta Exports could affect aquatic resources in the Delta. Under Alternative 3, impacts to X2 location is minimal, with a maximum shift of 0.25 km compared to the No Action Alternative in dry and critical years for all months. With the full allocation of M&I supplies under Alternative 3, impacts to average monthly Delta Outflow ranges from a decrease of 5 percent to an increase of 5 percent. With the full allocation of M&I supplies under Alternative 3, impacts to average monthly SOD exports ranges from a decrease of 5 percent to an increase of 5 percent. Projects identified with the potential to contribute to the cumulative condition are the same as Alternative 2 and include nearly every project listed as they all affect either flows into the Delta or habitat conditions in the Delta. The BDCP, North and South of Delta storage projects, the In-Delta Storage project, and other projects would affect the amount of water flowing into the Delta, flowing through the Delta or being diverted from the Delta. Under any of these projects there could be new rules developed for operating the Central Valley and State Water Projects that could affect flows in the Delta. BDCP and the Remanded BOs could allocate more water to manage Delta conditions thereby reducing exports under certain conditions. Future projects that could substantially affect flows into or through the Delta are unlikely to be approved due to the policies in place to manage conditions in the Delta and Central Valley rivers. Therefore the effect of full allocation of M&I supplies on the Delta flows under Alternative 3 in combination would not generate an adverse cumulative effect on aquatic resources in the Delta.

10.5.3 Alternative 4: Updated M&I WSP

Changes associated with the Updated M&I WSP allocations under Alternative 4 for aquatic resources would be the same as for the No Action Alternative for all Divisions.

10.5.4 Alternative 5: M&I Contractor Suggested WSP

Changes associated with the M&I Contractor Suggested WSP allocations under Alternative 5 to Sacramento River flows downstream of Shasta Lake to the Delta would have no effect on aquatic resources in the Sacramento River. Under Alternative 5, impacts to Sacramento River from changes in flow include decreases of up to one percent to increases of up to one percent in dry and critical year types for all months when compared to the No Action Alternative. Cumulative projects identified with the potential to impact river flows are the same as for Alternative 2. These projects would be implemented to increase water for agriculture and municipal supplies. As storage projects are being planned and developed, these projects would need to go through an environmental analysis related to fisheries. It is unlikely that a project would be approved that would substantially affect flows along the Sacramento River because there are already policies in place to manage specific river flow rates for fish and water supply concerns. Future projects along the river that could substantially affect flows are also unlikely to be approved due to the policies in place to manage specific river flows. Therefore the effect Alternative 5 in combination would not generate an adverse cumulative effect on aquatic resources in the Sacramento River.

Changes associated with Alternative 5 to surface water storage in Folsom Lake would have no effect on aquatic resources. The average monthly reservoir levels in Folsom Lake would vary less than one percent when compared to the No Action Alternative for dry and critical water year types for all months. Cumulative projects identified with the potential to contribute to the cumulative condition under Alternative 5 are the same as Alternative 2. Future projects that could substantially affect storage in Folsom Lake are unlikely to be approved due to the policies in place to manage storage volumes in the reservoir. Therefore the effect of Alternative 5 in combination would not generate an adverse cumulative effect on aquatic resources in Folsom Lake.

Changes associated with Alternative 5 in Lower American River flows downstream of Folsom Lake to the Sacramento River would have no effect aquatic resources in the Lower American River. Under Alternative 5, impacts to the Lower American River average monthly flows across dry and critical water year types for all months were less than one percent when compared to the No Action Alternative. Projects identified with the potential to contribute to the cumulative condition are the same as for Alternative 2. Under the Folsom Dam Safety and Flood Damage Reduction Project, there could be new rules developed for operating Folsom Lake that could allow more storage earlier in the winter and a reduced flood pool in the reservoir. This could affect flows into the Lower American River. BDCP and the Remanded BOs could allocate more water from Folsom to manage Delta conditions thereby reducing storage levels under certain conditions. Future projects that could substantially affect storage in Folsom Lake are unlikely to be approved due to the policies in place to manage storage volumes in Folsom Lake. Therefore the effect of Alternative 5 in combination would not generate an adverse cumulative effect on aquatic resources in the Lower American River.

Changes associated with Alternative 5 in Delta Outflow, X2 position and South of Delta Exports would have no effect on aquatic resources in the Delta. Under Alternative 5, impacts to X2 location is minimal, with a maximum shift of 0.01 km compared to the No Action Alternative in dry and critical years for all months. Under Alternative 5, impacts to average monthly Delta Outflow and SOD exports is less than one percent in all months for dry and critical water years. Projects identified with the potential to contribute to the cumulative condition are the same as Alternative 2 and include nearly every project listed in Chapter 21 as they all affect either flows into the Delta or habitat conditions in the Delta. The BDCP, North and South of Delta storage projects, the In-Delta Storage project, and other projects would affect the amount of water flowing into the Delta, flowing through the Delta or being diverted from the Delta. Under any of these projects there could be new rules developed for operating the CVP and SWP that could affect flows in the Delta. BDCP and the Remanded BOs could allocate more water to manage Delta conditions thereby reducing exports under certain conditions. Future projects that could substantially affect flows into or through the Delta are unlikely to be approved due to the policies in place to manage conditions in the Delta and Central Valley rivers. Therefore the effect of Alternative 5 in combination would not generate an adverse cumulative effect on aquatic resources in the Delta.

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Chapter 11
Terrestrial Resources

This chapter presents the existing terrestrial biological resources within the area of analysis and discusses potential effects on terrestrial biological resources from the proposed alternatives. Special-status terrestrial wildlife and plant species with the potential to occur in the area of analysis are identified and their general habitat associations summarized.

11.1 Affected Environment

The following section defines the area of analysis for assessing impacts on terrestrial biological resources from implementation of the proposed project and alternatives. It provides a description of the existing baseline biological conditions of each region of the area of analysis, including a discussion of terrestrial species with the potential to be affected by the alternatives. This section also provides an overview of the regulatory setting associated with terrestrial biological resources. The focus of this section will be on the natural and agricultural communities within each region and the terrestrial wildlife and plant species associated with these communities. Aquatic biological resources are discussed in Chapter 10, Aquatic Resources.

Special status species, for the purpose of this document, are either: 1) protected, or proposed for protection, under the federal Endangered Species Act (ESA); 2) protected, or proposed for protection, under the California Endangered Species Act (CESA); or 3) species that are considered sufficiently rare by the scientific community to qualify for such status. Additional federal regulations protecting special status species include the Fish and Wildlife Coordination Act of 1934 (as amended), the Bald Eagle and Golden Eagle Protection Act, and the Migratory Bird Treaty Act. Regulations related to the protection of special status species are discussed in more detail in the paragraphs that follow.

11.1.1 Area of Analysis

The area of analysis for terrestrial biological resources potentially affected by the action alternatives encompasses portions of four major geographic areas or regions of California: the Sacramento Valley region; the American River region; the Sacramento-San Joaquin River Delta (Delta) region; and the San Joaquin River Valley region. Agricultural habitats within these areas were modeled as the Sacramento Valley, San Joaquin River, and the Tulare Lake regions (see Chapter 11.2.1, Assessment Methods). Figure 11-1 depicts primary waterways in each of the regions and the three modeled agricultural areas. An overview description of the area of analysis is provided below, while a more detailed discussion of the sub-regions within the area of analysis is provided in Chapter 11.1.3.

Figure 11-1. Terrestrial Resources Area of Analysis

The Sacramento Valley region includes areas served by the Central Valley Project (CVP) from just north of the City of Sacramento to the Shasta Lake area. Counties included in this portion of the area of analysis include Butte, Colusa, Glenn, Sacramento, Shasta, Sutter, Tehama, Trinity, and Yolo.

The American River region includes service areas associated with the American River Division. Counties included in this portion of the area of analysis include El Dorado, Placer, and Sacramento.

The Delta region includes service areas associated with the eastern San Francisco Bay and the traditional Delta boundaries. Counties included in this portion of the area of analysis include Alameda and Contra Costa.

The San Joaquin Valley region includes areas south of the Delta, and east of the California Coast Ranges and west of the Sierra Nevada mountains. Counties included in this portion of the area of analysis include Fresno, Kings, Merced, San Joaquin (southern portion), and Stanislaus.

As discussed in Chapter 3, Resources Introduction, there are only relatively small changes to Shasta and Trinity lakes, Lake Oroville, and San Luis Reservoir as a result of the different agricultural and municipal and industrial (M&I) water service contractor CVP allocations in the alternatives. The changes in storage are a reasonable response of a complex system to different CVP allocation procedures and may not necessarily be specific responses to the different allocation schemes of one alternative versus another. The differences between all alternatives for CalSim II modeled water storage in Shasta Lake, Trinity Lake, Lake Oroville, and San Luis Reservoir are very small and range from zero to one percent. This is further discussed in Appendix B, Water Operations Model Documentation. These changes are within the range of existing operational variability. Because of the small changes in water surface elevation and storage, potential differences between alternatives to Shasta and Trinity lakes, Lake Oroville, and San Luis Reservoir will not be discussed further in this chapter.

11.1.2 Regulatory Setting

The following section describes the applicable laws, rules, regulations and policies relating to terrestrial biological resources.

11.1.2.1 Federal

Endangered Species Act The ESA grants protection over species that are formally listed as threatened, endangered, or proposed for listing. The primary protective requirement in the case of projects requiring federal permits, authorizations, or funding, is Section 7 of the ESA, which requires federal lead agencies to consult (or "confer" in the case of proposed species or proposed critical habitat) with the United States Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries) (where marine and anadromous fish species may be affected) to ensure that their actions do not jeopardize the continued existence of federally-listed species. In addition to Section 7 requirements, Section 9 of the ESA protects listed wildlife species from "take". Take is broadly defined as those activities that "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect [a protected species], or attempt to engage in any such conduct." USFWS regulations at 50 Code of Federal Regulations (CFR) §17.3 provide further definitions of harass and harm. Harass is defined as “an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering” (50 CFR §17.3). Harm is defined as “an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering” (50 CFR §17.3). The Bureau of Reclamation (Reclamation) is the lead federal agency responsible for consultation with the USFWS and NOAA Fisheries under Section 7 of the ESA. The ESA is described in more detail in Chapter 10.1.2.

11.1.2.2 State

California Endangered Species Act Pursuant to CESA and Section 2081 of the California Fish and Game Code, a permit from CDFW is required for a project that could result in the take of a state-listed threatened or endangered species (i.e., species listed under CESA). Under CESA, the definition of “take” includes an activity that would directly or indirectly kill an individual of a species, but the state definition does not include “harm” or “harass,” as the federal definition does. As a result, the threshold for take under the CESA is typically higher than that under the ESA. Under CESA, CDFW maintains a list of threatened species and endangered species (California Fish and Game Code 2070). The CDFW also maintains two additional lists: 1) a list of candidate species that are species CDFW has formally noticed as being under review for addition to either the list of endangered species or the list of threatened species; and 2) a list of “species of special concern;” these lists serve as “watch lists.”

California Native Plant Protection Act The California Native Plant Protection Act of 1977 (Fish and Game Code Sections 1900–1913) is intended to preserve, protect, and enhance endangered or rare native plants in California and gives the CDFW authority to designate state endangered, threatened, and rare plants and provides specific protection measures for identified populations.

California Fish and Game Code The California Fish and Game Code protects a variety of species from take. Certain species are considered *fully protected*, meaning that the code explicitly prohibits all take of individuals of these species except for take permitted for scientific research. It also is possible for a species to be protected under the California Fish and Game Code, but not fully protected.

California Native Plant Society The California Native Plant Society (CNPS) is a professional society of plant biologists, scientists, and associated professionals which has accumulated a statewide database on California native plants and their distributions. The CNPS has created five categorical rankings of plants to identify their respective concern for these species as potentially rare, threatened, or endangered species. These listings do not afford legal status or protection for these species, but the lists are used by agencies in their planning processes for activities that could affect the species or habitat. Vascular plants listed as rare or endangered by the CNPS (CNPS 2014) are defined as follows:

1. California Rare Plant Rank 1A – Plants presumed extinct in California
2. California Rare Plant Rank 1B – Plants rare, threatened, or endangered in California and Elsewhere
3. California Rare Plant Rank 2 – Plants rare, threatened, or endangered in California, but More Common Elsewhere
4. California Rare Plant Rank 3 – Plants about which we need more information – a review list
5. California Rare Plant Rank 4 – Plants of limited distribution – a watch list

In general, plants listed by CNPS as Rank 1A, 1B, or 2 meet the definition of section 1901, chapter 10 (Native Plant Protection Act) and sections 2062 and 2067 (CESA) of the California Fish and Game Code as rare or endangered species.

11.1.3 Existing Conditions

The following section describes the existing terrestrial biological conditions within the area of analysis. The broad terrestrial habitat types and general species assemblages within those habitat types are described to provide a general overview of terrestrial biological resources within the area of analysis. Only the habitat types that could potentially be affected by the alternatives are included. The area of analysis for terrestrial biological resources is broken down into four geographic regions to better describe the terrestrial habitat types found within these regions to allow a greater understanding of the spatial differences in habitat and associated terrestrial species within the area of analysis. Finally, the terrestrial special status species that could potentially be affected by the proposed project and alternatives are described.

11.1.3.1 Terrestrial Habitat Types in the Area of Analysis

Historically, the Central Valley, Delta, and the surrounding foothills contained a mosaic of riverine, wetland, and riparian habitat along rivers and streams with surrounding terrestrial habitats consisting of perennial grassland and oak and conifer woodland. With settlement of the Central Valley, agricultural and urban development converted land from native habitats to cultivated fields, pastures, residences, water impoundments, flood control structures, and other developments. As a result, native habitats generally are restricted in their distribution and size and are highly fragmented. Agricultural land comprises most of the area of analysis and includes row and field crops, rice, pasture, and orchards.

The types, amounts, and distribution of habitats in the service areas were derived primarily from the California Department of Forestry and Fire Protection, Fire and Resource Assessment Program (FRAP) (see Table 11-1). In FRAP, habitats were typed based on the California Wildlife Habitats Relationship System (CWHR) (Mayer and Laudenslayer 1988). This project focused on mapping habitats at a landscape scale. The database identifies general habitat types throughout the service areas but does not distinguish small habitat patches, such as patches of riparian habitat or small wetlands that can have high wildlife value. Where available, additional information is provided on the occurrence of important habitat types not distinguished in FRAP.

Table 11-1. Terrestrial Habitats in the Area of Analysis that may be Affected by the Alternatives

Division	Sacramento Valley	American River	Delta/Bay	San Joaquin Valley
Wetland Habitats				
Freshwater Emergent	X	X	X	X
Saline Emergent			X	X
Grasslands				
Annual Grassland	X	X	X	X
Shrub Habitats				
Mixed Chaparral	X	X		
Woodland Habitats				
Blue Oak	X	X	X	X
Blue Oak – Foothill Pine	X	X		X
Valley Oak	X	X	X	X
Montane Hardwood		X		
Valley Foothill Riparian	X	X	X	X
Conifer Forest	X	X		
Agricultural Habitats				
Irrigated Crops	X	X	X	X
Rice	X	X	X	X
Orchard and Vineyard	X	X	X	X
Other Habitats				
Urban	X	X	X	X
Barren	X	X	X	X

Freshwater Emergent Wetland Freshwater emergent wetlands occur in areas that are seasonally or perennially inundated. They form a transitional habitat between open water and upland habitats and occur in backwater areas of rivers, streams and lakes, and flood plains of rivers and streams. Freshwater emergent wetlands are characterized by erect rooted, herbaceous vegetation that emerges above the water surface. Water depths are generally shallow, up to about one to two feet. Common plant species include cattails (*Typha* sp.), bulrushes (*Scirpus* sp. and *Schoenoplectus* sp.), and rushes (*Juncus* sp.) (Mayer and Laudenslayer 1988).

Urban and agricultural development as well as hydrologic changes from flood control and water supply development has substantially decreased the amount of wetland habitat in the Central Valley. Because much of the wetland habitat in California has been developed into other land uses, several species associated with wetlands have been listed as threatened or endangered by USFWS and/or CDFW. In the 1940s, freshwater emergent wetlands occupied about 554,000 acres of the Central Valley (Frayer et al. 1989; Central Valley Habitat Joint Venture 1990). By 1990, only 86,704 acres remained. Regional reductions in freshwater emergent wetlands have been estimated at 88.7 percent in the Sacramento Basin, 96.2 percent in the San Joaquin Basin, 99.2 percent in the Tulare Basin, 98.3 percent in the Delta, and 97.2 percent in the San Francisco Bay area.

Wetlands provide important habitat for a variety of wildlife species, including waterfowl and other bird species (grebes, herons, egrets, bitterns, coots, shorebirds, rails, hawks, and owls), mammals including common muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), and American beaver (*Castor canadensis*), and reptiles and amphibians such as the common garter snake (*Thamnophis sirtalis*), aquatic garter snake (*Thamnophis atratus*), and Pacific treefrog (*Pseudacris regilla*). Many upland species such as ring-necked pheasant (*Phasianus colchicus*), California quail (*Callipepla californica*), and black-tailed jackrabbit (*Lepus californicus*) use the ecotone at the edge of wetlands for cover and forage (Mayer and Laudenslayer 1988).

The hydrology of many of the remaining wetlands has been altered from seasonal to permanent inundation. This change has altered plant communities and facilitated the invasion of introduced aquatic predators such as bullfrogs, bass, and sunfish. These species compete with or prey upon native listed species, including federally-listed species such as California red-legged frog (*Rana draytonii*) and giant garter snake (*Thamnophis gigas*).

Saline Emergent Wetland Saline emergent wetlands encompass salt and brackish water marshes. They occur along the margins of bays, lagoons and estuaries above intertidal sand and mud flats and below upland communities not subject to tidal action. Plant species composition and structure varies with the salinity, substrate and wave action. Characteristic plant species of more saline marshes are cordgrass (*Spartina foliosa*) and pickleweed (*Salicornia* sp.) while bulrushes and cattails occur in lower salinity marshes (Mayer and Laudenslayer 1988).

Only a small portion of the saline emergent wetlands that existed in the San Francisco Bay area in the mid-1800s remains. Many of the wetlands were dredged or filled in association with urban development. Runoff and discharges from urban and industrial development has also reduced and degraded wetlands. The suitability of the remaining wetlands for many species has been further limited, and in some cases precluded, by their small size, fragmentation, and lack of other habitat features.

Saline emergent wetlands, when intact and relatively unfragmented, provide important habitat for a variety of birds and mammals. Several species of lizards and snakes use marsh edges and a few amphibians can occur in brackish portions of these wetlands. Saline emergent wetlands provide important wintering and migratory stopover habitat for many birds, including waterfowl, herons, egrets, rails, and shorebirds. Several endemic bird subspecies inhabit saline emergent wetlands of the San Francisco Bay area including salt marsh yellowthroat (*Geothlypis trichas sinuosa*) and Belding's savannah sparrow (*Passerculus sandwichensis beldingi*). Common mammals that utilize saline emergent wetlands include shrews, bats, mice, and raccoons. Special-status species that use this habitat include California clapper rail (*Rallus longirostris*), California black rail (*Laterallus jamaicensis*), and salt marsh harvest mouse (*Reithrodontomys raviventris*) (Mayer and Laudenslayer 1988).

Annual Grassland Most grasslands in the analysis area are dominated by introduced annual grasses of Mediterranean origin and a mixture of native and introduced forbs. Common annual grassland plant species include wild oats (*Avena* spp.), soft chess (*Bromus hordeaceus*), ripgut brome (*Bromus diandrus*), red brome (*Bromus madritensis* ssp. *rubens*), and barley (*Hordeum* spp.). Annual native forbs also occur in annual grassland habitat and include filaree (*Erodium* spp.), California poppy (*Eschscholzia californica*), owl's-clover (*Castilleja* spp.), tarweed (*Holocarpha virgata*) and various lupines (*Lupinus* spp.). Yellow star-thistle (*Centaurea solstitialis*) is a noxious weed that has invaded many annual grassland habitats and degraded habitat quality for wildlife and livestock pasture. Annual grassland habitat intergrades with valley oak and blue oak woodlands, occurring where soil moisture is insufficient to support tree growth or is suppressed due to grazing (Mayer and Laudenslayer 1988).

Annual grassland habitats support a variety of birds, mammals, reptiles and amphibian species. Raptors, such as Swainson's hawk (*Buteo swainsoni*), ferruginous hawks (*Buteo regalis*), red-tailed hawks (*Buteo jamaicensis*), white-tailed kites (*Elanus leucurus*), American kestrel (*Falco sparverius*) and northern harriers (*Circus cyaneus*) commonly forage in annual grasslands. Short-eared owl (*Asio flammeus*) and burrowing owl (*Athene cunicularia*) forage and breed in this habitat. Horned larks (*Eremophila alpestris*), western meadowlarks (*Sturnella neglecta*), and savannah sparrows (*Passerculus sandwichensis*) are other common bird species observed in annual grassland habitats. Characteristic reptiles and amphibians include western fence lizard (*Sceloporus occidentalis*), common garter snake, and western rattlesnake (*Crotalus viridis*). Mammals that commonly use annual grassland habitat include black-tailed jackrabbits, California ground squirrels (*Spermophilus beecheyi*), California voles (*Microtus californicus*), badgers (*Taxidea taxus*), coyotes (*Canis latrans*), and Botta's pocket gophers

(*Thomomys bottae*). A number of special-status species use annual grassland habitat, including white-tailed kite, burrowing owl, prairie falcon (*Falco mexicanus*) (Mayer and Laudenslayer 1988), San Joaquin kit fox (*Vulpes macrotis mutica*), Fresno kangaroo rat (*Dipodomys nitratoides exilis*), and giant kangaroo rat (*Dipodomys ingens*).

Mixed Chaparral Mixed chaparral is a structurally homogeneous brushland habitat dominated by shrubs with thick, stiff, waxy evergreen leaves. This habitat type supports a wide diversity of woody plant species; though shrub height, crown cover, and vegetation composition vary with stand age (since last burn), precipitation regime, aspect, and substrate. Common mixed chaparral plant species include chemise (*Adenostoma fasciculatum*), redshank (*Adenostoma sparsifolium*), scrub oak (*Quercus berberidifolia*), ceanothus (*Ceanothus* spp.), manzanita (*Arctostaphylos* spp.), toyon (*Heteromeles arbutifolia*), and yerba-santa (*Eriodictyon californicum*). The upper and lower elevational limits of chaparral land cover varies considerably with precipitation, aspect and soil type, but typically occurs below 5,000 feet. Mixed chaparral merges with annual grassland and blue oak-foothill pine at lower elevations and with coastal oak woodland, ponderosa pine, or mixed conifer habitats at upper elevations (Mayer and Laudenslayer 1988).

No wildlife species are restricted to chaparral habitats. Common species occurring in mixed chaparral include western fence lizard, racer (*Coluber constrictor*), common garter snake, turkey vulture (*Cathartes aura*), red-tailed hawk, golden eagle (*Aquila chrysaetos*), mountain quail (*Oreortyx pictus*), ash-throated flycatcher (*Myiarchus cinerascens*), sage sparrow (*Amphispiza belli*), Virginia opossum, coyote, California ground squirrel, and black-tailed jackrabbit. No special-status species are dependent on this habitat type although several use chaparral habitats in addition to other habitats (Mayer and Laudenslayer 1988).

Blue Oak Woodland and Blue Oak-Foothill Pine Woodland Blue oak (*Quercus douglasii*) is the dominant overstory species of blue oak woodland and blue oak/foothill pine woodland. At higher elevations, foothill pine (*Pinus sabiniana*) becomes more dominant in the overstory. Where foothill pine or other conifers comprise 25 to 49 percent of the overstory with blue oak comprising at least 50 percent of the overstory canopy, the CWHR classifies this community as Blue oak/Foothill Pine woodland (Mayer and Laudenslayer 1988). Frequent fire favors blue oak (a long-lived stump sprouter) over foothill pine. Stands vary from open savannas with grassy understories (usually at lower elevations) to fairly dense woodlands with shrubby understories. Typical shrub species in blue oak woodland are poison-oak (*Toxicodendron diversilobum*), coffeeberry (*Frangula californica*), redbud (*Cercis occidentalis*), ceanothus, and manzanita with ground cover consisting of annuals such as bromegrass, wild oats, foxtail, and filaree (Mayer and Laudenslayer 1988).

Blue oak woodlands provide habitat for a diversity of wildlife species, although no species appear to be completely dependent on this habitat type. Verner and Boss (1980) state that 29 species of amphibians and reptiles, 57 species of birds, and 10 species of mammals find optimal breeding habitat conditions in mature stages of blue oak woodlands. Acorns produced by blue oaks are an important food resource for a diversity of bird and mammal species. Typical species inhabiting blue oak woodlands include western scrub jay (*Aphelocoma californica*), yellow-billed magpie (*Pica nuttalli*), gray squirrel (*Sciurus griseus*), and California ground squirrel. Special-status species associated with oak woodland habitats include oak titmouse (*Baeolophus inornatus*), Lawrence's goldfinch (*Spinus lawrencei*), and Nuttall's woodpecker (*Picoides nuttallii*).

Valley Oak Woodland Valley oak woodland is distributed throughout much of the Central Valley and into the Sierra Nevada foothills up to an elevation of about 2,000 feet. The overstory canopy of this habitat type is comprised of almost exclusively valley oak. Associated species include California sycamore (*Platanus racemosa*), black walnut (*Juglans californica*), interior live oak (*Quercus wislizeni*), boxelder (*Acer negundo*) and blue oak. Shrubs such as poison-oak, toyon, and coffeeberry occur in the understory although typically, the understory is comprised of annuals such as wild oats, bromegrass, barley, and rye grass (*Festuca* spp.) (Mayer and Laudenslayer 1988). Valley oak woodland merges with annual grasslands and often borders agricultural fields. Valley oak woodlands also often occur adjacent to riparian habitats along larger rivers and in small drainages. As distance from the watercourse increases, tree density declines, thus transitioning from a forest-like structure, to savanna-like to grassland.

Like other habitats containing oaks, valley oak woodland is used by a variety of wildlife species that use acorn as a food resource. Cavities formed in oak trees provide nesting opportunities and shelter for cavity-nesting birds and mammals. Common species inhabiting valley oak woodland include California quail, red-shouldered hawk (*Buteo lineatus*), acorn woodpecker (*Melanerpes formicivorus*), western scrub jay, bushtit (*Psaltriparus minimus*), gray squirrel, mule deer (*Odocoileus hemionus*), red-tailed hawk, and white-tailed kite. Special-status species associated with oak woodland habitats include oak titmouse, Lawrence's goldfinch, and Nuttall's woodpecker (Mayer and Laudenslayer 1988).

Montane Hardwood Montane hardwood forest occurs in eastern portions of the area of analysis at lower elevations than conifer forest communities, although it can be interspersed with ponderosa pine (*Pinus pondersosa*). This forest type is dominated by hardwood tree species including coastal live oak, California black oak (*Quercus kelloggii*), tanoak, and Pacific madrone, but often includes some conifers, such as foothill pine and ponderosa pine. Typical understory shrub species include manzanita, poison-oak, coffeeberry, currant (*Ribes* sp.), and ceanothus (Mayer and Laudenslayer 1988).

The oaks comprising montane hardwood forest habitat attract and support a diversity of bird and mammal species that use acorns as a food resource. Typical species include western scrub jay, acorn woodpecker, gray squirrel, wild turkey (*Meleagris gallopavo*), dusky-footed woodrat (*Neotoma fuscipes*), black bear (*Ursus americanus*), and mule deer. Reptiles are found in the litter on the forest floor and include western fence lizard, gopher snake (*Pituophis melanoleucus*), and western rattlesnake.

Valley Foothill Riparian Valley foothill riparian habitat occurs in the flood plains of low-gradient rivers and streams, typically as narrow bands of vegetation adjacent to freshwater reaches of permanent and seasonal watercourses. Dominant tree species include cottonwood (*Populus fremontii*), California sycamore, and valley oaks. Typical shrub species include willows (*Salix* spp.), elderberry (*Sambucus* sp.), and wild grape (*Vitis californica*) (Mayer and Laudenslayer 1988).

Valley foothill riparian forms a transitional community between the riverine environment and dry upland areas. The composition of riparian plant communities is shaped by the timing, intensity, and duration of flooding. Willows predominate in areas subject to regular inundation and quickly colonize newly deposited gravel bars or recently scoured areas. Cottonwoods occur farther from the river channel in areas subject to less frequent and intense flooding. Still, the persistence of cottonwoods is linked to the natural seasonal pattern of flows. Cottonwoods evolved to release seeds at the same time as high spring flows would deposit nutrient rich sediments where germination and seedling survival would be enhanced. Thus, the timing and intensity of flows is critical to the persistence of riparian vegetation. Flood control and water supply projects have resulted in hydrologic alterations that have changed the species composition, structure and extent of riparian habitats. In addition, most rivers have been channelized and are confined by levees which limit the area available to support riparian communities. As a result of these changes the extent of riparian land cover has been substantially reduced (Mayer and Laudenslayer 1988).

The structural and compositional diversity, abundant food resources, and availability of water in valley foothill riparian habitat make this habitat particularly valuable to wildlife. Wildlife species diversity is often higher in riparian habitats than in adjacent habitats. Many resident bird, amphibians, reptiles, and mammals breed in riparian habitats, while other species frequent this habitat in winter or during migration (Mayer and Laudenslayer 1988; Holland 1986). Special-status species associated with riparian habitats include the valley elderberry longhorn beetle (*Desmocercus californicus dimorphus*), Swainson's hawk, and western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) (Mayer and Laudenslayer 1988).

Conifer Forest There are several CWHR habitat types that are dominated by conifers in the area of analysis: Ponderosa pine, Sierran mixed conifer, Douglas-fir, Jeffrey pine, and redwood. Conifer forest habitats occur primarily in eastern portions of the area of analysis, in foothill and higher elevation areas of the Sierra Nevada Mountains. A small amount of conifer forest habitat also is present in the Coast Range in the western portion of the area of analysis. The species composition of the conifer forest habitat varies with elevation, soil composition, and rainfall. Conifer forest habitats occur at elevations as low as 2,500 feet in elevation. Ponderosa pine occurs at the lowest elevation where it can be interspersed with montane hardwood. At higher elevations, ponderosa pine is replaced by Sierran mixed conifer and Douglas-fir. Sierran mixed conifer habitat consists of a mix of five conifer species and one hardwood species - white fir (*Abies concolor*), Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine, sugar pine (*Pinus lambertiana*), incense-cedar (*Calocedrus decurrens*), and California black oak.

The Sierran mixed conifer habitat type occurs from about 4,000 to 10,000 feet in elevation in the area of analysis (Holland 1986) and grades with ponderosa pine and Douglas-fir habitats. In the Sierra Nevada, the Douglas-fir habitat is largely a subset of the Sierran mixed conifer type, where Douglas-fir occurs as a pure stand. Jeffery pine typically occurs at high elevations (above Sierran mixed conifer), but because it is tolerant of serpentine soils it occurs as pure stands in some areas of serpentine soils. A small amount of redwood forest occurs in the Coast Range in the western portion of the area of analysis. Redwood communities are dominated by redwoods (*Sequoia sempervirens*). Understory vegetation is usually dense, consisting of tall shrubs. Douglas-fir is a common associate.

Conifer forest habitat of the Sierra Nevada Mountains has been estimated to support about 355 species of vertebrates (Verner and Boss 1980). Mixed conifer forest typically supports greater species diversity than single-species conifer stands because of the greater plant species diversity. The variety in plant species composition of mixed conifer forest provides a diversity of food and cover types. Nonetheless, many wildlife species will exploit all of the conifer forest types to varying degrees. Special-status species potentially inhabiting conifer forest habitat in the area of analysis include California spotted owl (*Strix occidentalis occidentalis*), northern goshawk (*Accipiter gentilis*), Pacific fisher (*Pekania pennanti*), and bald eagle (*Haliaeetus leucocephalus*).

Cropland Cropland in the area of analysis consists of irrigated row crops, irrigated grain crops, and irrigated pasture. Diverse row crops are grown in the area of analysis including tomatoes, sugar beets, soy beans, alfalfa, melons, and other less common vegetable crops. Grain crops include barley, wheat, corn, and oats. Many of these grain crops are planted in fall and harvested in spring. Row and grain crops are intensively managed, and chemicals are often used to control pests and diseases.

The habitat value in cropland fluctuates with the crop production cycle. Most crops in California are annual species and are managed with a crop rotation system. During the year, several different crops may be produced on a given parcel of land. The habitat value of agricultural fields varies seasonally with changes in crop type as well as with the different stages of crop maturity.

The young green shoots of grain crops are used for foraging by greater white-fronted geese (*Anser albifrons*), tundra swan (*Cygnus columbianus*), and tule elk (*Cervus canadensis* ssp. *nannodes*). Other species, including red-winged blackbird (*Agelaius phoeniceus*), Brewer's blackbird (*Euphagus cyanocephalus*), ring-necked pheasant, waterfowl, and western harvest mouse (*Reithrodontomys megalotis*), feed on the seeds produced by these crops - foraging in fallow grain fields during the fall and winter months. Many species of rodents and birds are able to exploit croplands, which often may require intensive management through the use of various pesticides. Rodent species that are known to forage in row crops include the California vole, deer mouse (*Peromyscus maniculatus*), and the California ground squirrel. These rodent populations are preyed upon by Swainson's hawk, red-tailed hawk, and white-tailed kite.

Rice Cultivated rice in the Central Valley has some of the attributes found in seasonal wetlands. However, the intensive management of this habitat reduces many of the benefits found in natural wetlands. Flooded rice fields provide nesting and foraging habitat for waterfowl and shorebirds and rice grains provide important food source for many wildlife species. After harvest, waterfowl (e.g., mallards and Canada geese), sandhill crane (*Grus canadensis*), California voles, and deer mice feed upon the waste grain. Raptors, including northern harrier, white-tailed kite, and ferruginous hawk, feed upon rodents in this habitat. Irrigation ditches used to flood rice fields often contain dense cattail vegetation and provide suitable habitat for the Virginia rail (*Rallus limicola*), American bittern (*Botaurus lentiginosus*), snowy egret (*Egretta thula*), marsh wren (*Cistothorus palustris*), common yellowthroat, and song sparrow (*Melospiza melodia*) (Mayer and Laudenslayer 1988). In addition, the special-status giant garter snake inhabits rice fields in the Central Valley, foraging in flooded fields and adjacent irrigation ditches. The adjacent upland levees provide basking and upland refugia and hibernacula habitat for this species.

Orchard and Vineyard Orchard habitat consists of cultivated fruit or nut-bearing trees. Typically, they are open, tree-dominated habitats consisting of a single tree species. This habitat is planted in a uniform pattern and intensively managed. Understory vegetation is usually sparse; however, in some areas, grasses or forbs are allowed to grow between orchard rows to reduce erosion. Walnuts olives, and almonds are the primary orchard crops in the area of analysis and vineyards are primarily dedicated to wine grapes.

Orchards and vineyards provide limited resource opportunities for wildlife. Ground squirrels and other small mammals can inhabit understory areas and birds such as scrub jays may be seasonally attracted to fruit orchards. No special-status species rely on orchards or regularly use this habitat type (Mayer and Laudenslayer 1988).

Urban The structure of urban vegetation varies widely, including tree grove, street strip, shade tree/lawn, lawn, and shrub cover. Plant species composition also varies with planting design and climate. Typically, monoculture is observed in tree groves and street tree strips. A distinguishing feature of the urban habitat is the mixture of native and non-native species, both of which can be valuable to wildlife in providing a source of food in the form of fruits and berries (Mayer and Laudenslayer 1988).

Wildlife species diversity is extremely low in heavily developed urban settings (downtown) and progressively increases as the urban zones become less dense (urban residential and suburbs) with corresponding increase in vegetation cover. A variety of bird species uses urban habitats, including western scrub jay, northern mockingbird (*Mimus polyglottos*), and house finch. Mammals include the raccoon, Virginia opossum, striped skunk (*Mephitis mephitis*), and California slender salamander (*Batrachoseps attenuatus*). In suburban areas with mature vegetation closely resembling the natural environment, wildlife diversity increases with proportionately greater numbers of native species. Bird species include wrentit (*Chamaea fasciata*), bushtit (*Psaltriparus minimus*), chestnut-backed chickadee (*Poecile rufescens*), and California quail. Common mammals are mule deer, ringtail (*Bassariscus astutus*), black-tailed jackrabbit. Gopher snake and western fence lizard also occur in this zone (Mayer and Laudenslayer 1988).

Barren Barren areas are devoid of vegetation or support very sparse vegetation. Barren areas can be natural or human-created. Natural barren areas include sand bars, rock outcrops, beaches and mudflats. Human-created barren areas include exposed reservoir areas, quarries, roads and impervious surfaces associated with building structures.

Wildlife use of barren areas is strongly determined by the location and the type of barren habitat. Beaches and mudflats are used by numerous species of shorebirds that forage on invertebrates inhabiting the sand or brought in by wave action. Some shorebirds also nest on barren, sandy habitats. Rock outcrops, also classified as "barren," are used by a completely different suite of species. This habitat type may be used by bats are roosting locations, or mice, chipmunks and ground squirrels as shelter. Foxes and weasels forage for small mammals in these areas. In contrast, barren areas associated with urban settings provide very limited habitat for wildlife use.

Sub-Regions of the Area of Analysis The four sub-regions that make up the area of analysis for terrestrial biology are described below. Table 11-2 shows the habitat types and their geographic extent within the sub-regions of the area of analysis.

Table 11-2. Terrestrial Habitat Acres in the Area of Analysis

Division	Sacramento Valley	American River	Delta/Bay	San Joaquin Valley
Wetland Habitats				
Freshwater Emergent	2,932	258	3,895	2,365
Saline Emergent	0	0	2,168	0
Grasslands				
Annual Grassland	102,145	95,889	81,251	129,521
Shrub Habitats				
Mixed Chaparral	64,003	4,969	4,166	439
Woodland Habitats				
Blue Oak	131,790	32,315	3,015	3,907
Blue Oak – Foothill Pine	62,171	992	194	78
Valley Oak	2,271	61	1,072	0
Montane Hardwood	112,984	24,959	1,454	143
Montane Hardwood-Conifer	19,491	11,988	0	0
Valley Foothill Riparian	7,899	396	317	428
Conifer Forest	45,606	15,842	1,827	12
Agricultural Habitats				
Agriculture	166,841	20,834	154,688	1,194,962
Other Habitats				
Urban	74,417	87,856	229,445	67,696
Barren	6,275	812	372	0

Central Valley (includes Sacramento Valley, San Joaquin Valley, and the American River sub-regions) This region includes the Sacramento and San Joaquin River watersheds, encompassing most of the Central Valley of California. Fifteen of the 18 counties within the Central Valley contain parts of these two watersheds. The Central Valley contains approximately one-fifth the land area (27,000 square miles) of the state, and once supported a variety of grassland, savannah, riparian, and wetland habitats. Today the Central Valley is predominantly agricultural, with rice, orchards, and vineyards in the northern part of the valley and cotton and citrus orchards in the southern part. Undeveloped land in the Central Valley is mostly non-native annual grasslands. However, the Central Valley still includes remnants of native perennial grassland, vernal pool wetlands, riparian, and oak woodland habitats providing the Central Valley with a diversity of habitats.

Delta The Sacramento, San Joaquin, and other rivers, join in the Delta and flow westward into Suisun and San Pablo bays, and ultimately, reach the San Francisco Bay. Today, the Delta Region contains about 641,000 acres of agricultural land that dominate its lowland areas. Other dominant habitats in the region include valley foothill riparian and fresh and saline emergent wetlands. Although less prominent, other important habitats include seasonal fresh-water wetlands and non-tidal freshwater, tidal freshwater, and brackish water emergent marsh. Hundreds of miles of waterways divide the Delta Region into islands, some of which are below sea level. The Delta Region relies on more than 1,000 miles of levees to protect these islands.

11.1.3.2 Special Status Species (Terrestrial)

Special-status species are plants and animals that are legally protected under ESA and CESA or other regulations and species that are considered sufficiently rare by the scientific community to qualify for such listing. These species are in the following categories:

- Plants or animals listed or proposed for listing as threatened or endangered under ESA (50 CFR] 17.12 [listed plants], 17.11 [listed animals] and various notices in the Federal Register [FR] [proposed species]).
- Plants or animals that are candidates for possible future listing as threatened or endangered under ESA (61 FR 40, February 28, 1996);
- Plants or animals listed or proposed for listing by the State of California as threatened or endangered under CESA (14 California Code of Regulations 670.5);
- Fully Protected Species under CDFW Code Sections 3511, 4700, 5050, and 5515; and
- Plants listed as rare or endangered under the California Native Plant Protection Act (California Fish and Game Code, Section 1900 et seq.).

A list of special-status plant and animal species that have the potential to occur within the vicinity of the project area was compiled based on data in California Natural Diversity Database (CDFW 2014) and the USFWS List of Federal Endangered and Threatened Species that may be Affected by Projects in the area of analysis (USFWS 2014). Table 11-3 lists special-status plants and animals with the potential to occur within the area of analysis. Table 11-4 shows the location of previous occurrences of special status species in relation to the geographic sub-regions within the area of analysis.

Table 11-3. Federally-Listed Wildlife and Plant Species Potentially Occurring in the Area of Analysis

Species (Common Name)	Species (Scientific Name)	Status
Plants		
Antioch Dunes evening-primrose	*Oenothera deltoides* ssp. *howelli*	E
Butte County meadowfoam	*Limnanthes floccosa* ssp. *californica*	E
California jewelflower	*Caulanthus californicus*	E
California sea-blite	*Suaeda californica*	E
Colusa grass	*Neostapfia colusana*	T
Contra Costa wallflower	*Erysimum capitatum* ssp. *angustatum*	E
Contra Costa goldfields	*Lasthenia conjugens*	E
Coyote ceanothus	*Ceanothus ferrisiae*	E
El Dorado bedstraw	*Galium californicum* ssp. *sierrae*	E
Greene's tuctoria	*Tuctoria greenei*	E
Hairy Orcutt grass	*Orcuttia pilosa*	E
Hartweg's golden sunburst	*Pseudobahia bahiifolia*	E
Hoover's sprurge	*Chamaesyce hooveri*	T
Large-flowered fiddleneck	*Amsinckia grandiflora*	E
Layne's butterweed	*Packera layneae*	T
Keck's checkerbloom	*Sidalcea keckii*	E
Mariposa pussy-paws	*Calyptridium pulchellum*	T
Metcalf Canyon jewelflower	*Streptanthus albidus* ssp. *albidus*	E
Pallid manzanita	*Arctostaphylos pallida*	T
Palmate-bracted bird's beak	*Chloropyron palmatum*	E
Pine Hill ceanothus	*Ceanothus roderickii*	E
Pine Hill flannelbush	*Fremontodendron decumbens*	E
Sacramento Orcutt grass	*Orcuttia viscida*	E
San Benito evening-primrose	*Camissonia benitensis*	T
San Joaquin adobe sunburst	*Pseudobahia peirsonii*	T
San Joaquin Valley Orcutt grass	*Orcuttia inaequalis*	T
San Joaquin woolly-threads	*Monolopia congdonii*	E
Santa Clara Valley dudleya	*Dudleya abramsii* ssp. *setchellii*	E
Santa Cruz tarplant	*Holocarpha macradenia*	T
Slender Orcutt grass	*Orcuttia tenuis*	T
Showy Indian clover	*Trifolium amoenum*	E
Soft bird's beak	*Chloropyron molle* ssp. *molle*	E
Solano grass	*Tuctoria mucronata*	E
Stebbins's morning glory	*Calystegia stebbinsii*	E
Succulent owl's clover	*Castilleja campestris* var. *succulenta*	T
Tiburon Indian paintbrush	*Castilleja affinis* var. *neglecta*	E

Species (Common Name)	Species (Scientific Name)	Status
Invertebrates		
Bay checkerspot butterfly	*Euphydryas editha bayensis*	T
California freshwater shrimp	*Syncaris pacifica*	E
Callipe silverspot butterfly	*Speyeria callippe callippe*	E
Conservancy fairy shrimp	*Branchinecta conservatio*	E
Delta green ground beetle	*Elaphrus viridis*	T
Lange's metalmark butterfly	*Apodemia mormo langei*	E
Longhorn fairy shrimp	*Branchinecta longiantenna*	E
Shasta crayfish	*Pacifastacus fortis*	E
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	T
Vernal pool fairy shrimp	*Branchinecta lynchi*	T
Vernal pool tadpole shrimp	*Lepidurus packardi*	E
Amphibians		
California red-legged frog	*Rana draytonii*	T
California tiger salamander, central California population (DPS)	*Ambystoma californiense*	T
Reptiles		
Alameda whipsnake	*Masticophis lateralis euryxanthus*	T
Blunt-nosed leopard lizard	*Gambelia silus*	E
Giant garter snake	*Thamnophis gigas*	T
San Francisco garter snake	*Thamnophis sirtalis tetrataenia*	E
Birds		
California brown pelican	*Pelecanus occidentalis californicus*	E
California clapper rail	*Rallus longirostris obsoletus*	E
California condor	*Gymnogyps californianus*	E
California least tern	*Sterna antillarum browni*	E
Least Bell's vireo	*Vireo bellii pusillus*	E
Marbled murrelet	*Brachyramphus marmoratus*	T
Northern spotted owl	*Strix occidentalis caurina*	T
Western snowy plover	*Charadrius nivosus nivosus*	T
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	C
Mammals		
Fresno kangaroo rat	*Dipodomys nitratoides exilis*	E
Giant kangaroo rat	*Dipodomys ingens*	E
Riparian woodrat	*Neotoma fuscipes riparia*	E
Riparian brush rabbit	*Sylvilagus bachmani riparius*	E
Salt marsh harvest mouse	*Reithrodontomys raviventris*	E
San Joaquin kit fox	*Vulpes macrotis mutica*	E
Tipton kangaroo rat	*Dipodomys nitratoides nitratoides*	E

Source: USFWS 2014
Status codes:
E = Endangered
T = Threatened
C = Candidate

Table 11-4. Occurrence of Listed and Candidate Plant and Wildlife Species in the Area of Analysis

	Region			
	Sacramento Valley	**American River**	**Delta/Bay**	**San Joaquin River Valley**
Plants				
Antioch Dunes evening-primrose			X	
Butte County meadowfoam	X			
California jewelflower			X	X
California sea-blite			X	
Colusa grass	X		X	
Contra Costa wallflower			X	
Contra Costa goldfields			X	
Coyote ceanothus				
El Dorado bedstraw		X		
Greene's tuctoria	X			X
Hairy Orcutt grass	X			
Hartweg's golden sunburst				X
Hoover's sprurge	X			
Large-flowered fiddleneck			X	
Layne's butterweed	X	X		
Keck's checkerbloom	X			X
Mariposa pussy-paws				X
Metcalf Canyon jewelflower			X	X
Pallid manzanita			X	
Palmate-bracted bird's beak	X		X	X
Pine Hill ceanothus		X		
Pine Hill flannelbush		X		
Sacramento Orcutt grass	X	X		
San Benito evening-primrose				
San Joaquin adobe sunburst				X
San Joaquin Valley Orcutt grass				X
San Joaquin woolly-threads				X
Santa Clara Valley dudleya			X	
Santa Cruz tarplant			X	
Slender Orcutt grass	X	X		
Showy Indian clover			X	
Soft bird's beak		X	X	
Solano grass			X	
Stebbins's morning glory	X	X		
Succulent owl's clover	X			
Tiburon Indian paintbrush			X	

	Region			
	Sacramento Valley	American River	Delta/Bay	San Joaquin River Valley
Invertebrates				
Bay checkerspot butterfly			X	
California freshwater shrimp			X	
Callipe silverspot butterfly		X	X	
Conservancy fairy shrimp	X		X	
Delta green ground beetle			X	
Lange's metalmark butterfly			X	
Longhorn fairy shrimp		X	X	
Shasta crayfish	X			
Valley elderberry longhorn beetle	X	X	X	X
Vernal pool fairy shrimp	X	X	X	X
Vernal pool tadpole shrimp	X	X	X	X
Amphibians				
California red-legged frog	X	X	X	X
California tiger salamander, central population	X	X	X	X
Reptiles				
Alameda whipsnake			X	
Blunt-nosed leopard lizard				X
Giant garter snake	X	X	X	X
San Francisco garter snake			X	
Birds				
California brown pelican	X		X	X
California clapper rail				X
California condor				X
California least tern			X	
Least Bell's vireo				X
Marbled murrelet			X	
Northern spotted owl	X			
Western snowy plover		X	X	
Western yellow-billed cuckoo	X	X		X
Mammals				
Fresno kangaroo rat				X
Giant kangaroo rat				X
Riparian woodrat			X	X
Riparian brush rabbit			X	X
Salt marsh harvest mouse			X	
San Joaquin kit fox				X
Tipton kangaroo rat				X

11.2 Environmental Consequences

These sections describe the environmental consequences to terrestrial vegetation and wildlife associated with each alternative.

11.2.1 Assessment Methods

The assessment methods for impacts to terrestrial vegetation and wildlife include analysis of each of the alternatives and the potential for the alternative to affect special-status species and special-status species habitats, and federally-protected wetlands.

The impacts of each of the project alternatives were evaluated at a habitat level with a focus on riparian and wetland habitats that are associated with reservoirs and rivers (including Delta waterways) that have the potential to be influenced by changes in CVP operations, and agricultural habitats that have the potential to be influenced by changes in water allocations. Where potential impacts to wildlife habitats were identified, special-status species associated with these habitats were assessed individually.

Two models, CalSim II and the Statewide Agricultural Production (SWAP) model, were used in the analysis of the alternatives. Each model is briefly described below and in more detail in Appendix B, Water Operations Model Documentation, and Appendix D, Statewide Agricultural Production Model Documentation, respectively.

CalSim II is a hydrologic and operations model used by Reclamation and the California Department of Water Resources to conduct planning and impact analyses for the Sacramento River basin, San Joaquin River basin, and Delta. It is considered the best available tool for modeling operations of the CVP and the State Water Project (SWP). The model incorporates operating rules for the CVP and SWP that reflect a complex and extensive set of regulatory standards and operating criteria: water quality and endangered species requirements, flood control operating criteria, water delivery policies, instream flow, and Delta outflow requirements. CalSim II uses an 82-year historical period of simulation on a monthly time step. This period provides a variety of hydrologic conditions sufficient to evaluate potential impacts. It includes many different types and sequences of actual hydrologic conditions, ranging from floods to droughts of different magnitudes and durations.

The SWAP model projects agricultural production, broken down by major crop groups: grain; field; forage; vegetable/truck; and orchards/vineyards. Because different crops provide habitat for a variety of wildlife species, this model was used to predict potential impacts to these agricultural habitats. Model results are organized by SWAP regions – Sacramento Valley, San Joaquin River, and Tulare Lake – and water year type.

Five different water year types were analyzed (wet, above normal, below normal, dry, and critical) in the CalSim II and SWAP models. The models projected water storage and conveyance conditions (CalSim II), and agricultural projections (SWAP) for the project alternatives and compared Alternatives 2, 3, 4, and 5 with the No Action Alternative (Alternative 1).

Model results were given as a monthly average in CalSim II and as a yearly average in SWAP. Results of the CalSim II model were used to analyze the potential impacts of water storage conditions on adjacent habitats for all alternatives. Results of the SWAP model were used to assess potential impacts to agricultural habitats for all Project alternatives. The magnitude of each impact was evaluated based on scale, intensity, duration, and type (negative or beneficial).

11.2.1.1 Identification of Habitats and Special-Status Species to be Assessed

As described above, although the area of analysis encompasses a wide variety of habitat types- including many upland habitats- wetland and riparian are the focus of this analysis. Habitats associated with, or adjacent to, aquatic systems are most likely to be influenced under the various alternatives while impacts to upland habitats that are disconnected from aquatic systems are not expected to occur under any of the alternatives. This analysis also focuses on seasonally-flooded agriculture, particularly rice and wild rice production and the agricultural ditches and drainages associated with rice production. Rice fields provide important and useful habitat to a variety of wildlife species. Rice fields and the associated irrigation ditches and canals are home to fish, aquatic invertebrates, and insects which in turn provide food resources to a wide sample of vertebrate species. Various bird and small mammal species feed on rice and post-harvest waste grain. Waterfowl feed on aquatic plants, such as duckweed, and algae. Fish and invertebrates (crayfish and bloodworms) are often pumped into rice fields from irrigation canals and are preyed on by wading birds (herons, cranes, and egrets), shore birds, amphibians, and aquatic reptiles. In lieu of disappearing freshwater marsh habitat in the Sacramento Valley and San Joaquin Valley, giant garter snakes have increasingly utilized rice fields and irrigation ditches and canals to survive and currently appear to be most numerous in the rice growing counties of the state.

11.2.1.2 Giant Garter Snake

The giant garter snake is listed as threatened by the State of California and by USFWS. The giant garter snake is one of the largest garter snakes in the world and reaches total lengths of up to 1.6 meters (64 inches). Giant garter snakes are endemic to the valley floors of both the Sacramento and San Joaquin Valleys of California. Historically, the range of the giant garter snake probably occurred from Butte County in the north, southward to Buena Vista Lake in Kern County (USFWS 1999). The current range includes two disjunct populations. One that extends from Glenn County south to northern San Joaquin County and a second that occurs in Merced County and northern Fresno County. The current distribution and abundance of the giant garter snake is much reduced from the recent past. Agricultural conversion and flood control operations have extirpated the giant garter snake from much of its former range.

The giant garter snake inhabits marshes, sloughs, low gradient streams, ponds, irrigation and drainage canals, rice producing lands, and adjacent uplands. Habitat components most important to the giant garter snake include permanent water that persists through the summer months, emergent aquatic vegetation and vegetated banks, abundant food resources, and adjacent upland areas with small mammal burrows or other suitable winter retreats.

With the conversion or alteration of most freshwater marsh habitat in the Central Valley, giant garter snakes appear to be utilizing the rice growing regions of its current range. Though not ideal, rice production does provide giant garter snakes with much of its ecological needs.

11.2.1.3 Species Considered But Not Assessed in Detail

The species listed below may occasionally visit, but are not dependent on agricultural lands and would not be negatively affected by a reduction in agricultural production generally or a reduction in rice production acreage specifically.

California Red-Legged Frog This species does not normally use or occupy agricultural habitats. Changes in agricultural allocations should not negatively impact this species.

California Tiger Salamander This species does not normally use or occupy agricultural habitats (irrigated row crops and rice cultivation), though may occur in areas used for livestock grazing, particularly in stock ponds. Changes in agricultural allocations should not negatively impact this species.

Alameda Whipsnake Not typically associated with agricultural habitats. Changes in agricultural allocations should not negatively impact this species.

San Francisco Garter Snake Not typically associated with agricultural habitats. This species may not even occur within the area of analysis. Changes in agricultural allocations should not negatively impact this species.

California Brown Pelican Not typically associated with agricultural habitats. This species may not even occur within the area of analysis. Changes in agricultural allocations should not negatively impact this species.

California Clapper Rail This species does not normally use or occupy agricultural habitats. Changes in agricultural allocations should not negatively impact this species.

California Least Tern Not typically associated with agricultural habitats. This species may not even occur within the area of analysis. Changes in agricultural allocations should not negatively impact this species.

Marbled Murrelet Not typically associated with agricultural habitats. This species may not even occur within the area of analysis. Changes in agricultural allocations should not negatively impact this species.

Western Snowy Plover This species does not normally use or occupy agricultural habitats. Changes in agricultural allocations should not negatively impact this species.

11.2.2 Alternative 1: Future No Action

The No Action Alternative includes the most likely future conditions in the absence of the project.

11.2.2.1 Wetlands and Riparian Habitats

Under the No Action Alternative, changes to CVP deliveries and associated flow changes could affect wetlands and riparian habitats compared to existing conditions. These changes would be based on population growth and changes in land use. The changes in reservoir storage and river flow would not have an appreciable effect on wetlands and riparian habitats and associated wildlife as compared to existing conditions.

Under the No Action Alternative, CalSim II modeling indicates that water storage and elevation fluctuations for regional reservoirs, and stream flow changes in the region, would generally trend towards small decreases; however, they would remain within the range of existing operational variability. Reservoir conditions and river flows currently vary seasonally and year to year.

As a result of this normal fluctuation range, wetland and riparian habitats associated with these storage facilities and downstream waterways would experience the same or similar hydrologic conditions as under existing conditions. Therefore, riparian and wetland habitats associated with water storage reservoirs and waterways, including the Delta, are unlikely to appreciably change as a result of ongoing operations.

11.2.2.2 Agricultural Habitats

Under the No Action Alternative, changes to CVP deliveries would not have an appreciable effect on agricultural habitats and associated wildlife as compared to existing conditions. According to the SWAP model results, between approximately 20,000 and 25,000 additional acres of grain cultivation could be expected in the Sacramento Valley compared to existing conditions. It is uncertain what types of grain crops would increase and therefore the potential effect to wildlife is unknown.

With the No Action Alternative, the existing Draft M&I Water Shortage Policy (WSP) would continue to be implemented. Maintaining the existing water allocation methodology could result in small changes in agricultural water allocations and resulting crop patterns as compared to existing conditions; however, these changes would not be expected to directly contribute to discernible changes in agricultural practices that could impact agricultural habitats such as rice fields.

11.2.3 Alternative 2: Equal Agricultural and M&I Allocation

11.2.3.1 Riparian and Wetland Habitats

Under Alternative 2, changes to reservoir levels and river flows compared to the No Action Alternative could affect riparian and wetland habitats. The minor changes in reservoir storage and river flow would not have an appreciable or observational effect on wetlands and riparian habitats and associated wildlife as compared to the No Action Alternative.

The differences between the No Action Alternative and Alternative 2 for modeled water storage in Folsom Lake would range from two to six feet higher than the No Action Alternative during critically dry water years. These changes would be two to three feet higher from October through May and five to six feet higher from June through September. All of these changes are relatively small and are within the range of existing operational variability.

The shorelines at all reservoirs are currently subjected to water-level fluctuations that vary seasonally and year to year. The effect of regular cycles of increasing and decreasing water surface elevations restricts the formation of riparian, wetland, or other shoreline vegetation; consequently, the mostly barren conditions that result are not suitable for special-status plant and wildlife species. The small changes in the surface elevations would occur within the mostly barren areas that exist within the reservoirs and would not result in discernible changes to shoreline habitat.

Changes in flows and water levels in the rivers and Delta would be also be very small and well within the range of existing operational variability. Similar to water surface level changes in the reservoirs, these small changes would occur within normal water surface operating ranges where riparian and wetland vegetation typically occurs. As a result, the changes are not expected to be discernible or to reduce riparian and wetland habitat.

11.2.3.2 Agricultural Habitats

Under Alternative 2, changes in CVP deliveries to agricultural water service contractors could affect agricultural habitats. Minor changes in agricultural patterns would not be expected to have an appreciable effect on agricultural habitats as compared to the No Action Alternative.

Based on model results, approximately 3,000 additional acres of grain cultivation could be expected in dry years and 2,000 additional acres of grain cultivation could be expected in critically dry years compared to the No Action Alternative conditions. It is uncertain what types of grain crops would increase and therefore the potential effect to wildlife is unknown.

As mentioned above, giant garter snake are known to utilize rice fields, and adjacent irrigation ditches, for foraging and movement and the adjacent uplands for basking, refugia, or hibernacula. The giant garter snake is considered very scarce throughout its range in the Central Valley (Kucera 2008), therefore, even a short-term increase in grain production, particularly rice, could be beneficial to the species. However, the potential changes would be small and uncertain (regarding crop types).

11.2.3.3 Indirect Effects

If M&I contractors receive less water because of implementation of the M&I WSP under Alternative 2, they would likely take one of three actions to make up for their reduced water supply: 1) additional groundwater pumping, 2) crop fallowing, or 3) water transfers. These potential activities are not part of the project; however, they could occur in response to the project and would be considered an indirect effect and could have different likelihoods of occurring depending on the geographic area considered.

Central Valley (includes Sacramento Valley, San Joaquin Valley, and the American River sub-regions) M&I supplies would decrease during some dry and critical years, and these contractors may seek transfers from agricultural users to augment available supplies. Transfers could be made through groundwater substitution or cropland idling in the Central Valley. Cropland idling transfers can involve multiple crop types, but have primarily involved rice land in the past. Increased idling of rice land could affect species that use these lands, including the giant garter snake.

Delta Under Alternative 2, M&I contractors south of the Delta may engage in transfers that would involve additional pumping from the Delta. These transfers would be relatively small compared to the overall amount of Delta pumping; therefore, indirect effects to the dominant habitats in the region including valley foothill riparian, fresh and saline emergent wetlands, seasonal fresh-water wetlands and non-tidal freshwater, tidal freshwater, and brackish water emergent marsh would not be discernible.

11.2.4 Alternative 3: Full M&I Allocation Preference

11.2.4.1 Riparian and Wetland Habitats

Under Alternative 3, changes to reservoir levels and river flows compared to the No Action Alternative could affect riparian and wetland habitats. The minor changes in reservoir storage and river flow would not have an appreciable or observational effect on wetlands and riparian habitats and associated wildlife as compared to the No Action Alternative.

The differences between the No Action Alternative and Alternative 3 for modeled water storage in all reservoirs are very small and range from zero to one percent. All of these changes are well within the range of existing operational variability.

As described above, the shorelines at all reservoirs are currently subjected to water-level fluctuations that vary seasonally and year to year. The effect of regular cycles of increasing and decreasing water surface elevations restricts the formation of riparian, wetland, or other shoreline vegetation; consequently, the mostly barren conditions that result are not suitable for special-status plant and wildlife species. The small changes in the surface elevations would occur within the mostly barren areas that exist within the reservoirs and would not result in discernible changes to shoreline habitat.

Changes in flows and water levels in the rivers and Delta would be also be very small and well within the range of existing operational variability. Similar to water surface level changes in the reservoirs, these small changes would occur within normal water surface operating ranges where riparian and wetland vegetation typically occurs. As a result, the changes are not expected to be discernible or to reduce riparian and wetland habitat.

11.2.4.2 Agricultural Habitats

Under Alternative 3, changes in CVP deliveries to agricultural water service contractors would decrease irrigated acreage under production. Minor changes in agricultural patterns would not be expected to have an appreciable effect on agricultural habitats as compared to the No Action Alternative.

Based on model results, approximately 2,000 fewer acres of grain cultivation could be expected in dry years compared to the No Action Alternative. It is uncertain what types of grain crops would decrease and therefore the potential effect to wildlife is unknown.

As mentioned above, giant garter snake are known to utilize rice fields, and adjacent irrigation ditches, for foraging and movement and the adjacent uplands for basking, refugia, or hibernacula. The giant garter snake is considered very scarce throughout its range in the Central Valley (Kucera 2008); therefore, even a short-term decrease in grain production, particularly rice, could be adverse to the species. However, the potential changes would be very small and uncertain (regarding crop types).

11.2.4.3 Indirect Effects

If agricultural contractors have shortages from implementation of the WSP under Alternative 3, there would likely take one of three actions to make up for their reduced water supply: 1) additional groundwater pumping, 2) crop fallowing, or 3) water transfers. These potential activities are not part of the project; however, they could occur in response to the project and would be considered an indirect effect and could have different likelihoods of occurring depending on the geographic area considered.

Central Valley (includes Sacramento Valley, San Joaquin Valley, and the American River sub-regions) Given that small effects would result to agricultural water supplies, these shortfalls could be made up primarily by water transfers under Alternative 3 because less water is being exported south of the Delta. Transfers could be made through groundwater substitution or cropland idling in the Central Valley. Cropland idling transfers can involve multiple crop types, but have primarily involved rice land in the past. Increased idling of rice land could affect species that use these lands, including the giant garter snake.

Cropping patterns could also be modified; however, there is less flexibility to change cropping patterns in areas with permanent crops (nut trees) and vineyards, or specialized annual crops, like rice. Given the relatively small changes to agricultural water available under Alternative 3, indirect effects would not be discernable to Central Valley agricultural lands, with rice, orchards, and vineyards in the northern part of the valley and cotton and citrus orchards in the southern part.

Delta Under Alternative 3, with slightly less water available to the agricultural uses, the shortfall would likely be made up by water transfers as less water is being exported south of the Delta. This would result in small shifts in water use and, therefore, indirect effects to the dominant habitats in the region including valley foothill riparian and fresh and saline emergent wetlands, seasonal fresh-water wetlands and nontidal freshwater, tidal freshwater, and brackish water emergent marsh would not be discernible.

11.2.5 Alternative 4: Updated M&I WSP

Alternative 4 is similar to the No Action Alternative. There would be no discernible changes to reservoir storage, river flows, or agricultural acreage compared to the No Action Alternative; therefore, there would be no associated changes to riparian, wetland, or agricultural habitats. Because there would be no discernible change to these habitats, there are no impacts to terrestrial resources under Alternative 4 compared to the No Action Alternative.

11.2.6 Alternative 5: M&I Contractor Suggested WSP

Alternative 5 is similar to the No Action Alternative and Alternative 4. There would be no discernible changes to reservoir storage, river flows, or agricultural acreage compared to the No Action Alternative; therefore, there would be no associated changes to riparian, wetland, or agricultural habitats. Because there would be no discernible change to these habitats, there would be no impacts to terrestrial resources under Alternative 5 compared to the No Action Alternative.

11.2.6.1 Riparian and Wetland Habitats

Under Alternative 5, reservoir storage and river flow would not be expected to change or have an appreciable or observational effect on wetlands and riparian habitats and associated wildlife as compared to the No Action Alternative.

There are no differences between the No Action Alternative and Alternative 5 for CalSim II modeled water storage in all reservoirs. Changes in flows and water levels in the rivers and Delta would be very small and well within the range of existing operational variability. These small changes would occur within normal water surface operating ranges where riparian and wetland vegetation typically occurs. As a result, the changes are not expected to be discernible or to reduce riparian and wetland habitat.

11.2.6.2 Agricultural Habitats

Under Alternative 5, agricultural patterns would not be expected to change or have an appreciable effect on agricultural habitats compared to the No Action Alternative.

Model results show no differences in acreage of grain crops in the Sacramento Valley, San Joaquin River, and Tulare Lake regions between the No Action Alternative and Alternative 5 for the five modeled water year types. Based on these results, under Alternative 5, agricultural habitats associated with rice production are unlikely to change.

11.2.6.3 Indirect Effects

Alternative 5 results in very small changes in water supplies to agricultural or M&I contractors; therefore, they would not be likely to take additional actions that would result in indirect effects.

11.3 Mitigation Measures

Mitigation measures are not necessary because the minor changes in reservoir storage, river flow, and agricultural patterns that would result from the alternatives would not have an appreciable or observational effect on terrestrial resources.

11.4 Unavoidable Adverse Impacts

None of the action alternatives would result in unavoidable adverse impacts to terrestrial biological resources.

11.5 Cumulative Effects

The timeline for the terrestrial resources cumulative impacts analysis extends from 2010 through 2030, a 20-year period. The relevant geographic study area for the terrestrial impacts analysis is the same area of analysis as shown in Figure 11-1. The following section analyzes the cumulative impacts using the project method, which is further described in Chapter 20, Cumulative Effects Methodology. Chapter 20 describes the projects included in the cumulative condition. The cumulative analysis considers projects and conditions that could affect terrestrial resources within the area of analysis.

11.5.1 Alternative 2: Equal Agricultural and M&I Allocation

Under Alternative 2, M&I water service contractors would receive the same water shortage allocations as the agricultural water service contractors. The minor changes in reservoir storage, river flow, and agricultural patterns would be within the range of existing operational variability and would not have an appreciable or observational effect on terrestrial resources as compared to the No Action Alternative.

Under Alternative 2, CalSim II modeling indicates that water storage and elevation fluctuations for regional reservoirs, and stream flow changes in the region, would remain within the range of existing operational variability. Reservoir conditions and river flows currently vary seasonally and year to year. In addition, potential changes in agricultural patterns for agricultural water users due to changing water allocations could result in small changes in crop-type acreages, including those crops that provide agricultural habitat for wildlife.

An increase or decrease in water storage in regional reservoirs, in river flow, and changing agricultural patterns, would have the potential to influence wetland, riparian, and agricultural habitats within the area of analysis. The other projects identified with the potential to contribute to the cumulative condition, including the Bay Delta Conservation Plan (BDCP) and the Shasta Lake Water Resources Investigation, have the potential to result in an increase or decrease in water storage in regional reservoirs, in river flow, and changing agricultural patterns. The BDCP could potentially result in reduced average storage elevations with increased south-of-Delta export and the Shasta Lake Water Resources Investigation could generate the opposite effect with increased storage capacity and increase storage elevations as a result of a dam raise action.

Rice production in California's Sacramento and San Joaquin Valleys has replaced much of the freshwater marsh wetlands that existed in these areas previously, and provides habitat for giant garter snake. Changes in allocations to agricultural contractors could affect the acreage of rice production and, as a consequence, the acreage of suitable habitat for giant garter snake in the Sacramento and San Joaquin valleys. Other projects identified with the potential to contribute to the cumulative condition of rice production in the Sacramento Valley during dry years include the BDCP, the Shasta Lake Water Resources Investigation, the North Delta Flood Control and Ecosystem Restoration Project, In-Delta Storage Program, and North-of-the-Delta Offstream Storage Investigation. The BDCP, North Delta Flood Control and Ecosystem Restoration Project, and In-Delta Storage Program include habitat restoration as a primary component of the project and would therefore likely increase the total acreage of high-quality giant garter snake habitat in the Delta region in the long-term. The Shasta Lake Water Resources Investigation and North-of-the-Delta Offstream Storage Investigation would increase water supply reliability and Sacramento Valley water management flexibility, potentially reducing the impact to rice production during dry years and therefore maintaining the existing giant garter snake habitat in and adjacent to rice fields.

While these projects may result in cumulative changes to river flows, reservoir levels, and agricultural patterns, Alternative 2 would result in very minor contributions because it would not have an appreciable or observational effect on terrestrial resources. Therefore, the effect of the Alternative 2 in combination with the cumulative impacts identified above would not adversely impact terrestrial resources in the area of analysis.

11.5.2 Alternative 3: Full M&I Allocation Preference

Under Alternative 3, M&I water service contractors would receive higher CVP deliveries and agricultural water service contractors would receive lower CVP deliveries as compared to the No Action Alternative. The minor changes in reservoir storage, river flow, and agricultural patterns would be within the range of existing operational variability and would not have an appreciable or observational effect on terrestrial resources as compared to the No Action Alternative.

Under Alternative 3, Full M&I Allocation Preference, CalSim II modeling indicates that water storage and elevation fluctuations for regional reservoirs, and stream flow changes in the region, would remain within the range of existing operational variability. Reservoir conditions and river flows currently vary seasonally and year to year.

In addition, potential changes in agricultural patterns for agricultural water users due to changing water allocations would not result in new ground disturbance. An increase or decrease in water storage in regional reservoirs, in river flow, and changing agricultural patterns, would have the potential to influence wetlands, riparian, and agricultural habitats within the area of analysis. The other projects identified with the potential to contribute to the cumulative condition have the potential to result in an increase or decrease in water storage in regional reservoirs, in river flow, and changing agricultural patterns. However, all potential changes in reservoir storage, river flow, and crop types that result from Alternative 3 are within the current range of operational variability. The minor changes in reservoir storage, river flow, and agricultural patterns would be within the range of existing operational variability and would not have an appreciable or observational effect on terrestrial resources.

While these projects may result in cumulative impacts on river flows, reservoir levels, and agricultural patterns, Alternative 3 would result in very minor contributions because it would not have an adverse effect on terrestrial resources in the area of analysis. Therefore, the effect of the Alternative 3 in combination with the cumulative impacts identified above would not generate an adverse cumulative effect on terrestrial resources in the area of analysis.

11.5.3 Alternative 4: Updated M&I WSP

Alternative 4 is similar to the No Action Alternative. There would be no discernible changes to reservoir storage, river flows, or agricultural acreage compared to the No Action Alternative; therefore, there would be no associated changes to riparian, wetland, or agricultural habitats. Because there would be no discernible change to these habitats, there are no impacts to terrestrial resources under Alternative 4 compared to the No Action Alternative.

Under Alternative 4, CalSim II modeling indicates that water storage and elevation fluctuations for regional reservoirs, and stream flow changes in the region, would remain within the range of existing operational variability. Reservoir conditions and river flows currently vary seasonally and year to year. In addition, potential changes in agricultural patterns for agricultural water users due to changing water allocations would result in small changes in crop-type acreages, including those crops that provide agricultural habitat for wildlife. An increase or decrease in water storage in regional reservoirs, in river flow, and changing agricultural patterns, would have the potential to influence wetland, riparian, and agricultural habitats within the area of analysis. The other projects identified with the potential to contribute to the cumulative condition have the potential to result in an increase or decrease in water storage in regional reservoirs, in river flow, and changing agricultural patterns. However, because all potential changes in reservoir storage, river flow, and crop types that result from Alternative 4 are essentially the same as the No Action Alternative and there would be no associated changes in riparian, wetland, or agricultural habitats, there would be no impact on terrestrial resources. Therefore, the effect of the Alternative 4 in combination with the cumulative impacts identified above would not generate an adverse cumulative effect on terrestrial resources in the area of analysis.

11.5.4 Alternative 5: M&I Contractor Suggested WSP

Alternative 5 is similar to the No Action Alternative and Alternative 4. There would be no discernible changes to reservoir storage, river flows, or agricultural acreage compared to the No Action Alternative; therefore, there would be no associated changes to riparian, wetland, or agricultural habitats. Because there would be no discernible change to these habitats, there are no impacts to terrestrial resources under Alternative 5 compared to the No Action Alternative.

Under Alternative 5, CalSim II modeling indicates that water storage and elevation fluctuations for regional reservoirs, and stream flow changes in the region, would remain within the range of existing operational variability. Reservoir conditions and river flows currently vary seasonally and year to year. In addition, potential changes in agricultural patterns for agricultural water users due to changing water allocations would result in small changes in crop-type acreages, including those crops that provide agricultural habitat for wildlife. An increase or decrease in water storage in regional reservoirs, in river flow, and changing agricultural patterns, would have the potential to influence wetland, riparian, and agricultural habitats within the area of analysis. The other projects identified with the potential to contribute to the cumulative condition have the potential to result in an increase or decrease in water storage in regional reservoirs, in river flow, and changing agricultural patterns. However, because all potential changes in reservoir storage, river flow, and crop types that result from Alternative 5 are essentially the same as the No Action Alternative, they would not have an appreciable or observational effect on terrestrial resources. Therefore, the effect of the Alternative 5 in combination with the cumulative impacts identified above would not generate an adverse cumulative effect on terrestrial resources in the area of analysis.

11.6 References

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Chapter 12
Agricultural Resources

This chapter will analyze the effects to agricultural resources through the change in Central Valley Project (CVP) deliveries to agricultural water service contractors. Agricultural resources analyzed in this section include focus on potential changes (either temporary or permanent) to land currently used for agricultural purposes.

12.1 Affected Environment

This section presents existing conditions for agricultural resources within the area of analysis.

12.1.1 Area of Analysis

The area of analysis for agricultural resources includes counties where CVP deliveries to agricultural water service contractors would be affected by the Municipal and Industrial Water Shortage Policy (M&I WSP). These counties include Tehama, Glenn, Colusa, Sutter, Yolo, Contra Costa, San Joaquin, Alameda, Santa Clara, Santa Cruz, Stanislaus, Merced, Fresno, Kings, Tulare, and Kern. Figure 12-1 shows the area of analysis for agricultural land use. Monterey and Alameda counties also have agricultural resources; however, these counties do not receive CVP water for agricultural purposes and, therefore, are not included in the analysis. The Sacramento Valley Region falls within the North of the Sacrament-San Joaquin River Delta (Delta) geographic area, and the San Joaquin River, Tulare Lake, and Central Coast regions fall within the South of Delta geographic area.

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Figure 12-1. Agricultural Resources Area of Analysis

12.1.2 Regulatory Setting

12.1.2.1 Federal

Conservation Reserve Program The Conservation Reserve Program (CRP) is a Federal program administered by the United States Department of Agriculture (USDA) Farm Service Agency. The CRP is a voluntary program that offers annual rental payments, incentive payments, and annual maintenance payments for certain activities, and cost-share assistance to establish approved cover on eligible cropland. To be eligible for placement in the CRP, land must be: 1) cropland that is planted or considered planted to an agricultural commodity two of the five most recent crop years (including field margins) and that is physically and legally capable of being planted in a normal manner to an agricultural commodity; or 2) marginal pastureland that is either enrolled in the Water Bank Program or suitable for use as a riparian buffer to be planted to trees. As of November 2013, there was a total of 81,987 acres of active CRP cropland in California (USDA, Farm Service Agency 2013a). Counties in the area of analysis with cropland acres in the CRP include Glenn, Colusa, Sutter, Yolo, Tehama, Stanislaus, Monterey, Kern, and Merced (USDA, Farm Service Agency 2013b).

12.1.2.2 State

Williamson Act The California Land Conservation Act, also known as the Williamson Act, preserves agricultural and open space lands by discouraging premature and unnecessary conversion to urban uses. The act creates an arrangement whereby private landowners contract with counties and cities to voluntarily restrict their land to agricultural and compatible open space uses. The vehicle for these agreements is a rolling term, 10-year contract (unless either party files a “notice of nonrenewal,” the contract is automatically renewed for an additional year). In return, restricted parcels are assessed for property tax purposes at a rate consistent with their actual use, rather than potential market value.

The Williamson Act established its own definition of Prime agricultural lands based on the actual or potential agricultural productivity of the land being restricted (California Department of Conservation [DOC] 2010; California DOC 2007a). Contracted land that meets the Williamson Act definition of Prime agricultural land is designated as “Prime.” Under the law, Prime agricultural land is defined as (California DOC 2007b):

- Land which qualifies for rating as class I or class II in the Natural Resources Conservation Service land use capability classifications;

- Land which qualifies for rating 80 to 100 in the Storie Index Rating;

- Land which supports livestock used for the production of food and fiber and which has an annual carrying capacity equivalent to at least one animal unit per acre as defined by the USDA;

- Land planted with fruit or nut-bearing trees, vines, bushes, or crops which have a nonbearing period of less than five years and which will normally return during the commercial bearing period on an annual basis from the production of unprocessed agricultural plant production not less than $200 per acre;

- Land which has returned from the production of unprocessed agricultural plant production and has an annual gross value of not less than $200 per acre for three of the previous five years.

Non-Prime agricultural land is defined as land which does not meet any of the criteria for classification as Prime agricultural land. Most Non-Prime land is in agricultural uses such as grazing or non-irrigated crops. However, Non-Prime land may also include other open space uses which are compatible with agriculture and consistent with local general plans.

The Williamson Act also establishes a Farmland Security Zone (FSZ), which introduces a 20-year contract between a private landowner and a county that restricts land to agricultural or open space uses.[1] FSZ lands are designated as Urban and Non-Urban for subvention payment purposes. FSZ contracted land within a city's sphere of influence, or within three miles of the exterior boundaries of a city's sphere of influence, is "Urban", while all other FSZ contracted land is "Non-Urban." Table 12-1 summarizes farm acreage by county enrolled in the Williamson Act and FSZ program in 2010 and 2011, which is compiled by the California DOC Division of Land Resource Protection (DLRP).

[1] An FSZ is essentially an area created within an agricultural preserve by a board of supervisors upon request by a landowner or group of landowners. An agricultural preserve defines the boundary of an area within which a city or county will enter into Williamson Act contracts with landowners. The boundary is designated by resolution of the board of supervisors or city council having jurisdiction. Agricultural preserves must generally be at least 100 acres in size.

Table 12-1. Williamson Act and Agricultural Conservation Easement Acreage in Area of Analysis (2010-2011)

County	2010 Williamson Act (acres)		2010 Total (Williamson Act lands; acres)	2011 Williamson Act (acres)		2011 Total (Williamson Act lands; acres)	Percent Change (Total Williamson Act lands; 2010-2011)	Farmland Security Zone (2011 acres): Urban		Farmland Security Zone (2011 acres): Non-Urban		Agricultural Conservation Easement (through the CFCP[1]; 2011 acres)		2011 Total Conserva-tion lands (acres)[2]
	Prime	Non Prime		Prime	Non Prime			Prime	Non Prime	Prime	Non Prime	Prime	Non Prime	
Tehama	53,616	736,028	**789,644**	53,439	735,902	**789,341**	**-0.04**	2,692	2,602	1,315	4,918	--	--	**800,868**
Glenn	63,618	267,432	**331,050**	63,781	270,024	**333,805**	**+0.83**	14,112	500	73,600	2,226	--	--	**424,243**
Colusa	66,952	193,720	**260,672**	66,952	193,720	**260,672**	**0**	15,989	737	40,628	2,035	--	--	**320,060**
Sutter	51,408	13,165	**64,573**	51,408	13,165	**64,573**	**0**	--	--	--	--	--	--	**64,573**
Yolo	240,988	176,114	**417,102**	198,642	156,651	**355,593**	**-14.7**	158	1	--	--	200	7	**355,658**
San Joaquin	323,478	149,489	**472,967**	322,528	148,460	**470,988**	**-0.4**	15,213	79	34,608	10,098	--	--	**530,985**
Stanislaus	293,495	396,459	**689,954**	--	--	**0**	**-100**	--	--	--	--	--	--	--
Santa Clara	10,132	296,105	**306,237**	9,731	295,546	**305,277**	**-0.3**	--	--	--	--	286	--	**305,563**
Santa Cruz	2,724	12,865	**15,589**	2,725	12,865	**15,590**	**+0.006**	82	32	--	10	307	63	**16,803**
Merced	258,883	209,080	**467,963**	259,199	208,768	**467,967**	**+2.64**	--	--			--	--	**467,967**
Fresno	982,032	483,245	**1,465,277**	982,032	483,245	**1,465,277**	**-0.06**	--	--	25,799	3,482	--	--	**1,494,558**
Kings	279,062	110,671	**389,733**	278,839	110,671	**389,510**	**-0.07**	28,851	227	248,090	10,642	--	--	**677,320**
Tulare	573,296	513,946	**1,087,242**	572,435	513,896	**1,086,331**	**-0.08**	11,102	50	--	--	--	--	**1,098,168**
Kern	628,186	912,223	**1,540,409**	628,640	911,564	**1,540,204**	**-0.01**	25,176	--	133,751	--	--	--	**1,699,132**

Source: California DOC 2013

[1] CFCP = California Farmland Conservation Program

[2] 2010 total conservation lands includes all Williamson Act lands, Farmland Security Zone lands, and Agricultural Conservation Easements in 2010.

California Farmland Conservancy Program The California Farmland Conservancy Program (CFCP) is a voluntary program that seeks to encourage the long-term, private stewardship of agricultural lands through the use of agricultural conservation easements. The CFCP provides grant funding for projects that use and support agricultural conservation easements for protection of agricultural lands. An agricultural conservation easement is a voluntary, legally recorded deed restriction that is placed on a specific property used for agricultural production. The goal of an agricultural conservation easement is to maintain agricultural land in active production by removing the development pressures from the land. Such an easement prohibits practices that would damage or interfere with the agricultural use of the land. Because the easement is a restriction on the deed of the property, the easement remains in effect even when the land changes ownership. Table 12-1 summarizes the agricultural conservation easements in the area of analysis.

Farmland Mapping and Monitoring Program The Farmland Mapping and Monitoring Program (FMMP) was established in 1982 and produces maps and statistical data used for analyzing effects on California's agricultural resources. The maps are updated every two years with the use of aerial photographs, a computer mapping system, public review, and field reconnaissance. The FMMP rates agricultural land according to soil quality and irrigation status and denotes the best quality land Prime Farmland. FMMP characterizes land use into the following categories:

- **Prime Farmland**[2] – Land with the best combination of physical and chemical features able to sustain long-term production of agricultural crops. This land has the soil quality, growing season, and moisture supply needed to produce sustained high yields. Land must have been used for production of irrigated crops at some time during the two-year cycles prior to the mapping update.

- **Farmland of Statewide Importance** – Land similar to Prime Farmland that has a good combination of physical and chemical characteristics for the production of crops. This land has minor shortcomings, such as greater slopes or less ability to store soil moisture than Prime Farmland. Land must have been used for production of irrigated crops at some time during the two update cycles prior to the mapping date.

- **Unique Farmland** – Lesser quality soils used for the production of the state's leading agricultural crops. This land is usually irrigated, but may include non-irrigated orchards or vineyards as found in some climatic zones in California. Land must have been cropped at some time during the two update cycles prior to the mapping date.

[2] The term "Prime" as used here refers to the FMMP's designation of the location and extent of "Prime Farmland" as described above. The state's Williamson Act designates Prime agricultural land based on different economic or production criteria, as described under the Williamson Act section above.

- **Farmland of Local Importance** – Land of importance to the local agricultural economy as determined by each county's board of supervisors and a local advisory committee. Often includes lands used for dryland farming and formerly irrigated land that has been left idle for three or more update cycles.

- **Grazing Land** – Land on which the existing vegetation is suited to the grazing of livestock.

- **Urban and Built-Up Land** – Land occupied by structures with a building density of at least one unit to 1.5 acres, or approximately six structures to one 10-acre parcel.

- **Other Land** – Land that does not meet the criteria of any other category.

- **Water** – Water areas with an extent of at least 40 acres.

12.1.2.3 Regional/Local

The following local policies apply to agricultural lands in the area of analysis.

Tehama County The Tehama County General Plan, Open Space and Conservation Element, includes the following policies in relation to the preservation of agricultural lands (Tehama County 2009):

- Policy OS-9.1: Protect and enhance resource lands for the continued benefit of agriculture, timber, grazing, recreation, waterfowl wildlife habitat, watersheds, and quality of life.

- Policy OS-12.1: Recognize the need to protect and conserve areas where soils have high resource values, especially in terms of potential agricultural productivity.

Glenn County The Glenn County General Plan, Volume I – Policies, includes the following policies in relation to the preservation of agricultural lands (Glenn County 1993):

- Policy NRP-1: Maintain agriculture as a primary, extensive land use, not only in recognition of the economic importance of agriculture, but also in terms of agriculture's contribution to the preservation of open space and wildlife habitat.

- Policy NRP-2: Support the concept that agriculture is a total, functioning system which will suffer when any part of it is subjected to regulation resulting in the decline of agriculture: economics productivity, unmitigated land use conflicts and/or excessive land fragmentation.

- Policy NRP-5: Continue participation in the Williamson Act policy, and allow new lands devoted to commercial agriculture and located outside urban limit lines to enter the program, subject to the specific standards for inclusion in this General Plan.

- Policy NRP-8: Assure future land use decisions protect and enhance the agricultural economics industry while also protecting existing uses from potential incompatibilities.

Glenn County Code Title 15 establishes the Unified Development Code. Section 15.460 describes the Agricultural Preserve (AP) Zone. The AP Zone applies to lands covered by the Williamson Act with the county and has the purpose of:

- Preserving the maximum amount of the limited supply of agricultural land which is necessary in the conservation of the county's economic resources and vital for a health agricultural economy; and,

- Protecting the general welfare of the agricultural community for encroachments of unrelated agricultural uses which, by their nature, would be injurious to the physical and economic well-being of the agricultural community.

The county code defines permitted uses in AP zones. Similarly, Section 15.470 defines FSZs within the county and permitted uses on these lands (Ordinance Number 1183 §2) (Glenn County 2006).

Colusa County   The Conservation Element of Colusa County's 1989 General Plan includes Policy CO-2, which states that agricultural land should be preserved and protected (Colusa County 1989).

Colusa County's Code, Chapter 34, Farming Practices, is intended to, in part, "preserve and protect for agricultural use those lands zoned for agricultural use" (Ordinance Number 510) (Colusa County 2012).

Appendix 1.4, Article 4 of the county's code establishes zoning district regulations for the agricultural preserve zone and the exclusive agriculture zone.

Sutter County   Chapter 4 of the Sutter County General Plan (Sutter County 2011a) addresses agricultural resources and agricultural resource policies within the county. Relevant policies include the following:

- AG 1.1 – Preserve and maintain agriculturally designated lands for agricultural use and direct urban/suburban and other nonagricultural related development to the cities, unincorporated rural communities, and other clearly defined and comprehensively planned development areas.

- AG 1.5 – Discourage the conversion of agricultural land to other uses unless all of the following findings can be made:

- The net community benefit derived from conversion of the land outweighs the need to protect the land for long-term agricultural use;
- There are no feasible alternative locations for the proposed use that would appreciably reduce impacts upon agricultural lands; and,
- The use will not have significant adverse effects, or can mitigate such effects, upon existing and future adjacent agricultural lands and operations.

Chapter 1500, Division 13 of Sutter County's Code establishes the zoning code for unincorporated areas in the county (Sutter County 2011). As with other counties in the area of analysis, the Sutter County zoning code establishes permitted uses for agricultural lands within the unincorporated county.

Yolo County The Yolo County 2030 Countywide General Plan Agriculture and Economic Development Element (Yolo County 2009) addresses the preservation of agricultural resources through the following policies:

- Policy AG-1.2: Maintain parcel sizes outside of the community growth boundaries large enough to sustain viable agriculture and discourage conversion to non-agricultural home sites.
- Policy AG-1.3: Prohibit the division of agricultural land for non-agricultural uses.
- Policy AG-1.4: Prohibit land use activities that are not compatible within agriculturally designated areas.
- Policy AG-1.5: Strongly discourage the conversion of agricultural land for other uses. No lands shall be considered for redesignation from Agricultural or Open Space to another land use designation unless all of the following findings can be made:
- There is a public need or net community benefit derived from the conversion of land that outweighs the need to protect the land for long-term agricultural use;
- There are no feasible alternative locations for the proposed project that are either designated for non-agricultural land uses or are less productive agricultural lands; and,
- The use would not have a significant adverse effect on existing or potential agricultural activities on surrounding lands designated Agriculture.

- Policy AG-1.6: Continue to mitigate at a ratio of no less than 1:1 the conversion of farm land and/or the conversion of land designated or zoned for agriculture, to other uses.

- Policy AG-1.8: Regulate and encourage removal of incompatible land uses and facilities from agriculturally designated lands.

- Policy AG-1.21: Within conservation easements, preclude the practice of fallowing fields for the purpose of water export. Fallowing as a part of normal crop rotation is not subject to this policy.

Yolo County's Code, Title 8, Chapter 2, addresses zoning in the unincorporated county including Agricultural Preserve zones, Agricultural Exclusive zones, and Agricultural General zones (Articles 4, 5, and 6) (Yolo County 2000). The zoning codes establish the principle uses for each agricultural zone.

Santa Cruz County The Santa Cruz County 1994 General Plan Conservation and Open Space Element (Santa Cruz County 1994) addresses the preservation of agricultural resources through the following objective:

- Objective 5.13: To maintain for exclusive agricultural use those lands identified on the County Agricultural Resources Map as best suited to the commercial production of food, fiber and ornamental crops and livestock that agricultural is a priority land use and to resolve policy conflicts in favor of preserving and promoting agriculture on designated commercial agricultural lands.

Santa Clara County The Santa Clara County 2020 General Plan Agriculture and Agricultural Resources Element (Santa Clara County 1994) addresses the preservation of agricultural resources through the following policies:

- Policy R-RC 59: Preserve large parcels of remaining agricultural lands.

- Policy R-RC 65: Maintain and enhance the long-term economic viability of agricultural activities.

- Policy R-RC 66: Promote, preserve, and maintain Williamson Act contracts for agricultural lands.

San Joaquin County The San Joaquin County 1992 General Plan Resources Element (San Joaquin County 1992) addresses the preservation of agricultural resources through the following objective:

- To protect agricultural lands needed for the continuation of commercial agricultural enterprises, small-scale farming operations and the preservation of open space.

Stanislaus County The Stanislaus County General Plan Agricultural Element (Stanislaus County 1992) addresses the preservation of agricultural resources through the following goals:

- Goal 1: Strengthen the agricultural sector of the economy.

- Goal 2: Conserve agricultural lands for agricultural uses.

Merced County Merced County's 2030 General Plan Agricultural Element (Merced County 2013) addresses the preservation of agricultural resources through the following Agricultural Land Preservation goal:

- Goal AG-2: Ensure the long-term preservation and conservation of land used for productive agriculture, potentially-productive agricultural land, and agricultural-support facilities.

Fresno County Fresno County's 2000 General Plan Agriculture and Land Use Element (Fresno County 2014) addresses the preservation of agricultural resources through the following goals and policies:

- Goal LU-A: To promote the long-term conservation of productive and potentially productive agricultural lands and to accommodate agricultural-support services and agriculturally-related activities that support the viability of agriculture and further the County's economic development goals.

- Policy LU-A.16: The County should implement agricultural land preservation programs for long-term conservation of viable agricultural operations. Examples of programs to be considered include: land trusts; conservation easements; dedication incentives; new and continued Williamson Act contracts; Farmland Security Act contracts; the California Farmland Conservancy Program; agricultural education programs; zoning regulations; agricultural mitigation fee program; urban growth boundaries; transfers of development rights; purchases of development rights; and agricultural buffer policies.

Kings County Kings County's 2035 General Plan Resource Conservation Element (Kings County 2010) addresses the preservation of agricultural resources through the following objective:

- RC Objective C1.1: Conserve prime agricultural soils, and avoid their conversion to non-agricultural uses.

Tulare County Tulare County's 2030 General Plan Prosperity Component (Tulare County 2010) addresses the preservation of agricultural resources through the following policies:

- AG-1.1: The County shall maintain agriculture as the primary land use in the valley region of the County, not only in recognition of the economic importance of agriculture, but also in terms of agriculture's real contribution to the conservation of open space and natural resources.

- AG-1.2: The County shall coordinate its agricultural policies and programs with State and federal regulations to preserve agricultural lands.

- AG-1.3: The County should promote the use of the California Land Conservation Act (Williamson Act) on all agricultural lands throughout the County located outside established Urban Development Boundaries (UDBs) and Hamlet Development Boundaries (HDBs). However, this policy carries with it a caveat that support for the Williamson Act as a tax reduction component is premised on continued funding of the State subvention program that offsets the loss of property taxes.

- AG-1.4: The County shall support non-renewal or cancellation processes that meet State law for lands within UDBs and HDBs.

- AG-1.5: The County may work to remove parcels that are less than 10 acres in Prime Farmland and less than 40 Acres in Non-Prime Farmland from Williamson Act Contracts (Williamson Act key term for Prime/Non-Prime).

- AG-1.6: The County shall consider developing an Agricultural Conservation Easement Program (ACEP) to help protect and preserve agricultural lands (including "Important Farmlands"), as defined in this Element. This program may require payment of an in-lieu fee sufficient to purchase a farmland conservation easement, farmland deed restriction, or other farmland conservation mechanism as a condition of approval for conservation of important agricultural land to non-agricultural use. If available, the ACEP shall be used for replacement lands determined to be of statewide significance (Prime or other Important Farmlands), or sensitive and necessary for the preservation of agricultural land, including land that may be a part of a community separator as part of a comprehensive program to establish community separators. The in-lieu fee or other conservation mechanism shall recognize the importance of land value and shall require equivalent mitigation.

- AG-1.7: The County shall promote the preservation of its agricultural economic base and open space resources through the implementation of resource management programs such as the Williamson Act, Rural

Valley Lands Plan, Foothill Growth Management Plan or similar types of strategies and the identification of growth boundaries for all urban areas located in the County.

Kern County Kern County's General Plan, Resource Element (Kern County 2009) addresses the preservation of agricultural resources through the following measures:

- Prime agricultural lands, according to the Kern County Interim-Important Farmland map produced by the Department of Conservation, which have Class I or II soils and a surface delivery water system shall be conserved through the use of agricultural zoning with minimum parcel size provisions.
- Property placed under the Williamson Act/FSZ Contract must be in a Resource designation.

12.1.3 Existing Conditions

The following section describes the existing agricultural resources within the area of analysis.

12.1.3.1 Sacramento Valley

Tehama County In 2010, of the 1,839,494 acres mapped in Tehama County, 1,779,543 were in agricultural use, 13,805 acres were urbanized, 6,182 acres were water, and 39,964 acres were "other" (California DOC, DLRP 2012). Table 12-2 summarizes further land use classifications and net changes in land use categories. In Tehama County, Farmland of Local Importance includes lands which are not included in Prime, Statewide, or Unique and are farmed continuously or on a cyclic basis. Farmland of Local Importance also includes non-irrigated lands within the L category which have soil mapping units listed for Prime or Statewide (California DOC 2011).

Table 12-2. Tehama County Summary and Change by Land Use Category

	Total Acreage Inventoried		2008-10 Acreage Changes			
Land Use Category	**2008**	**2010**	**Acres Lost (-)**	**Acres Gained (+)**	**Total Acreage Changed**	**Net Acreage Changed**
Prime Farmland	63,038	62,175	1,981	1,118	3,099	-863
Farmland of Statewide Importance	17,231	17,304	499	572	1,071	73
Unique Farmland	18,054	19,565	244	1,755	1,999	1,511
Farmland of Local Importance	132,608	132,548	2,442	2,382	4,824	-60
Important Farmland Subtotal	230,931	231,592	5,166	5,827	10,993	661
Grazing Land	1,549,800	1,547,951	2,417	568	2,985	-1,849

Land Use Category	Total Acreage Inventoried 2008	Total Acreage Inventoried 2010	2008-10 Acreage Changes: Acres Lost (-)	Acres Gained (+)	Total Acreage Changed	Net Acreage Changed
Agricultural Land Subtotal	1,780,731	1,779,543	7,583	6,395	13,978	-1,188
Urban and Built-up Land	13,633	13,805	48	220	268	172
Other Land	38,948	39,964	273	1,289	1,562	1,016
Water Area	6,182	6,182	0	0	0	0
Total Area Inventoried	1,839,494	1,839,494	7,904	7,904	15,808	0

Source: California DOC, DLRP 2012.

Glenn County In 2010, of the 849,129 acres mapped in Glenn County, 574,984 were in agricultural use, 6,420 acres were urbanized, 5,950 acres were water, and 261,775 acres were "other" (California DOC, DLRP 2012). Table 12-3 summarizes further land use classifications and net changes in land use categories. In Glenn County, Farmland of Local Importance includes lands which are not included in Prime, Statewide, or Unique and are farmed continuously or on a cyclic basis. Farmland of Local Importance also includes non-irrigated lands which have soil mapping units listed for Prime or Statewide (California DOC 2011).

Table 12-3. Glenn County Summary and Change by Land Use Category

Land Use Category	Total Acreage Inventoried 2008	Total Acreage Inventoried 2010	2008-10 Acreage Changes: Acres Lost (-)	Acres Gained (+)	Total Acreage Changed	Net Acreage Changed
Prime Farmland	159,811	157,940	3,576	1,705	5,281	-1,871
Farmland of Statewide Importance	87,497	87,071	1,244	818	2,062	-426
Unique Farmland	17,306	17,300	1,007	1,001	2,008	-6
Farmland of Local Importance	83,544	85,836	3,446	5,738	9,184	2,292
Important Farmland Subtotal	348,158	348,147	9,273	9,262	18,535	-11
Grazing Land	227,391	226,837	1,587	1,033	2,620	-554
Agricultural Land Subtotal	575,549	574,984	10,860	10,295	21,155	-565
Urban and Built-up Land	6,372	6,420	123	171	294	48
Other Land	261,258	261,775	1,087	1,604	2,691	517
Water Area	5,950	5,950	0	0	0	0
Total Area Inventoried	849,129	849,129	12,070	12,070	24,140	0

Source: California DOC, DLRP 2012.

Colusa County In 2010, of the 740,393 acres mapped in Colusa County, 563,856 were in agricultural use, 5,142 acres were urbanized, 1,911 acres were water, and 169,484 acres were "other" (California DOC, DLRP 2012). Table 12-4 summarizes further land use classifications and net changes in land use categories.

Table 12-4. Colusa County Summary and Change by Land Use Category

Land Use Category	Total Acreage Inventoried		2008-10 Acreage Changes			
	2008	2010	Acres Lost (-)	Acres Gained (+)	Total Acreage Changed	Net Acreage Changed
Prime Farmland	197,497	196,320	1,537	360	1,897	-1,177
Farmland of Statewide Importance	2,012	2,046	14	48	62	34
Unique Farmland	121,186	120,316	1,435	565	2,000	-870
Farmland of Local Importance	235,023	236,013	729	1,719	2,448	990
Important Farmland Subtotal	555,718	554,695	3,715	2,692	6,407	-1,023
Grazing Land	9,111	9,161	49	99	148	50
Agricultural Land Subtotal	564,829	563,856	3,764	2,791	6,555	-973
Urban and Built-up Land	5,111	5,142	26	57	83	31
Other Land	168,542	169,484	406	1,348	1,754	942
Water Area	1,911	1,911	0	0	0	0
Total Area Inventoried	740,393	740,393	4,196	4,196	8,392	0

Source: California DOC, DLRP 2012.

In Colusa County, Farmland of Local Importance includes all farmable lands within the county that do not meet the definitions of Prime, Statewide, or Unique, but are currently irrigated pasture or non-irrigated crops. The classification also includes non-irrigated land with soils qualifying for Prime Farmland or Farmland of Statewide Importance and lands that would have Prime or Statewide designation and have been improved for irrigation but are now idle. Additionally, lands in this category include lands with a General Plan Land Use designation for agricultural purposes, and lands that are legislated to be used only for agricultural (farmland) purposes (California DOC 2011).

Sutter County In 2010, of the 389,314 acres mapped in Sutter County, 339,358 were in agricultural use, 13,560 acres were urbanized, 1,883 acres were water, and 34,513 acres were “other.” (California DOC, DLRP 2012) Table 12-5 summarizes further land use classifications and net changes from 2008 to 2010. In Sutter County, the Board of Supervisors determined there would be no Farmland of Local Importance designation (California DOC 2011).

Table 12-5. Sutter County Summary and Change by Land Use Category

Land Use Category	Total Acreage Inventoried		2008-10 Acreage Changes			
	2008	2010	Acres Lost (-)	Acres Gained (+)	Total Acreage Changed	Net Acreage Changed
Prime Farmland	165,315	162,673	3,266	624	3,890	-2,642
Farmland of Statewide Importance	106,597	105,395	1,709	507	2,216	-1,202
Unique Farmland	19,156	17,752	1,720	316	2,036	-1,404
Farmland of Local Importance	0	0	0	0	0	0
Important Farmland Subtotal	291,068	285,820	6,695	1,447	8,142	-5,248
Grazing Land	52,571	53,538	1,426	2,393	3,819	967
Agricultural Land Subtotal	343,639	339,358	8,121	3,840	11,961	-4,281
Urban and Built-up Land	13,230	13,560	25	355	380	330
Other Land	30,562	34,513	670	4,621	5,291	3,951
Water Area	1,883	1,883	0	0	0	0
Total Area Inventoried	389,314	389,314	8,816	8,816	17,632	0

Source: California DOC, DLRP 2012.

Yolo County In 2010, of the 653,453 acres mapped in Yolo County, 534,984 were in agricultural use, 30,537 acres were urbanized, 7,804 acres were water, and 80,128 acres were "other" (California DOC, DLRP 2012). Table 12-6 summarizes further land use classifications and net increases and reductions in categories from 2008 to 2010. In Yolo County, Farmland of Local Importance includes cultivated farmland having soils which meet the criteria for Prime or Statewide, except that the land is not presently irrigated, and other non-irrigated land (California DOC 2011).

Table 12-6. Yolo County Summary and Change by Land Use Category

Land Use Category	Total Acreage Inventoried		2008-10 Acreage Changes			
	2008	2010	Acres Lost (-)	Acres Gained (+)	Total Acreage Changed	Net Acreage Changed
Prime Farmland	255,193	252,083	3,661	551	4,212	-3,110
Farmland of Statewide Importance	16,793	16,412	568	187	755	-381
Unique Farmland	45,750	43,629	3,071	950	4,021	-2,121
Farmland of Local Importance	60,345	62,410	3,096	5,161	8,257	2,065
Important Farmland Subtotal	378,081	374,534	10,396	6,849	17,245	-3,547
Grazing Land	157,963	160,450	2,337	4,824	7,161	2,487
Agricultural Land Subtotal	536,044	534,984	12,733	11,673	24,406	-1,060
Urban and Built-up Land	30,225	30,537	20	332	352	312
Other Land	79,370	80,128	693	1,451	2,144	758
Water Area	7,814	7,804	10	0	10	-10
Total Area Inventoried	653,453	653,453	13,456	13,456	26,912	0

Source: California DOC, DLRP 2012

12.1.3.2 Central Coast

Santa Cruz County In 2010, of the 285,713 acres mapped in Santa Cruz County, 38,845 acres were in agricultural use, 32,750 acres were urbanized, 357 acres were water and 213,761 acres were "other" (California DOC, DLRP 2012). Table 12-7 summarizes further land use classifications and net changes in land use categories. In Santa Cruz County, Farmland of Local Importance includes lands used for Christmas tree farms and nurseries that do not meet the requirements for Prime, Statewide, or Unique classifications (California DOC 2011).

Table 12-7. Santa Cruz County Summary and Change by Land Use Category

	Total Acreage Inventoried		2008-10 Acreage Changes			
Land Use Category	**2008**	**2010**	**Acres Lost (-)**	**Acres Gained (+)**	**Total Acreage Changed**	**Net Acreage Changed**
Prime Farmland	14,357	13,817	604	64	668	-540
Farmland of Statewide Importance	2,706	2,449	272	15	287	-257
Unique Farmland	4,249	3,763	560	74	634	-486
Farmland of Local Importance	516	548	5	37	42	32
Important Farmland Subtotal	21,828	20,577	1,441	190	1,631	-1,251
Grazing Land	17,952	18,268	238	554	792	316
Agricultural Land Subtotal	39,780	38,845	1,679	744	2,423	-935
Urban and Built-up Land	32,013	32,750	47	784	831	737
Other Land	213,563	213,761	809	1,007	1,816	198
Water Area	357	357	0	0	0	0
Total Area Inventoried	285,713	285,713	2,535	2,535	5,070	0

Source: California DOC, DLRP 2012.

Santa Clara County In 2010, of the 835,223 acres mapped in Santa Clara County, 420,528 were in agricultural use, 189,129 acres were urbanized, 8,458 acres were water, and 217,108 acres were "other" (California DOC, DLRP 2012). Table 12-8 summarizes further land use classifications and net changes in land use categories. In Santa Clara County, Farmland of Local Importance includes small orchards, vineyards, and dry croplands for grains and hay (California DOC 2011).

Table 12-8. Santa Clara County Summary and Change by Land Use Category

Land Use Category	Total Acreage Inventoried		2008-10 Acreage Changes			
	2008	2010	Acres Lost (-)	Acres Gained (+)	Total Acreage Changed	Net Acreage Changed
Prime Farmland	18,804	17,270	1,701	167	1,868	-1,534
Farmland of Statewide Importance	4,028	3,630	415	17	432	-398
Unique Farmland	2,489	2,523	279	313	592	34
Farmland of Local Importance	5,967	4,328	2,211	572	2,783	-1,639
Important Farmland Subtotal	31,288	27,751	4,606	1,069	5,675	-3,537
Grazing Land	390,091	392,777	792	3,478	4,270	2,686
Agricultural Land Subtotal	421,379	420,528	5,398	4,547	9,945	-851
Urban and Built-up Land	188,882	189,129	189	436	625	247
Other Land	216,504	217,108	460	1,064	1,524	604
Water Area	8,458	8,458	0	0	0	0
Total Area Inventoried	835,223	835,223	6,047	6,047	12,094	0

Source: California DOC, DLRP 2012.

12.1.3.3 San Joaquin River

San Joaquin County In 2010, of the 912,593 acres mapped in San Joaquin County, 754,229 acres were in agricultural use, 91,929 acres were urbanized, 11,773 acres were water, and 54,662 acres were "other" (California DOC, DLRP 2012). Table 12-9 summarizes further land use classifications and net changes in land use categories. In San Joaquin County, Farmland of Local Importance includes all farmable land not meeting the requirements of Prime, Statewide, or Unique and any recently idle lands with soils previously designated by characteristics of those aforementioned categories (California DOC 2011).

Table 12-9. San Joaquin County Summary and Change by Land Use Category

Land Use Category	Total Acreage Inventoried		2008-10 Acreage Changes			
	2008	2010	Acres Lost (-)	Acres Gained (+)	Total Acreage Changed	Net Acreage Changed
Prime Farmland	396,984	385,337	12,570	923	13,493	-11,647
Farmland of Statewide Importance	86,297	83,307	3,202	212	3,414	-2,990
Unique Farmland	66,621	69,481	1,590	4,450	6,040	2,860
Farmland of Local Importance	65,788	76,869	3,644	14,725	18,369	11,081
Important Farmland Subtotal	615,690	614,994	21,006	20,310	41,316	-696
Grazing Land	142,460	139,235	3,341	116	3,457	-3,225

Land Use Category	Total Acreage Inventoried		2008-10 Acreage Changes			
	2008	2010	Acres Lost (-)	Acres Gained (+)	Total Acreage Changed	Net Acreage Changed
Agricultural Land Subtotal	758,150	754,229	24,347	20,426	44,773	-3,921
Urban and Built-up Land	90,529	91,929	127	1,527	1,654	1,400
Other Land	52,141	54,662	838	3,359	4,197	2,521
Water Area	11,773	11,773	0	0	0	0
Total Area Inventoried	912,593	912,593	25,312	25,312	50,624	0

Source: California DOC, DLRP 2012.

Stanislaus County In 2012, of the 970,168 acres mapped in Stanislaus County, 832,453 were in agricultural use, 64,822 acres were urbanized, 7,465 acres were water, and 65,428 acres were "other" (California DOC, DLRP 2012). Table 12-10 summarizes further land use classifications and net changes in land use categories. In Stanislaus County, Farmland of Local Importance includes dryland pastures and small grains, as well as irrigated pasture (California DOC 2011).

Table 12-10. Stanislaus County Summary and Change by Land Use Category

Land Use Category	Total Acreage Inventoried		2010-12 Acreage Changes			
	2010	2012	Acres Lost (-)	Acres Gained (+)	Total Acreage Changed	Net Acreage Changed
Prime Farmland	253,434	251,723	3,037	1,326	4,363	-1,711
Farmland of Statewide Importance	31,475	31,765	297	587	884	290
Unique Farmland	87,524	95,187	715	8,378	9,093	7,663
Farmland of Local Importance	31,366	31,331	2,312	2,277	4,589	-35
Important Farmland Subtotal	403,799	410,006	6,361	12,568	18,929	6,207
Grazing Land	429,545	422,447	8,968	1,870	10,838	-7,098
Agricultural Land Subtotal	833,344	832,453	15,329	14,438	29,767	-891
Urban and Built-up Land	64,529	64,822	76	369	445	293
Other Land	64,830	65,428	521	1,119	1,640	598
Water Area	7,465	7,465	0	0	0	0
Total Area Inventoried	970,168	970,168	15,926	15,926	31,852	0

Source: California DOC, DLRP 2012.

Merced County In 2012, of the 1,265,613 acres mapped in Merced County, 1,158,642 acres were in agricultural use, 38,736 acres were urbanized, 16,674 acres were water, and 51,561 acres were "other" (California DOC, DLRP 2012). Table 12-11 summarizes further land use classifications and net changes in land use categories.

Table 12-11. Merced County Summary and Change by Land Use Category

Land Use Category	Total Acreage Inventoried		2010-12 Acreage Changes			
	2010	2012	Acres Lost (-)	Acres Gained (+)	Total Acreage Changed	Net Acreage Changed
Prime Farmland	271,100	271,812	1,106	1,818	2,924	712
Farmland of Statewide Importance	151,337	153,103	604	2,370	2,974	1,766
Unique Farmland	109,028	110,698	2,799	4,469	7,268	1,670
Farmland of Local Importance	65,057	62,925	6,588	4,456	11,044	-2,132
Important Farmland Subtotal	596,522	598,538	11,097	13,113	24,210	2,016
Grazing Land	562,461	560,104	2,712	355	3,067	-2,357
Agricultural Land Subtotal	1,158,983	1,158,642	13,809	13,468	27,277	-341
Urban and Built-up Land	38,376	38,736	77	437	514	360
Other Land	51,395	51,561	871	1,037	1,908	166
Water Area	16,859	16,674	185	0	185	-185
Total Area Inventoried	1,265,613	1,265,613	14,942	14,942	29,884	0

Source: California DOC, DLRP 2012.

Merced County defines Farmland of Local Importance as farmlands that have physical characteristics that would qualify for Prime or Statewide except for the lack of irrigation water. Merced County also includes farmlands that produce crops not listed under Unique but are important to the economy of the county or city (California DOC 2011).

12.1.3.4 Tulare Lake

Fresno County In 2008, of the 2,437,414 acres mapped in Merced County, 2,196,025 acres were in agricultural use, 120,753 acres were urbanized, 4,914 acres were water, and 115,722 acres were "other" (California DOC, DLRP 2012). Table 12-12 summarizes further land use classifications and net changes in land use categories.

Table 12-12. Fresno County Summary and Change by Land Use Category

Land Use Category	Total Acreage Inventoried		2008-10 Acreage Changes			
	2008	2010	Acres Lost (-)	Acres Gained (+)	Total Acreage Changed	Net Acreage Changed
Prime Farmland	693,174	685,411	11,052	3,289	14,341	-7,763
Farmland of Statewide Importance	439,020	415,689	24,776	1,445	26,221	-23,331
Unique Farmland	94,177	92,649	2,065	537	2,602	-1,528
Farmland of Local Importance	149,907	176,524	7,963	34,580	42,543	26,617
Important Farmland Subtotal	1,376,278	1,370,273	45,856	39,851	85,707	-6,005
Grazing Land	826,953	825,752	1,423	222	1,645	-1,201
Agricultural Land Subtotal	2,203,231	2,196,025	47,279	40,073	87,352	-7,206

Land Use Category	Total Acreage Inventoried		2008-10 Acreage Changes			
	2008	2010	Acres Lost (-)	Acres Gained (+)	Total Acreage Changed	Net Acreage Changed
Urban and Built-up Land	117,567	120,753	399	3,585	3,984	3,186
Other Land	111,702	115,722	2,208	6,228	8,436	4,020
Water Area	4,914	4,914	0	0	0	0
Total Area Inventoried	2,437,414	2,437,414	49,886	49,886	99,772	0

Source: California DOC, DLRP 2012.

In Fresno County, all farmable lands within the county that do not meet the definitions of Prime, Statewide, or Unique are defined as Farmland of Local Importance. This definition includes land that is or has been used for irrigated pasture, dryland farming, confined livestock and dairy, poultry facilities, aquaculture and grazing land (California DOC 2011).

Kings County In 2012, of the 890,785 acres mapped in Kings County, 822,143 were in agricultural use, 36,640 acres were urbanized, 62 acres were water, and 31,940 acres were "other" (California DOC, DLRP 2012). Table 12-13 summarizes further land use classifications and net changes from 2008 to 2010. Lands that support dairies, confined livestock, and poultry operations are defined as Farmland of Local Importance in Kings County (California DOC 2011).

Table 12-13. Kings County Summary and Change by Land Use Category

Land Use Category	Total Acreage Inventoried		2010-12 Acreage Changes			
	2010	2012	Acres Lost (-)	Acres Gained (+)	Total Acreage Changed	Net Acreage Changed
Prime Farmland	130,258	118,449	12,083	274	12,357	-11,809
Farmland of Statewide Importance	388,891	376,869	13,104	1,082	14,186	-12,022
Unique Farmland	21,802	19,864	2,118	180	2,298	-1,938
Farmland of Local Importance	11,136	11,152	102	118	220	16
Important Farmland Subtotal	552,087	526,334	27,407	1,654	29,061	-25,753
Grazing Land	271,830	295,809	1,829	25,808	27,637	23,979
Agricultural Land Subtotal	823,917	822,143	29,236	27,462	56,698	-1,774
Urban and Built-up Land	35,847	36,640	84	877	961	793
Other Land	30,959	31,940	414	1,395	1,809	981
Water Area	62	62	0	0	0	0
Total Area Inventoried	890,785	890,785	29,734	29,734	59,468	0

Source: California DOC, DLRP 2012.

Tulare County In 2010, of the 1,585,869 acres mapped in Tulare County, 1,300,033 were in agricultural use, 59,944 acres were urbanized, 4,656 acres were water, and 221,236 acres were "other" (California DOC, DLRP 2012). Table

12-14 summarizes further land use classifications and net changes in land use categories. In Tulare County, Farmlands of Local Importance are defined as lands that produce dryland grains, lands that have all the physical characteristics to qualify as Prime or Statewide but lack irrigation, and lands that support livestock, poultry, and/or aquaculture operations (California DOC 2011).

Table 12-14. Tulare County Summary and Change by Land Use Category

Land Use Category	Total Acreage Inventoried		2008-10 Acreage Changes			
	2008	2010	Acres Lost (-)	Acres Gained (+)	Total Acreage Changed	Net Acreage Changed
Prime Farmland	375,119	370,249	6,071	1,201	7,272	-4,870
Farmland of Statewide Importance	327,204	323,599	6,606	3,001	9,607	-3,605
Unique Farmland	11,919	11,593	545	219	764	-326
Farmland of Local Importance	150,193	154,550	4,280	8,637	12,917	4,357
Important Farmland Subtotal	864,435	859,991	17,502	13,058	30,560	-4,444
Grazing Land	439,851	440,042	246	437	683	191
Agricultural Land Subtotal	1,304,286	1,300,033	17,748	13,495	31,243	-4,253
Urban and Built-up Land	57,947	59,944	93	2,090	2,183	1,997
Other Land	218,980	221,236	1,144	3,400	4,544	2,256
Water Area	4,656	4,656	0	0	0	0
Total Area Inventoried	1,585,869	1,585,869	18,985	18,985	37,970	0

Source: California DOC, DLRP 2012.

Kern County In 2010, of the 5,224,262 acres mapped in Kern County, 2,741,475 were in agricultural use, 141,899 acres were urbanized, 9,890 acres were water, and 2,330,998 acres were “other” (California DOC, DLRP 2012). Table 12-15 summarizes further land use classifications and net changes in land use categories. In Kern County, the Board of Supervisors determined there would be no Farmland of Local Importance designation (California DOC 2011).

Table 12-15. Kern County Summary and Change by Land Use Category

Land Use Category	Total Acreage Inventoried 2008	Total Acreage Inventoried 2010	2008-10 Acreage Changes: Acres Lost (-)	Acres Gained (+)	Total Acreage Changed	Net Acreage Changed
Prime Farmland	626,217	608,789	19,583	2,155	21,738	-17,428
Farmland of Statewide Importance	216,347	213,465	3,957	1,075	5,032	-2,882
Unique Farmland	96,657	91,830	5,213	386	5,599	-4,827
Farmland of Local Importance	0	0	0	0	0	0
Important Farmland Subtotal	939,221	914,084	28,753	3,616	32,369	-25,137
Grazing Land	1,807,069	1,827,391	4,113	24,435	28,548	20,322
Agricultural Land Subtotal	2,746,290	2,741,475	32,866	28,051	60,917	-4,815
Urban and Built-up Land	138,696	141,899	260	3,463	3,723	3,203
Other Land	2,329,396	2,330,998	2,709	4,311	7,020	1,602
Water Area	9,880	9,890	1	11	12	10
Total Area Inventoried	5,224,262	5,224,262	35,836	35,836	71,672	0

Source: California DOC, DLRP 2012.

12.2 Environmental Consequences

These sections describe the environmental consequences associated with each alternative.

12.2.1 Assessment Methods

To analyze impacts to agricultural resources, potential changes in agricultural land use were evaluated quantitatively within the counties that would be affected by changes in CVP allocations to agricultural water service contractors. Changes in CVP allocations were modeled using the CalSim II model. The CalSim II model results were then used by the Statewide Agricultural Production (SWAP) model to evaluate the effects on agricultural production from changes in CVP allocations under each alternative. The SWAP model is a regional agricultural production and economic optimization model that simulates the decisions of farmers across 93 percent of agricultural land in California. The SWAP modeling analyzed irrigated acreage by crop type in all water year types for the Sacramento Valley, San Joaquin River, and Tulare Lake regions (see Table 12-16). Information on the CalSim II model can be found in Appendix B, Water Operations Model Documentation. SWAP model documentation in included as Appendix D, Statewide Agricultural Production Model Documentation.

Table 12-16. California Counties Covered by the SWAP Model

Sacramento Valley	San Joaquin River	Tulare Lake
Tehama	San Joaquin	Fresno
Glenn	Stanislaus	Kings
Colusa	Merced	Tulare
Sutter		Kern
Yolo		

12.2.2 Alternative 1: No Action

Reductions in CVP deliveries to agricultural water service contractors under the No Action Alternative could substantially or permanently affect or convert lands categorized as Prime Farmland, Farmland of Statewide Importance, or Unique Farmland under the FMMP compared to existing conditions. Under the No Action Alternative, CVP deliveries to agricultural water service contractors in all areas would be less than under existing conditions primarily as a result of the No Action Alternative's operation with projected future population growth and the associated increases in M&I water demands in all water years (see Chapter 4 for further information on the changes in CVP deliveries to agricultural water service contractors). However, there would be some minor increases in irrigated acreage as agricultural water service contractors are able to make use of other supplemental supplies. Table 12-17 shows the estimated change in the number of acres of cropland that are expected under the No Action Alternative compared to existing conditions for the areas that are covered under the SWAP model. In general, under all year types and all agricultural areas, the number acres of field and forage crops would decrease, while the acreage of grain, vegetable and truck crops, and orchard and vineyards would increase. The No Action Alternative would cause an adverse impact to the Sacramento Valley Region by reducing agricultural acreage by a total of 12,850 acres (approximately a one percent loss). However, with the exception of critical years in the Sacramento Valley Region, there would be minimal loses to irrigated farmlands in the other regions for all year types.

Table 12-17. Changes in Irrigated Farmlands between the No Action Alternative and Existing Conditions (thousands acres)

Sac Yr Type	Grain	Field	Forage	Vegetable/ Truck Crops	Orchards & Vineyards	Total	Percent Change
Sacramento Valley							
W	25	-11	-24	11	1	3	0.2%
AN	25	-11	-24	11	1	2	0.1%
BN	26	-9	-27	11	1	2	0.1%
D	23	-12	-22	11	1	-1	0.0%
C	20	-11	-23	10	-9	-13	-1.0%
San Joaquin River							
W	2	-3	-24	22	6	3	0.2%
AN	2	-3	-24	22	6	3	0.2%
BN	2	-3	-25	22	6	3	0.2%

Sac Yr Type	Grain	Field	Forage	Vegetable/ Truck Crops	Orchards & Vineyards	Total	Percent Change
D	2	-3	-25	22	6	2	0.2%
C	2	-2	-24	22	6	4	0.3%
Tulare Lake							
W	3	-19	-14	26	13	8	0.3%
AN	3	-19	-14	26	13	8	0.3%
BN	4	-9	-16	29	13	20	0.9%
D	6	-29	-12	32	13	11	0.5%
C	8	-44	-12	34	14	1	0.0%

Note: Negative numbers indicate that the No Action Alternative would decrease total irrigated farmland compared to the existing conditions; positive numbers indicate that the No Action Alternative would increase total irrigated farmland.

Key: Sac Yr Type = year type, W = wet, AN = above normal, BN = below normal, D = dry, C = critical

Reduced CVP water supply allocations to agricultural water service contractors could result in increased land idling in Santa Clara and Santa Cruz counties. As shown in Tables 12-7 and 12-8, these counties have lost acres of prime farmland, farmland of statewide importance, and unique farmland (with the exception of Santa Clara County which gained 34 acres) in recent years. Much of this acreage was converted to non-irrigated land uses because it was fallow for three or more update cycles. This trend would likely continue under the No Action Alternative. Land reclassified to a non-irrigated uses would not be a permanent change in land use; farmers can place previously idled lands back into production and land could be reclassified to its previous status.

Reductions in CVP deliveries to agricultural water service contractors could convert agricultural lands under the Williamson Act and other land resource programs to an incompatible use. Reductions in CVP water allocations to agricultural water service contractors under the No Action Alternative could cause cropland to be idle in critical years (as indicated by the negative numbers), as shown in Table 12-17. Some farmers may choose to take land out of production for one or two years and others may remove land from agricultural production for the long-term if reduced allocations are expected to prolong and increase. Under the No Action Alternative, lands taken out of agricultural production temporarily would not affect Williamson Act or FSZ contracts. Some land may be reclassified as Non-Prime, but the land would still be in the program and be compatible with agricultural uses. As shown in Table 12-1, from 2010 to 2011, most counties in the area of analysis had minor decreases in the amount of acreage in Williamson Act contracts, ranging from a decrease of 14.7 percent to an increase of 2.64 percent, depending upon the county (not including Stanislaus County, which had a 100 percent decrease in Williamson Act lands). This trend is expected to continue under the No Action Alternative.

The No Action Alternative could cause indirect effects from actions agricultural water service contractors would take from future reduced water allocations. Agricultural water service contractors would have reduced allocations of CVP water under the No Action Alternative compared to existing conditions. To supplement reduced CVP water supplies, it is possible that agricultural water service contractors could participate in water transfers from contractors north of the Delta in order to obtain additional water. Contractors making water available for sale and transfer could use cropland idling as a method to increase water supplies to buyers south of the Delta. Indirect effects of these activities could include decreased agricultural land in production north of the Delta and increased agricultural land in production south of the Delta.

12.2.3 Alternative 2: Equal Agricultural and M&I Allocation

Changes in CVP deliveries to agricultural water service contractors could substantially or permanently affect or convert lands categorized as Prime Farmland, Farmland of Statewide Importance, or Unique Farmland under the FMMP compared to the No Action Alternative.

As described in Chapter 4, under Alternative 2, there would be an increase in CVP deliveries to agricultural water service contractors, while there would be a decrease in CVP deliveries to M&I contractors. These increased volume of CVP deliveries to agricultural water service contractors could result in changes in irrigated crop acreage in the future. Existing croplands would be irrigated and there would be a reduction in cropland idling that may otherwise occur under the No Action Alternative. Table 12-18 shows the estimated change in the number of acres of cropland that could be expected under Alternative 2 as compared to the No Action Alternative for the areas that are covered under the SWAP model. With the exception of the increase in field crops in the Tulare Lake Region for dry and critical years, the expected change in irrigated crops for the SWAP modeled areas would be minimal. The total impacts per region are expected to range from no change to an increase of 1.6 percent in total irrigated acreage. For the agricultural areas not analyzed by the SWAP model, it is assumed effects would be similar to those shown in Table 12-18 because all CVP agricultural water service contractors would be similarly affected by changes in south of the Delta CVP water allocations.

Table 12-18. Changes in Irrigated Farmlands between Alternative 2 and the No Action Alternative (thousands acres)

Sac Yr Type	Grain	Field	Forage	Vegetable/ Truck Crops	Orchards & Vineyards	Total	Percent Change
Sacramento Valley							
W	0.00	0.00	0.00	0	0	0	0.0%
AN	0.00	0.00	0.00	0	0	0	0.0%
BN	0.05	0.08	2.93	0.03	0.03	3.12	0.2%
D	3.35	1.56	0.02	0.21	0.17	5.31	0.4%
C	1.96	0.02	0.05	0.06	7.54	9.63	0.7%
San Joaquin River							
W	0	0	0.1	0	0	0.1	0.0%
AN	0	0	0.1	0	0	0.1	0.0%
BN	0	0.1	-0.1	0	0	0	0.0%

Sac Yr Type	Grain	Field	Forage	Vegetable/ Truck Crops	Orchards & Vineyards	Total	Percent Change
D	0	-0.1	0	0	0	0	0.0%
C	0	0	0.1	0	-0.1	0	0.0%
Tulare Lake							
W	0	0	0	0	0	0	0.0%
AN	0	0	0	0	0	0	0.0%
BN	-0.2	3	4	-0.1	0.1	7	0.3%
D	0.1	28	0.1	0.3	0.1	29	1.3%
C	0	34	0.1	0	-0.1	34	1.6%

Note: Negative numbers indicate that Alternative 2 would decrease total irrigated farmland compared to the existing conditions; positive numbers indicate that Alternative 2 would increase total irrigated farmland.
Key: Sac Yr Type = year type, W = wet, AN = above normal, BN = below normal, D = dry, C = critical

Changes in CVP deliveries to agricultural water service contractors could result in the conversion of agricultural lands under the Williamson Act and other land resource programs to an incompatible use. As discussed above, with the exception of the larger increase (greater than 10 percent) in field crops in Tulare Lake Region in dry and critical years, there would be very small positive changes, or no change, to irrigated acreage under Alternative 2. Therefore, Alternative 2 would not result in the conversion of agricultural land to an incompatible use.

Implementation of Alternative 2 could cause indirect effects from actions contractors would take from future water shortages. Because agricultural contractors would have a larger allocation of water during water shortages compared to the No Action Alternative, no additional actions to supplement water are expected to occur. As a result, there would be no indirect effects from implementation of Alternative 2.

12.2.4 Alternative 3: Full M&I Allocation Preference

Reductions in CVP deliveries to agricultural water service contractors could substantially or permanently affect or convert lands categorized as Prime Farmland, Farmland of Statewide Importance, or Unique Farmland under the FMMP. As described in Chapter 4, under the Alternative 3, there would be a decrease in CVP deliveries to agricultural water service contractors during water shortage years compared to the No Action Alternative. This could result in changes to irrigated crop acreage. Table 12-19 shows the estimated change in the number of acres of cropland that could be expected under Alternative 3 as compared to the No Action Alternative for the areas that are analyzed by the SWAP model. Alternative 3 would cause an adverse impact to the Tulare Lake region by reducing agricultural acreage by 22,880 acres (approximately a 1 percent decrease). For all other year types and regions, the total expected change in irrigated acreage would be a reduction of less than one percent. For the agricultural areas not analyzed by the SWAP model, it is assumed effects would be similar to those shown in Table 12-19 because all CVP agricultural water service contractors would be similarly affected by changes in south of Delta CVP water allocations.

Table 12-19. Changes in Irrigated Farmlands between Alternative 3 and the No Action Alternative (thousands acres)

Sac Yr Type	Grain	Field	Forage	Vegetable/ Truck Crops	Orchards & Vineyards	Total	Percent Change
Sacramento Valley							
W	0	0	0	0	0	0	0.0%
AN	0	0	0	0	0	0	0.0%
BN	-0.3	-0.8	0	-0.1	-0.2	-1	-0.1%
D	-2	-0.8	0	0	0	-3	-0.2%
C	-0.1	-0.1	0	0	-4	-4	-0.3%
San Joaquin River							
W	0	0	0	0	0	0	0.0%
AN	0	0	0	0	0	0	0.0%
BN	0	0	0.1	0	0	0	0.0%
D	0	0	0	0	0	0	0.0%
C	-0.1	-0.1	-0.1	0.1	0.1	-0.1	0.0%
Tulare Lake							
W	0	0	0	0	0	0	0.0%
AN	0	0	0	0	0	0	0.0%
BN	0.3	-3	-4	0.2	-0.1	-7	-0.3%
D	0	-18	0	-0.1	0	-18	-0.8%
C	-6	-9	-0.1	-6	-2	-23	-1.1%

Note: Negative numbers indicate that Alternative 3 would decrease total irrigated farmland compared to the existing conditions; positive numbers indicate that Alternative 3 would increase total irrigated farmland.
Key: Sac Yr Type = year type, W = wet, AN = above normal, BN = below normal, D = dry, C = critical

Changes in CVP deliveries to agricultural water service contractors could result in the conversion of agricultural lands under the Williamson Act and other land resource programs to an incompatible use. As previously discussed, there would be small losses to irrigated acreage from a reduction in CVP deliveries to agricultural water service contractors both north and south of the Delta. The change in irrigated acreage across all regions and water year types would be one percent or less, and would not be expected to result in permanent changes to the land or conversion of agricultural land to an incompatible use.

Alternative 3 could cause indirect effects from actions contractors would take from future water shortages. Agricultural water service contractors would have reduced allocations of CVP water under the Alternative 3 compared to the No Action Alternative. To supplement reduced CVP water supplies, it is possible that agricultural water service contractors could participate in water transfers from contractors north of the Delta in order to obtain additional water. Contractors making water available for sale and transfer could use cropland idling as a method to increase water supplies to buyers south of the Delta. Indirect effects of these activities could include decreased agricultural land in production north of the Delta and increased agricultural land in production south of the Delta.

12.2.5 Alternative 4: Updated M&I WSP

CVP deliveries to agricultural water service contractors under Alternative 4 would be similar to CVP deliveries to agricultural water service contractors under the No Action Alternative; therefore, there would be no changes to agricultural resources within the area of analysis under Alternative 4.

12.2.6 Alternative 5: M&I Contractor Suggested WSP

CVP deliveries to agricultural water service contractors under Alternative 5 would be similar to CVP deliveries to agricultural water service contractors under the No Action Alternative; therefore, there would be no changes to agricultural resources within the area of analysis under Alternative 5.

12.3 Mitigation Measures

There are no mitigation measures identified for the adverse impacts anticipated in Alternative 3.

12.4 Unavoidable Adverse Impacts

Alternative 3 would result in a decrease in irrigated acreage in the Tulare Lake Region of up to 1.1 percent.

12.5 Cumulative Effects

The timeline for the surface water cumulative effects analysis extends from 2010 through 2030, a 20-year period. The relevant geographic study area for the cumulative effects analysis is the same area of analysis as shown in Figure 12-1. The following section analyzes the cumulative effects using the project method, which is further described in Chapter 20, Cumulative Effects Methodology. The cumulative effects analysis for agricultural resources considers State Water Project (SWP) water transfers and the Long-Term Water Transfers project. Chapter 20 further describes these projects and policies.

12.5.1 Alternative 2: Equal Agricultural and M&I Allocation

Changes in CVP deliveries to agricultural water service contractors could substantially or permanently affect or convert lands categorized as Prime Farmland, Farmland of Statewide Importance, or Unique Farmland under the FMMP. Water management activities that could result in cumulative effects with the M&I WSP include annual transfers, analyzed in the Long-Term Water Transfers Environmental Impact Statement/Environmental Impact Report (EIS/EIR); and annual transfers of water from SWP contractors. Annual transfers of water could increase the amount of water available to agricultural water service contractors south of the Delta. As part of the annual transfers contemplated in the Long-term Water

Transfers EIS/EIR, croplands north of the delta could be idled to increase the available agricultural water supply.

Cropland idling undertaken by SWP contractors to make water available for transfer could result in a maximum of 64,750 acres of idled farmland. Similar to cropland idling undertaken by CVP contractors to make water available for transfer, cropland idling actions taken by SWP contractors would be a temporary effect and would not result in land being converted to incompatible uses. Under the cumulative condition, land classifications could change if parcels are repeatedly idled under other water transfer programs. Water could be made available for transfer in Sutter County by both CVP and SWP contractors, although projected transfers by SWP contractors in Sutter County are relatively small.

Changes in CVP deliveries to agricultural water service contractors could result in the conversion of agricultural lands under the Williamson Act and other land resource programs to an incompatible use. As previously described, cropland idling caused by changes in CVP deliveries to agricultural water service contractors during water shortage years under Alternative 2 or actions undertaken by SWP contractors to make water available for transfer would be minimal and temporary in nature; and transfers would affect a small percentage of the overall Important Farmland acres within counties in the area of analysis.

Cropland idling actions undertaken to make water available for transfer, as analyzed in the Long-Term Water Transfers EIS/EIR, could cause a conversion of agricultural lands and the reclassification of FMMP designations. While counties in the area set policies to guide development in ways that conserve agricultural lands, permanent conversions of agricultural lands would continue in the future. As such, all city general plans acknowledge the possibility of future pressures for annexation of lands designated as agriculture. However, the M&I WSP would not cause any permanent conversions of agricultural lands, and therefore would not contribute to this cumulative impact.

12.5.2 Alternative 3: Full M&I Allocation Preference

Cumulative effects would be the same or less than those described for Alternative 2. Therefore, there would be no minimal cumulative effects on agricultural resources.

12.5.3 Alternative 4: Updated M&I WSP

Cumulative effects would be the same or less than those described for the No Action Alternative. Therefore, there would be no cumulative effects on agricultural resources as compared to the No Action Alternative.

12.5.4 Alternative 5: M&I Contractor Suggested WSP

Cumulative effects would be the same or less than those described for the No Action Alternative. Therefore, there would be no cumulative effects on agricultural resources as compared to the No Action Alternative.

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Chapter 13 Socioeconomics

This chapter presents the socioeconomic environment within the area of analysis and discusses potential effects on regional economics from the proposed alternatives.

13.1 Affected Environment

This section describes the area of analysis and affected environment for socioeconomics.

13.1.1 Area of Analysis

The area of analysis for socioeconomics includes counties where Central Valley Project (CVP) water service contractors affected by the CVP Municipal and Industrial Water Shortage Policy (M&I WSP) are located. See Chapter 1, Introduction, for a list of applicable CVP contractors. These CVP water service contractors have service areas north of the Sacramento-San Joaquin River Delta (Delta) throughout the Sacramento Valley along both the Sacramento and American rivers, in areas of the San Joaquin Valley ranging from the Delta south to Kern County, and in the Bay Area region. The socioeconomic area of analysis is divided into the following regions, which are made up of counties grouped together based on whether the major water use is agricultural or M&I.

- Sacramento Valley Region – most CVP water use is agricultural
- American River Region – most CVP water use is M&I
- San Joaquin Valley Region – most CVP water use is agricultural
- Bay Area Region – most CVP water use is M&I

Figure 13-1 shows the socioeconomic area of analysis. In many of the counties, CVP service areas are a small fraction of the county area and CVP water supplies are a small fraction of all water supplies. In some counties, CVP service areas and water supplies are important shares of the totals. Chapter 4, Surface Water, provides data on water supplies for the CVP contractors.

Figure 13-1. Socioeconomic Area of Analysis

13.1.2 Regulatory Setting

Under the National Environmental Policy Act (NEPA), economic or social effects must be discussed if they are inter-related to the natural or physical environmental effects of a project. NEPA states the following with regard to analysis of economic effects (Title 40, Code of Federal Regulations, Section 1508.14):

> *"…economic or social effects are not intended by themselves to require preparation of an environmental impact statement. When an environmental impact statement is prepared and economic or social and natural or physical effects are interrelated, then the environmental impact statement will discuss all of these effects on the human environment."*

Since economic effects of the project are related to physical environmental effects, a NEPA economic analysis is required.

Local governments have adopted policies and ordinances to protect local economies. County and city general plans in the area of analysis have policies for economic development, including the promoting the agricultural economy.

13.1.3 Existing Conditions

This section presents the regional economic conditions within the socioeconomics area of analysis. The section first presents the 2011 economy by region as defined by the area of analysis, and then summarizes the 2011 economy of each individual county in the region. Chapter 12, Agricultural Resources, presents data on agricultural production and irrigated acreage in each county.

Regional economic data is shown for output, employment, labor income, and value added. Output represents the dollar value of industry production. Employment is measured in number of jobs. Income is the dollar value of total payroll for each industry plus income received by self-employed individuals. Total value added is the difference between an industry's total output and cost of its intermediate inputs. It consists of compensation of employees, taxes on production and imports less subsidies and gross operating surplus. Chapter 14 presents demographic data for the counties in the area of analysis.

13.1.3.1 Sacramento Valley Region

The CVP water service contractors within the Sacramento Valley Region have service areas within Colusa, Glenn, Shasta, Tehama, and Yolo counties. Table 13-1 presents the regional economy for this entire region, followed by a discussion of the regional economy in each individual county.

With the exception of Yolo County, the counties in the Sacramento Valley Region have economies that are largely dependent on agricultural production for output, employment and labor income. Yolo County also has an important agricultural economy, but is supported by more urban-based industries as it is adjacent to the Sacramento metropolitan area and contains the University of California at Davis.

In 2011, the total population in the 5-county region was 493,106 (IMPLAN Group, LLC 2012).

CVP contractors in this region deliver both irrigation and M&I water supplies. Most CVP water provided in the region is used for irrigation for agricultural production.

In 2011, services provided the most jobs (102,981 jobs) in the region, followed by government (54,474 jobs), trade (32,544 jobs) and agriculture (19,873 jobs). Services also had the highest output ($12.4 billion) of all industries in the region, followed by manufacturing ($5.1 billion), government ($4.8 billion), and trade ($3.3 billion).

Table 13-1. Sacramento Valley Region 2011 Regional Economy Summary (Colusa, Glenn, Shasta, Tehama, and Yolo Counties)

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	19,873	$2,749.8	$821.8	$1,224.0
Mining	1,310	$303.9	$37.1	$125.8
Construction	12,487	$1,437.8	$673.2	$788.8
Manufacturing	11,920	$5,089.3	$708.8	$1,159.3
Transportation, Information, Public Utilities (TIPU)	14,603	$2,513.9	$757.2	$1,221.4
Trade	32,544	$3,286.1	$1,350.5	$2,391.8
Service	102,981	$12,372.4	$3,744.5	$7,637.8
Government	54,474	$4,768.8	$3,970.6	$4,507.6
Total	250,192	$32,521.8	$12,063.7	$19,056.3

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Colusa County Colusa County has a highly agricultural economy. Colusa and Williams are the only incorporated cities in the county (California State Association of Counties [CSAC] 2014).

In 2011, the total population in Colusa County was 21,549 (IMPLAN Group, LLC 2012). In 2011, agriculture provided the most jobs (3,810 jobs) in Colusa County, followed by services (2,722 jobs), and government (2,083 jobs). Specifically, the grain farming sector provided the most jobs, followed by state and local government, and tree nut farming. Manufacturing had the highest output ($854.9 million) in the county, followed by agriculture ($642.3 million), and services ($321.6 million). Specifically, flour milling and malt manufacturing had the highest output of all sectors in the county, followed by tree nut farming and fruit and vegetable canning (IMPLAN Group, LLC 2012). Table 13-2 summarizes the regional economy in Colusa County, in terms of employment, output, labor income, and total value added.

Table 13-2. Colusa County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	3,810	$642.3	$179.1	$296.0
Mining	5	$1.4	$0.2	$0.4
Construction	251	$31.9	$16.6	$18.9
Manufacturing	1,485	$854.9	$90.0	$152.4
TIPU	273	$76.5	$17.5	$30.6
Trade	1,495	$186.3	$73.4	$135.6
Service	2,722	$321.6	$86.5	$194.5
Government	2,083	$160.3	$120.4	$144.1
Total	12,124	$2,275.2	$583.7	$972.5

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Glenn County Glenn County has a highly agricultural economy. Orland and Willows are the only incorporated cities in the county (CSAC 2014).

In 2011, the total population in Glenn County was 28,128 (IMPLAN Group, LLC 2012). In 2011, agriculture provided the most jobs (3,924 jobs) in Glenn County, followed by services (3,730 jobs), and government (2,015 jobs). Agriculture had the highest output ($703.7 million) in the county, followed by services ($445.2 million), and manufacturing ($278.1 million). Specifically, tree nut farming and grain farming had the highest employment and output of all sectors in the county (IMPLAN Group, LLC 2012). Table 13-3 summarizes the regional economy in Glenn County, in terms of employment, output, labor income, and total value added.

Table 13-3. Glenn County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	3,924	$703.7	$148.0	$307.9
Mining	43	$13.2	$3.8	$7.1
Construction	695	$70.3	$27.8	$34.2
Manufacturing	616	$278.1	$34.7	$57.0
TIPU	837	$170.6	$38.4	$64.4
Trade	1,054	$109.3	$45.3	$79.4
Service	3,730	$445.2	$93.2	$279.7
Government	2,015	$185.1	$146.2	$170.5
Total	12,914	$1,975.5	$537.4	$1,000.2

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Shasta County Shasta County's economy is based on agriculture and travel. Incorporated cities are Anderson, Redding, and Shasta Lake (CSAC 2014).

In 2011, the total population in Shasta County was 177,774 (IMPLAN Group, LLC 2012). In 2011, services provided the most jobs (44,448 jobs) in Shasta

County, followed by trade (12,810 jobs), and government (12,225 jobs). Specifically, state and local government and food services and drinking places had the highest employment of all sectors in the county. Services had the highest output ($5.1 billion) in the county, followed by trade ($1.1 billion), and government ($1.0 billion). Specifically, rental income had the highest output of all sectors in the county (IMPLAN Group, LLC 2012). Table 13-4 summarizes the regional economy in Shasta County, in terms of employment, output, labor income, and total value added.

Table 13-4. Shasta County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	2,465	$218.3	$76.1	$86.1
Mining	753	$133.9	$16.0	$58.0
Construction	5,306	$597.2	$272.3	$321.4
Manufacturing	2,524	$733.0	$143.8	$202.8
TIPU	3,786	$925.0	$236.4	$405.7
Trade	12,810	$1,129.9	$458.9	$824.8
Service	44,448	$5,074.1	$1,598.3	$3,170.5
Government	12,225	$1,033.3	$827.4	$966.4
Total	84,317	$9,844.7	$3,629.2	$6,035.7

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Tehama County Tehama County's economy is based on agriculture, including ranching. Corning, Red Bluff, and Tehama are the only incorporated cities in the county (CSAC 2014).

In 2011, the total population in Tehama County was 63,601 (IMPLAN Group, LLC 2012). In 2011, services provided the most jobs (8,946 jobs) in Tehama County, followed by government (3,853 jobs), and agriculture (3,290 jobs). Services had the highest output ($1,056.5 million) in the county, followed by manufacturing ($495.0 million), and agriculture ($367.1 million). Specifically, rental income had the highest output of all sectors in the county, followed by fruit and vegetable canning and wood work manufacturing (IMPLAN Group, LLC 2012). Table 13-5 summarizes the regional economy in Tehama County, in terms of employment, output, labor income, and total value added.

Table 13-5. Tehama County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	3,290	$367.1	$106.0	$164.7
Mining	169	$55.3	$3.2	$14.5
Construction	1,284	$128.2	$49.6	$61.5
Manufacturing	1,430	$495.0	$86.7	$117.7

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
TIPU	1,569	$280.3	$80.1	$126.0
Trade	2,573	$239.7	$92.0	$173.4
Service	8,946	$1,056.5	$272.6	$637.0
Government	3,853	$303.2	$228.1	$273.2
Total	23,114	$2,925.3	$918.3	$1,568.0

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Yolo County Yolo County has an increasingly growing urban economy, relative to its agricultural economy. Yolo County urban areas are tied to education facilities, the I-80 corridor, and the Sacramento urban economy. Incorporated cities in Yolo County include Davis, West Sacramento, Winters, and Woodland (CSAC 2014).

In 2011, the total population in Yolo County was 202,054 (IMPLAN Group, LLC 2012). In 2011, services provided the most jobs (43,135 jobs) in Yolo County, followed by government (34,297 jobs), and trade (14,613 jobs). Services had the highest output ($5,475.0 million) in the county, followed by government ($3,087.0 million), and manufacturing ($2,728.3 million). Specifically, state and local government education had the highest employment and output of all sectors in the county (IMPLAN Group, LLC 2012). Table 13-6 summarizes the regional economy in Yolo County, in terms of employment, output, labor income, and total value added.

Table 13-6. Yolo County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	6,385	$818.2	$312.6	$369.3
Mining	340	$100.2	$14.0	$45.7
Construction	4,951	$610.1	$307.0	$352.8
Manufacturing	5,865	$2,728.3	$353.5	$629.4
TIPU	8,138	$1,061.4	$384.9	$594.6
Trade	14,613	$1,620.9	$680.8	$1,178.6
Service	43,135	$5,475.0	$1,693.9	$3,356.1
Government	34,297	$3,087.0	$2,648.5	$2,953.3
Total	117,724	$15,501.1	$6,395.2	$9,479.8

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

13.1.3.2 American River Region

The CVP water service contractors within the American River Region have service areas within El Dorado, Placer, and Sacramento counties. Table 13-7 presents the regional economy for this entire region, followed by a discussion of the regional economy in each individual county.

The counties in the American River Region are largely represented by the Sacramento metropolitan area, which has large government, services, and manufacturing sectors. In 2011, the total population in the 3-county region was 1,974,181 (IMPLAN Group, LLC 2012). Most CVP contractors in this region provide M&I water service with the exception of one M&I and agriculture water service contract.

In 2011, services provided the most jobs (556,308 jobs) in the region, followed by government (216,659 jobs), trade (128,508 jobs) and construction (55,875 jobs). Services also had the highest output ($76.9 billion) of all industries in the region, followed by government ($21.2 billion), manufacturing ($15.9 billion), and trade ($12.1 billion).

Table 13-7. American River Region 2011 Regional Economy Summary (El Dorado, Placer, and Sacramento Counties)

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	6,432	$1,112.3	$312.3	$485.2
Mining	815	$276.8	$18.4	$107.5
Construction	55,875	$7,127.4	$3,707.5	$4,224.3
Manufacturing	29,538	$15,897.7	$2,555.0	$4,941.5
TIPU	18,857	$4,720.9	$1,476.2	$2,327.3
Trade	128,508	$12,092.2	$5,286.1	$8,919.1
Service	556,308	$76,992.0	$26,572.6	$49,496.2
Government	216,659	$21,189.7	$17,910.4	$20,414.5
Total	1,012,992	$139,409.0	$57,838.5	$90,915.6

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

El Dorado County The only incorporated cities in El Dorado County are Placerville and South Lake Tahoe (CSAC 2014). A relatively large share of the population resides in the unincorporated communities of Cameron Park and El Dorado Hills, suburbs of Sacramento, in the western portion of the County.

In 2011, the total population in El Dorado County was 180,938 (IMPLAN Group, LLC 2012). In 2011, services provided the most jobs (59,539 jobs) in El Dorado County, followed by government (10,707 jobs), and trade (9,564 jobs). Services had the highest output ($7.1 billion) in the county, followed by government ($952.9 million), and construction ($860.8 million). Specifically, real estate establishment and rental income generated the highest output in the county of all the sectors, followed by insurance carriers (IMPLAN Group, LLC 2012). Table 13-8 summarizes the regional economy in El Dorado County, in terms of employment, output, labor income, and total value added.

Table 13-8. El Dorado County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	1,302	$113.9	$33.4	$48.3
Mining	194	$75.5	$3.4	$24.1
Construction	7,796	$860.8	$383.4	$455.6
Manufacturing	1,714	$515.3	$102.4	$164.6
TIPU	1,592	$268.5	$55.3	$137.7
Trade	9,564	$839.9	$328.6	$615.9
Service	59,539	$7,066.5	$1,903.5	$4,442.8
Government	10,707	$952.9	$753.9	$881.0
Total	92,408	$10,693.3	$3,563.9	$6,770.0

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Placer County The incorporated cities in this county are Auburn, Colfax, Lincoln, Loomis, Rocklin, and Roseville (CSAC 2014). Most of the population and economy is in the western portion of the county in the Sacramento Valley.

In 2011, the total population in Placer County was 357,138 (IMPLAN Group, LLC 2012). In 2011, services provided the most jobs (104,943 jobs) in Placer County, followed by trade (32,379 jobs), government (17,230 jobs), and construction (12,972 jobs). Services had the highest output ($14.3 billion) in the county, followed by manufacturing ($3.7 billion), and trade ($3.0 billion). Specifically, real estate establishment and rental income generated the highest output in the county of all the sectors, followed by monetary authorities (IMPLAN Group, LLC 2012). Table 13-9 summarizes the regional economy in Placer County, in terms of employment, output, labor income, and total value added.

Table 13-9. Placer County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	1,661	$166.8	$30.7	$54.8
Mining	297	$62.7	$2.1	$16.1
Construction	12,972	$1,856.4	$1,063.3	$1,183.0
Manufacturing	7,533	$3,741.1	$683.7	$1,275.1
TIPU	3,117	$1,287.9	$343.9	$583.3
Trade	32,379	$3,047.9	$1,342.5	$2,273.3
Service	104,943	$14,303.9	$4,740.8	$9,137.6
Government	17,230	$1,496.6	$1,207.4	$1,400.8
Total	180,132	$25,963.3	$9,414.4	$15,924.0

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Sacramento County The incorporated cities in this county include Citrus Heights, Elk Grove, Folsom, Rancho Cordova, and Sacramento (CSAC 2014). Sacramento, as the State capital of California, provides much economic base.

In 2011, services provided the most jobs (391,826 jobs) in Sacramento County, followed by government (188,723 jobs), and trade (86,564 jobs). Services had the highest output ($55.6 billion) in the county, followed by government ($18.7 billion), and manufacturing ($11.6 billion). Specifically, state and local government had the highest employment and output in the county (IMPLAN Group, LLC 2012). Table 13-10 summarizes the regional economy in Sacramento County, in terms of employment, output, labor income, and total value added.

Table 13-10. Sacramento County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	3,468	$831.7	$248.3	$382.1
Mining	325	$138.7	$12.9	$67.3
Construction	35,107	$4,410.2	$2,260.8	$2,585.7
Manufacturing	20,291	$11,641.3	$1,768.8	$3,501.8
TIPU	14,149	$3,164.5	$1,077.0	$1,606.2
Trade	86,564	$8,204.4	$3,615.0	$6,029.8
Service	391,826	$55,621.6	$19,928.2	$35,915.8
Government	188,723	$18,740.2	$15,949.1	$18,132.7
Total	740,453	$102,752.6	$44,860.1	$68,221.4

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

13.1.3.3 San Joaquin Valley Region

The CVP water service contractors within the San Joaquin Valley have service areas within Fresno, Kern, Kings, Merced, San Joaquin, Stanislaus, and Tulare counties. Table 13-11 presents the regional economy for this entire region, followed by a discussion of the regional economy in each individual county.

In 2011, the total population in the 7-county region was 3,872,266 (IMPLAN Group, LLC 2012). The region is largely rural with some large population centers in the cities of Stockton, Merced, Fresno, and Bakersfield. Much of the region's land is in agricultural production. In 2011, the region accounted for seven counties of the top eight counties ranked for value of agricultural production in the state, generating over $28.6 billion in gross value of agricultural production (USDA 2012).

CVP contractors in this region deliver both irrigation and M&I water supplies with the majority of the CVP water used in the region for agriculture.

In 2011, services provided the most jobs (679,500 jobs) in the region, followed by government (244,456 jobs), trade (218,369 jobs), and agriculture (199,324 jobs). Services also had the highest output ($82.6 billion) of all industries in the region, followed by manufacturing ($58.8 billion), agriculture ($29.5 billion), and government ($24.4 billion).

Table 13-11. San Joaquin Valley 2011 Regional Economy Summary (Fresno, Kern, Kings, Merced, San Joaquin, Stanislaus, and Tulare Counties)

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	199,324	$29,462.1	$9,776.1	$13,953.8
Mining	15,863	$7,151.0	$1,732.6	$4,002.8
Construction	74,500	$8,809.9	$4,250.1	$4,938.9
Manufacturing	105,641	$58,828.5	$6,181.0	$12,615.9
TIPU	71,564	$13,600.0	$4,175.8	$7,111.9
Trade	218,369	$20,967.3	$8,589.7	$15,221.1
Service	679,500	$82,640.1	$25,092.7	$52,288.1
Government	244,456	$24,394.9	$19,961.8	$23,148.3
Total	1,609,217	$245,853.8	$79,759.8	$133,280.8

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Fresno County Fresno County has 14 incorporated cities, including Fresno, Clovis, Reedley, and Selma (CSAC 2014). The county's economy is highly agricultural except that Fresno provides a more diverse economic base.

In 2011, the total population in Fresno County was 942,904 (IMPLAN Group, LLC 2012). In 2011, services provided the most jobs (196,250 jobs) in Fresno County, followed by government (61,505 jobs), and trade (58,944 jobs). Specifically, state and local government and support activities for agriculture had the highest employment of all sectors (IMPLAN Group, LLC 2012). Services had the highest output ($24.1 billion) in the county, followed by manufacturing ($11.2 billion), and agriculture ($7.3 billion). Table 13-12 summarizes the regional economy in Fresno County, in terms of employment, output, labor income, and total value added.

Table 13-12. Fresno County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	50,811	$7,262.1	$2,805.7	$3,778.5
Mining	339	$125.8	$23.8	$70.1
Construction	18,037	$2,154.7	$1,050.7	$1,217.4
Manufacturing	27,686	$11,158.3	$1,463.4	$2,439.0
TIPU	15,906	$3,567.0	$919.5	$1,991.9
Trade	58,944	$5,715.3	$2,303.9	$4,141.7
Service	196,250	$24,140.2	$7,359.8	$15,291.5
Government	61,505	$5,903.9	$4,873.0	$5,624.2
Total	429,478	$60,027.3	$20,799.8	$34,554.3

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Kern County Kern County has 11 incorporated cities, including Bakersfield, Delano, Ridgecrest, and Wasco (CSAC 2014). The county's economy is agricultural except that transportation, petroleum and some urban areas, primarily Bakersfield, provide other economic base.

In 2011, the total population in Kern County was 851,710 (IMPLAN Group, LLC 2012). In 2011, services provided the most jobs (140,557 jobs) in Kern County, followed by government (58,154 jobs), and agriculture (49,515 jobs). Support activities for agriculture had the highest employment of all sectors, 29,557 jobs. Services had the highest output ($17,726.2 million) in the county, followed by manufacturing ($16,760.4 million), and government ($6,995.4 million). Specifically, petroleum refineries and extraction of oil and natural gas were the two largest sectors in terms of output (IMPLAN Group, LLC 2012). Table 13-13 summarizes the regional economy in Kern County, in terms of employment, output, labor income, and total value added.

Table 13-13. Kern County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	49,515	$5,088.0	$2,262.0	$2,622.1
Mining	15,136	$6,903.9	$1,688.6	$3,874.5
Construction	21,249	$2,534.2	$1,233.6	$1,430.2
Manufacturing	13,619	$16,760.4	$978.2	$3,807.7
TIPU	12,836	$3,176.0	$1,044.5	$1,695.7
Trade	42,907	$4,213.3	$1,801.9	$3,089.5
Service	140,557	$17,726.2	$5,641.1	$11,231.0
Government	58,154	$6,995.4	$5,906.9	$6,715.5
Total	353,973	$63,397.4	$20,556.8	$34,466.2

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Kings County Kings County has four incorporated cities, being Avenal, Concoran, Hanford, and Lemoore (CSAC 2014). The economy is very agricultural with a naval air station and manufacturing contributing.

In 2011, the total population in Kings County was 153,765 (IMPLAN Group, LLC 2012). In 2011, government provided the most jobs (18,066 jobs) in Kings County, followed by services (16,824 jobs), and agriculture (7,265 jobs). Manufacturing had the highest output ($3.2 billion) in the county, followed by government ($2.2 billion), and services ($2.1 billion). Specifically, cheese manufacturing had the highest output of all sectors in the county, dairy cattle and milk production ranked third (IMPLAN Group, LLC 2012). Table 13-14 summarizes the regional economy in Kings County, in terms of employment, output, labor income, and total value added.

Table 13-14. Kings County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	7,265	$1,965.5	$401.3	$735.3
Mining	0	$0.0	$0.0	$0.0
Construction	1,560	$174.3	$78.7	$93.2
Manufacturing	5,274	$3,193.2	$286.5	$463.0
TIPU	1,549	$260.6	$67.7	$112.0
Trade	5,599	$466.0	$199.2	$338.0
Service	16,824	$2,114.6	$607.0	$1,325.5
Government	18,066	$2,212.4	$1,730.8	$2,134.1
Total	56,137	$10,386.6	$3,371.2	$5,201.1

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Merced County Merced County has six incorporated cities: Atwater, Dos Palos, Gustine, Livingston, Los Banos, and Merced (CSAC 2014). The county's economy is highly agricultural. Merced is the largest city.

In 2011, the total population in Merced County was 259,898 (IMPLAN Group, LLC 2012). In 2011, services provided the most jobs (34,518 jobs) in Merced County, followed by agriculture (16,175 jobs), and government (15,817 jobs). Specifically, state and local government and support activities for agriculture had the highest employment of all sectors (IMPLAN Group, LLC 2012). Services had the highest output ($4.3 billion) in the county, followed by manufacturing ($3.3 billion), and agriculture ($3.1 million). Dairy cattle and milk production had the highest output of all sectors in the county ($1.1 billion). Table 13-15 summarizes the regional economy in Merced County, in terms of employment, output, labor income, and total value added.

Table 13-15. Merced County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	16,175	$3,121.9	$680.3	$1,260.2
Mining	119	$27.5	$7.4	$12.1
Construction	3,469	$407.1	$194.7	$226.8
Manufacturing	7,764	$3,348.4	$383.7	$606.0
TIPU	4,254	$731.0	$220.1	$386.7
Trade	12,206	$1,107.5	$425.7	$800.1
Service	34,518	$4,320.3	$1,101.8	$2,617.3
Government	15,817	$1,306.5	$1,050.8	$1,229.9
Total	94,322	$14,370.2	$4,064.5	$7,139.1

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

San Joaquin County The incorporated cities in this county include Lathrop, Lodi, Manteca, Stockton, and Tracy, among others (CSAC 2014). The economy is largely based on agriculture, transportation and manufacturing. Much of the manufacturing is based on agricultural products. Stockton is the largest city.

In 2011, the total population in San Joaquin County was 696,214 (IMPLAN Group, LLC 2012). In 2011, services provided the most jobs (124,825 jobs) in San Joaquin County, followed by trade (42,569 jobs), and government (34,953 jobs). State and local government provided the most jobs of all sectors in the county (18,530 jobs). Services had the highest output ($15.2 billion) in the county, followed by manufacturing ($8.2 billion), and trade ($4.2 billion). Table 13-16 summarizes the regional economy in San Joaquin County, in terms of employment, output, labor income, and total value added.

Table 13-16. San Joaquin County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	18,209	$2,890.0	$981.1	$1,398.2
Mining	134	$52.7	$7.7	$27.8
Construction	12,562	$1,575.9	$807.3	$923.3
Manufacturing	18,259	$8,263.0	$1,080.0	$1,916.4
TIPU	18,402	$3,114.1	$1,058.0	$1,553.9
Trade	42,569	$4,205.9	$1,680.4	$3,042.6
Service	124,825	$15,216.3	$4,549.7	$9,704.1
Government	34,953	$3,413.5	$2,788.0	$3,199.8
Total	269,913	$38,731.4	$12,952.2	$21,766.1

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Stanislaus County Stanislaus County has nine incorporated cities, including Modesto, Newman, Oakdale, Patterson, and Turlock (CSAC 2014). The economy is largely based on transportation, agriculture, and manufacturing. Much of the manufacturing is based on agricultural products. Modesto and Turlock account for about half of the county population.

In 2011, the total population in Stanislaus County was 518,522 (IMPLAN Group, LLC 2012). In 2011, services provided the most jobs (99,976 jobs) in Stanislaus County, followed by trade (33,193 jobs), and government (25,316 jobs). State and local government provided the most jobs of all sectors in the county (15,672 jobs). Services had the highest output ($11,909.9 million) in the county, followed by manufacturing ($10,324.2 million), and trade ($3,117.5 million). Specifically, fruit and vegetable was the largest manufacturing sector, and ranked second of all sectors in the county in value of output (IMPLAN Group, LLC 2012). Table 13-17 summarizes the regional economy in Stanislaus County, in terms of employment, output, labor income, and total value added.

Table 13-17. Stanislaus County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	17,533	$2,463.4	$676.1	$1,118.2
Mining	65	$19.8	$2.2	$7.1
Construction	10,309	$1,141.6	$510.4	$605.8
Manufacturing	21,029	$10,324.2	$1,394.0	$2,347.8
TIPU	10,280	$1,216.5	$436.5	$574.7
Trade	33,193	$3,117.5	$1,255.0	$2,245.3
Service	99,976	$11,909.9	$3,697.9	$7,622.6
Government	25,316	$2,098.1	$1,673.6	$1,958.4
Total	217,701	$32,291.0	$9,645.7	$16,479.9

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Tulare County The incorporated cities in this county include Tulare and Visalia, among other (CSAC 2014). The economy is largely agricultural.

In 2011, the total population in Tulare County was 449,253 (IMPLAN Group, LLC 2012). In 2011, services provided the most jobs (66,550 jobs) in Tulare County, followed by agriculture (39,816 jobs), and government (30,646 jobs). Support for agricultural activities provided the most jobs of all sectors in the county (25,679 jobs). Services had the highest output ($7,212.5 million) in the county, followed by agriculture ($6,671.2 million), and manufacturing ($5,781.1 million). Specifically, fruit farming produced the highest output of all sectors in the county, followed by dairy and cattle production (IMPLAN Group, LLC 2012). Table 13-18 summarizes the regional economy in Tulare County, in terms of employment, output, labor income, and total value added.

Table 13-18. Tulare County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	39,816	$6,671.2	$1,969.6	$3,041.3
Mining	69	$21.3	$3.0	$11.3
Construction	7,313	$822.3	$374.7	$442.3
Manufacturing	12,010	$5,781.1	$595.1	$1,036.0
TIPU	8,337	$1,534.7	$429.4	$797.0
Trade	22,950	$2,141.9	$923.5	$1,563.9
Service	66,550	$7,212.5	$2,135.5	$4,496.1
Government	30,646	$2,465.0	$1,938.7	$2,286.3
Total	187,691	$26,650.0	$8,369.5	$13,674.2

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

13.1.3.4 Bay Area Region

The CVP water service contractors within the Bay Area have service areas within Alameda, Contra Costa, San Benito, and Santa Clara counties. Table 13-19 presents the regional economy for this entire region, followed by a discussion of the regional economy in each individual county. In 2011, the total population in the 5-county region was 4,883,319 (IMPLAN Group, LLC 2012). Alameda, Contra Costa, and Santa Clara counties have the largest urban areas in the region, supporting the most employment and industry. These counties include residential suburbs of San Francisco, but are also home to important business services and retail businesses. California's Silicon Valley, the center of the region high-tech businesses, is in Santa Clara County.

CVP contractors in this region deliver both irrigation and M&I water supplies with Alameda, Contra Costa, and Santa Clara counties more reliant on M&I deliveries and San Benito County more reliant on irrigation deliveries.

In 2011, services provided the most jobs (1,559,187 jobs) in the region, followed by trade (353,936 jobs), government (264,851 jobs) and manufacturing (254,838 jobs). Manufacturing had the highest output ($318.6 billion) of all industries in the region, followed by services ($247.0 billion), trade ($41.5 billion), and government ($29.8 billion).

Table 13-19. Bay Area Region 2011 Regional Economy Summary (Alameda, Contra Costa, San Benito, and Santa Clara Counties)

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	7,829	$1,060.4	$461.6	$559.9
Mining	3,091	$1,547.7	$338.9	$914.4
Construction	115,711	$16,101.6	$9,019.6	$10,088.4
Manufacturing	247,720	$315,977.5	$37,776.3	$100,118.8
TIPU	57,748	$13,726.0	$4,156.0	$6,826.0
Trade	329,122	$38,935.6	$19,274.7	$29,816.1
Service	1,466,241	$235,398.0	$103,398.0	$159,185.8
Government	230,123	$24,986.0	$21,152.5	$23,795.2
Total	2,457,585	$647,732.8	$195,577.6	$331,304.6

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Alameda County The incorporated cities in this county include Alameda, Albany, Berkeley, Emeryville, Fremont, Hayward, Livermore, Oakland, Pleasanton, San Leandro, and Union City, among others (CSAC 2014). Oakland is the largest city in a major metropolitan area, the East Bay, which is divided by the Oakland Hills.

In 2011, Alameda County had a population of 1,529,875 (IMPLAN Group, LLC 2012). In 2011, services provided the most jobs (491,208 jobs) in Alameda County, followed by trade (123,535 jobs), and government (99,992 jobs). Services had the highest output ($69,727.7 million) in the county, followed by manufacturing ($37,549.1 million), and trade ($14,244.8 million). Specifically, top services in terms of output included rental income, real estate establishments, scientific research and development services, and management of companies and enterprises (IMPLAN Group, LLC 2012). Table 13-20 summarizes the regional economy in Alameda County, in terms of employment, output, labor income, and total value added.

Table 13-20. Alameda County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	1,175	$131.8	$63.0	$68.7
Mining	495	$198.6	$18.7	$105.0
Construction	44,360	$6,108.7	$3,394.6	$3,803.9
Manufacturing	66,793	$37,549.1	$6,319.7	$12,049.0
TIPU	28,780	$6,762.0	$2,037.0	$3,130.6
Trade	123,535	$14,244.8	$6,505.2	$10,685.1
Service	491,208	$69,727.7	$28,896.4	$45,941.4
Government	99,992	$11,102.1	$9,499.0	$10,647.3
Total	856,338	$145,824.8	$56,733.6	$86,431.0

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Contra Costa County The incorporated cities in this county include Antioch, Concord, Lafayette, Martinez, Pittsburg, Pleasant Hill, Richmond, and Walnut Creek, among others (CSAC 2014).

In 2011, Contra Costa County had a population of 1,066,096 (IMPLAN Group, LLC 2012). In 2011, services provided the most jobs (297,383 jobs) in Contra Costa County, followed by trade (62,583 jobs), and government (45,553 jobs). Manufacturing had the highest output ($89.5 billion) in the county, followed by services ($44.8 billion), and trade ($6.0 billion). Most of the manufacturing in Contra Costa County was from petroleum refineries, which was the largest sector in the county in terms of output ($82.4 billion) (IMPLAN Group, LLC 2012). Table 13-21 summarizes the regional economy in Contra Costa County, in terms of employment, output, labor income, and total value added.

Table 13-21. Contra Costa County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	1,552	$175.5	$54.5	$77.9
Mining	2,145	$1,165.5	$303.8	$717.0
Construction	26,433	$3,700.9	$2,082.4	$2,327.0
Manufacturing	21,506	$89,528.0	$3,588.4	$20,286.2
TIPU	15,678	$4,071.4	$1,287.2	$2,045.7
Trade	62,583	$6,014.1	$2,782.4	$4,487.2
Service	297,383	$44,777.9	$16,103.6	$29,393.1
Government	45,553	$4,542.7	$3,741.4	$4,257.3
Total	472,833	$153,976.0	$29,943.7	$63,591.4

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

San Benito County The incorporated cities in this county are Hollister and San Juan Bautista (CSAC 2014). Important economic base includes agriculture and residential sectors.

In 2011, San Benito County had a population of 56,072 (IMPLAN Group, LLC 2012). In 2011, services provided the most jobs (6,786 jobs) in San Benito County, followed by manufacturing (3,414 jobs), and trade (3,137 jobs). Manufacturing had the highest output ($1.2 billion) in the county, followed by services ($823.3 million), and agriculture ($369.8 million). Specifically, the fruit and vegetable canning sector, which is part of manufacturing, had the highest output in the county ($354.2 million) (IMPLAN Group, LLC 2012). Table 13-22 summarizes the regional economy in San Benito County, in terms of employment, output, labor income, and total value added.

Table 13-22. San Benito County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	1,750	$369.8	$132.7	$192.5
Mining	21	$5.1	$1.1	$1.9
Construction	1,450	$148.9	$60.1	$73.6
Manufacturing	3,414	$1,169.9	$160.9	$268.0
TIPU	875	$186.9	$30.2	$63.1
Trade	3,137	$293.8	$135.7	$222.0
Service	6,786	$823.3	$194.2	$511.4
Government	2,995	$280.7	$222.7	$257.4
Total	20,428	$3,278.4	$937.6	$1,589.9

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

Santa Clara County The incorporated cities in this county include Cupertino, Los Altos, Los Altos Hills, Palo Alto, San Jose, and Sunnyvale, among others (CSAC 2014). The county is world-renowned as the “Silicon Valley,” an important region for computer and information technology development in the United States.

In 2011, Santa Clara County had a population of 1,809,378 (IMPLAN Group, LLC 2012). In 2011, services provided the most jobs (670,863 jobs) in Santa Clara County, followed by manufacturing (156,006 jobs), and trade (139,867 jobs). Manufacturing had the highest output ($187.7 billion) in the county, followed by services ($120.1 billion), and trade ($18.4 billion). Specifically, the top two sectors in value of output in the county were electronic computer manufacturing ($104.6 billion) and semiconductor and related devices manufacturing ($41.3 billion) (IMPLAN Group, LLC 2012). Table 13-23 summarizes the regional economy in Santa Clara County, in terms of employment, output, labor income, and total value added.

Table 13-23. Santa Clara County 2011 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)	Total Value Added (Million $)
Agriculture	3,351	$383.2	$211.5	$220.8
Mining	431	$178.5	$15.3	$90.4
Construction	43,467	$6,143.1	$3,482.5	$3,884.0
Manufacturing	156,006	$187,730.6	$27,707.3	$67,515.7
TIPU	12,415	$2,705.7	$801.5	$1,586.5
Trade	139,867	$18,382.9	$9,851.5	$14,421.8
Service	670,863	$120,069.2	$58,203.8	$83,339.9
Government	81,582	$9,060.6	$7,689.5	$8,633.2
Total	1,107,982	$344,653.8	$107,962.9	$179,692.3

Source: 2011 IMPLAN data; IMPLAN Group, LLC 2012

13.2 Environmental Consequences

This section presents the assessment methods and environmental consequences of each alternative. M&I economic effects are evaluated in all regions defined in the area of analysis. Agricultural economic effects are evaluated in the Sacramento Valley and San Joaquin Valley regions.

13.2.1 Assessment Methods

The M&I WSP alternatives could result in socioeconomic effects to M&I water users, agricultural water users, and their respective regional economies. Changes in water supply to CVP contractors and the associated assessment methods are described in other chapters and appendices of this Environmental Impact Statement. Effects to CVP water service contractor deliveries are evaluated in Chapter 4 and effects to groundwater are evaluated in Chapter 6. Appendix B, Water Operations Model Documentation, includes information on assumptions of future water supply conditions. This section applies various economic models, described below, to quantify potential effects of the action alternatives on regional economies relative to the No Action Alternative. Some socioeconomic effects are described qualitatively.

13.2.1.1 M&I Service Area Economic Effects Analysis

The M&I economic effects analysis uses the Least Cost Planning Simulation Model (LCPSIM) and the Other Project Water Economic Model (OPWEM) to estimate economic effects to M&I water service contractors as a result of the water supply changes caused by the M&I WSP alternatives. Direct effects are the increased costs incurred by water agencies for implementing alternate water supply options as a result of decreased CVP supplies. This cost is passed onto customers which reduces their discretionary income available to spend in the region.

LCPSIM is used to estimate the economic benefits and costs of water supply for M&I purposes in the urban areas of the CVP water service contractors in the Bay

Area Region. LCPSIM was constructed to include the Bay Area and Southern California regions and does not include other areas of California. LCPSIM uses CalSim II results for annual M&I water supply under the 2030 condition over the 1922 to 2003 hydrologic period as input.

LCPSIM is an annual time-step urban water system model that finds the point which minimizes the sum of the total annual cost of the adopted long-term measures and the total expected annual shortage costs and losses remaining after their adoption. Long-term measures available for the Bay Area Region are indoor conservation, outdoor conservation, and water recycling. LCPSIM accounts for the ability of shortage management (contingency) measures, including temporary water transfers, to reduce regional costs and losses associated with shortage events, and for the ability of long-term regional demand reduction and supply augmentation measures, in conjunction with regional carryover storage opportunities, to reduce the frequency, magnitude, and duration of shortage events. To estimate costs of shortage, LCPSIM uses a shortage loss function derived from contingent valuation studies and water agency shortage allocation strategies. LCPSIM generates output for shortage size, costs and losses due to shortage, quantities and costs of water transfers, surface and groundwater carryover storage operations, and overall system operations costs.

OPWEM estimates representative economic benefits or costs of changes in CVP supplies for all urban areas outside of the Bay Area Region that receive these supplies. The model is similar to LCPSIM in terms of the types of management taken in response to changing water supplies.

OPWEM includes CVP M&I supplies in the Sacramento Valley, American River basin, and San Joaquin Valley. Twenty-four providers who have CVP M&I water service contracts, and 13 providers who have CVP agricultural water service contracts that provide some water for M&I purposes are included. OPWEM includes small amounts of agricultural use that could not be separated from urban use.

OPWEM uses CalSim II results for annual CVP M&I water supply under the 2030 condition over the 1922 to 2003 hydrologic period as input. For each year of the hydrologic period, demand and supply quantities are compared. If supply is insufficient to meet demand, the costs of additional water supplies are calculated. OPWEM uses two different types of unit costs of water supplies – one for years that are wetter than dry years, and another for dry and critical years. These unit costs are based on data from individual providers, where available, but most costs are groundwater costs or water transfer costs developed from secondary information. OPWEM also includes water shortage costs in dry and critical years. Shortage costs are based on individual retail water prices and quantities, and a short-run demand elasticity of -0.1.

LCPSIM and OPWEM results are input into the IMpact analysis for PLANning (IMPLAN) model to estimate regional economic effects. Average annual effects are reported. IMPLAN modeling is described below. Appendix G, M&I Economic Model Documentation, provides a detailed description of the models, methods, and results of the M&I economic effects analysis.

13.2.1.2 Agricultural Economic Effects Analysis

The Statewide Agricultural Production (SWAP) model was used to evaluate the effects on agricultural production for each alternative. The SWAP model is a regional agricultural production and economic optimization model that simulates the decisions of farmers across 93 percent of agricultural land in California. The model assumes that farmers maximize profit subject to resource, technical, and market constraints. Farmers sell and buy in competitive markets, and no one farmer can affect or control the price of any commodity. The model selects those crops, water supplies, and other inputs that maximize profit subject to constraints on water and land, and subject to economic conditions regarding prices, yields, and costs. The SWAP model incorporates project water supplies (State Water Project [SWP] and CVP), other local water supplies, and groundwater. As conditions change within a SWAP region (e.g., the quantity of available project water supply increases or the cost of groundwater pumping increases), the model optimizes production by adjusting the crop mix, water sources and quantities used, and other inputs. It also fallows land when that appears to be the most cost-effective response to resource conditions.

The SWAP model is used to compare the long-run response of agriculture to potential changes in SWP and CVP irrigation water delivery, other surface or groundwater conditions, or other economic values or restrictions. Results from the SWAP model are used to compare the long-run agricultural economic responses to changes in CVP irrigation water delivery under the M&I WSP alternatives. Results from the CalSim II model are used as inputs into SWAP through a standardized data linkage tool. For this agricultural analysis, the San Joaquin Valley Region is split into the San Joaquin River Region that includes most of Sacramento, San Joaquin, Stanislaus, Merced, and Madera counties, and the Tulare Lake Region that includes Fresno, Kings, Tulare, and Kern counties.

The SWAP model provides changes in value of production and groundwater pumping costs. The SWAP model estimates effects during all year types. Results for critical years are presented in this section. Changes in value of production are used as inputs to the regional economic effects analysis, described below. Effects of changes in groundwater pumping costs are also discussed in the economic effects analysis. Appendix D, Statewide Agricultural Production Model Documentation, provides a detailed description of the model and methods of the agricultural economic effects analysis.

13.2.1.3 Regional Economic Effects Analysis

Regional economic effects occur because of trade linkages in a regional economy. Industries purchase and sell inputs from and to one another. For example, many businesses trade with farmers. Farmers buy inputs from workers, farm stores, equipment supply stores, custom operators, and other farmers. Other regional businesses earn their income by transporting, storing, marketing, and processing agricultural products. Changes in crop production affect the volume of sales for these businesses and also household income that these businesses support. Regional economic effects analyses quantify these indirect and induced impacts. Specifically, indirect effects are caused by expenditures in the region by affected regional industries, and include purchases of inputs to grow crops and make products. Induced effects are caused by expenditure of household income. The analysis estimates the regional economic effects of the alternatives using IMPLAN.

IMPLAN is a county-level database and modeling package that calculates the economic indirect and induced impacts of a change in value of production, labor income, household income, industry and institutional spending. IMPLAN estimates effects on various economic measures, including employment, labor income, and total value of output, and total value added. This analysis uses IMPLAN 2011 data set for all counties that could be affected by the M&I WSP, which is developed by the IMPLAN Group, LLC. The IMPLAN data sets include study area data, industry accounts, social accounts, and multipliers. The study area data is presented above in Chapter 13.1.3. This chapter presents IMPLAN model results in Chapters 13.2.2 through 13.2.6. For the analysis of M&I economic effects, LCPSIM and OPWEM estimate changes in discretionary income as a result of changes in water costs. A change in water costs is assumed to result in an equivalent change in retail water revenues through water rates, which changes household spending, which is input into IMPLAN to estimate regional economic effects. That is, changes in water costs must be passed onto customers, and the customers then have less money to spend for other things. The impact is a change in the household spending pattern.

For the analysis of agricultural economic effects, SWAP estimates changes in value of production of crops as a result of changes in water supply. This is a direct effect to the crop industry sectors, which is input into IMPLAN as an industry change to estimate regional economic effects.

13.2.2 Alternative 1: No Action

Under the No Action Alternative, CVP allocations to M&I water service contractors could result in economic effects to M&I water service contractors and the regional economy. Under the No Action Alternative, socioeconomic effects could occur to M&I water users due to water shortages in some years and unmet public health and safety (PHS) water needs. Chapter 4 defines PHS needs and discusses water users that could experience unmet PHS demands under the No Action Alternative.

In the Sacramento Valley Region and American River Region, PHS demands would be met, except for a slight shortage in the Shasta and Trinity River Division (less than 1 percent in 10 percent of the 81 modeled years; see Chapter 4.2.2.1). This would not result in socioeconomic effects because it is such a small amount of water and the shortage occurs infrequently. Contractors would likely find a way to meet the need through conservation, increased groundwater pumping, or transfers with adjacent agencies.

In the San Joaquin Valley Region, there would be unmet PHS demands in the Cross Valley Canal Unit under the No Action Alternative (see Chapter 4.2.2.2). The M&I contractors in this unit may not have sufficient alternate water supplies readily available to meet PHS demands. This could result in adverse short- and long-term economic impacts. In the short-term, contractors may need to implement more expensive options to provide water supply, such as trucking water in. Businesses and residents may also need to spend additional money on purchasing water. In the long-term, the area may not be attractive to future economic development, which would hinder growth of the regional economy.

In the Bay Area Region, PHS demands would be met under the No Action Alternative (see Chapter 4.2.2.2). This would not result in socioeconomic effects.

Under the No Action Alternative, CVP allocations could result in economic effects to agricultural water users and the regional economy. Under the No Action Alternative, socioeconomic effects could occur to agricultural water users and the regional economy due to changes in water supply, crop demand, crop prices, and other market factors. Additionally, California producers will continue to be strongly affected by international market and trade conditions.

Under the No Action Alternative, agricultural water deliveries would decrease. Growers would implement actions, such as idling or increased groundwater pumping, to respond to water shortages under the No Action Alternative. Idling could last for one year or multiple years depending on the length of the shortage. Cropland idling would reduce farm incomes, purchases of agricultural inputs, and farm labor. These would be adverse effects to regional economics. Some farm laborers would move to other areas of the region to work on farms, as the opportunity is available, which would offset some of the regional economic impacts. Impacts associated with increased groundwater pumping are addressed below.

Changes in crop demand and prices would affect crop production and the regional economy in the future. Increases in population and income would increase crop demand, which would increase crop prices in the future. Increased crop prices would increase value of production for the agricultural economy. This would increase output, employment, and income in the regional economy, which would be a positive effect under the No Action Alternative. Increased prices may affect other sectors of the economy if residents are spending more money on food because of higher prices. This may adversely affect sales and output in other sectors of the regional economy, but total sales would increase under the No Action Alternative.

Under the No Action Alternative, M&I WSP allocations could change groundwater pumping costs for agricultural water users. Expenditures for groundwater pumping in the future would rise due to increasing electricity costs, whose rise is unrelated to the proposed project. Because of increasing electricity costs in the future, it is expected that growers would try to pump less groundwater for irrigation when surface water supplies are available. As a result, groundwater pumping costs could decrease during years when surface water is available. This would increase net revenues from crop production because input costs would decrease. During years when surface water shortages would occur, growers may need to rely on groundwater for irrigation. In this event, production costs could increase substantially due to the need for increased groundwater pumping, as well as the increased electricity costs associated with that pumping. Growers would need to make a business decision regarding whether or not to produce a crop during surface water shortages based on these economic factors. Growers could also implement other cost savings measures, such as switching to more energy efficient water tools/equipment. Any reduced value of production would be an adverse economic effect under the No Action Alternative.

13.2.3 Alternative 2: Equal Agricultural and M&I Allocation

13.2.3.1 Sacramento Valley Region

Providing equal allocations to agricultural and M&I water service contractors could result in economic effects to M&I water users and the regional economy. Alternative 2 would result in reduced CVP water supplies to M&I water service contractors in the Sacramento Valley Region when the M&I WSP is implemented. As a result, these water contractors would need to use alternate water supplies to provide water to customers, which would increases costs to the water contractors and their customers.

OPWEM estimates that implementation of Alternative 2 would increase water supply costs, including net operations costs, in the Sacramento Valley Region by an average of about $2.2 million annually, relative to the No Action Alternative. The water supply cost represents increased costs to the M&I water service contractors in the Sacramento Valley Region for alternate water supplies. These costs would be passed on to customers through increased water rates. The resulting socioeconomic effect would be a reduction in customers' discretionary income available to spend in the region. This would result in induced effects in the regional economy. Table 13-24 summarizes the regional economic effects of a reduction in household spending in the Sacramento Valley Region, as measured by IMPLAN. These adverse effects would be a small change relative to the baseline economy and would be offset by beneficial economic effects in the agriculture sector, as described below.

Table 13-24. Average Annual M&I Economic Effects in the Sacramento Valley Region of Alternative 2

	Employment (jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Economic Effect	-13	-$0.46	-$0.93	-$1.5

Providing equal allocations to agricultural and M&I water service contractors could result in economic effects to crop value of production and the regional economy. Implementation of Alternative 2 would increase water supplies to CVP agricultural water service contractors in the Sacramento Valley Region. As a result, growers would increase irrigated acreage and crop production, which would be a positive effect in the regional economy. Modeling predicts that irrigated acreage would increase by about 10,000 acres in critical years. In addition, there would be a total increase in annual value of production of about $35.7 million in critical years. Increased value of production would increase employment, value added, labor income, and output in the regional economy through indirect and induced impacts. Table 13-25 summarizes the total economic effect on the regional economy in the Sacramento Valley relative to the No Action Alternative. These would be a positive effect to the regional economy.

Table 13-25. Agricultural Economic Effects in Critical Water Years in the Sacramento Valley Region of Alternative 2

	Employment (jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Direct Effect	210	$11.72	$20.28	$35.72
Indirect Effect	117	$3.96	$5.27	$7.86
Induced Effect	75	$2.72	$5.55	$8.76
Total Effect	402	$18.40	$31.10	$52.34

Modeling estimates that value of production would be the same in wet and above normal years relative to the No Action Alternative. Positive economic effects in below normal and dry years would be less than in critical years because water supply and irrigated acreage would not increase as much. Average annual value of production would increase by $3.7 million in below normal years and $10.6 million in dry years. Positive effects to the regional economy in below normal and dry would be proportionate to those shown in Table 13-25 for critical years.

Providing equal allocations to agricultural and M&I water service contractors could change groundwater pumping costs for agricultural water users. Increased water supplies to agricultural CVP contractors in the Sacramento Valley Region would decrease the need for groundwater pumping as additional surface water supply would be available for irrigation needs. Modeling estimates that annual groundwater pumping costs would decrease by about $0.2 million in critical years relative to the No Action Alternative. Decreased pumping expenditures would reduce production costs for growers, which would increase net revenues. This would be a positive effect to growers' incomes. They would likely spend a portion of the increased income in the regional economy, which would be a minor positive effect to output, sales and income in the region. Positive effects would be greater in wetter hydrologic conditions because more surface water would be available, and less groundwater pumping would be necessary for irrigation.

13.2.3.2 American River Region

Providing equal allocations to agricultural and M&I water service contractors could result in economic effects to M&I water users and the regional economy. Similar to the Sacramento Valley Region, OPWEM estimates economic costs to M&I water service contractors in the American River Region. Implementation of Alternative 2 would increase water supply costs, including net operations costs, in the American River Region by an average of about $8.0 million annually, relative to the No Action Alternative.

The increased water supply cost represents increased costs to the M&I water service contractors in the American River Region for alternate water supplies. These costs would be passed on to customers through increased water rates. The resulting socioeconomic effect would be a reduction in customers' discretionary income available to spend in the region. Table 13-26 summarizes the regional economic effects of a reduction in household spending in the American River Region. These adverse effects would be a small change relative to the baseline economy.

Table 13-26. Average Annual M&I Economic Effects in the American River Region of Alternative 2

	Employment (jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Economic Effect	-52	-$2.3	-$4.3	-$6.7

13.2.3.3 San Joaquin Valley Region

Providing equal allocations to agricultural and M&I water service contractors could result in economic effects to M&I water users and the regional economy. Similar to the Sacramento Valley Region, OPWEM estimates economic costs to M&I water service contractors in the San Joaquin Valley Region. Implementation of Alternative 2 would increase water supply costs, including net operations costs, in the San Joaquin Valley Region by an average of about $7.0 million annually, relative to the No Action Alternative.

This cost represents increased costs to the water contractors in the San Joaquin Valley Region for alternate water supplies. These costs would be passed on to customers through increased water rates. The resulting socioeconomic effect would be a reduction in customers' discretionary income available to spend in the region. Table 13-27 summarizes the regional economic effects of a reduction in household spending in the San Joaquin Valley Region. These adverse effects would be a small change relative to the baseline economy.

Table 13-27. Average Annual M&I Economic Effects in the San Joaquin Valley Region of Alternative 2

	Employment (jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Economic Effect	-43	-$1.6	-$3.3	-$5.5

Providing equal allocations to agricultural and M&I water service contractors could result in economic effects to crop value of production and the regional economy. For this agricultural analysis, the San Joaquin Valley Region is split into the San Joaquin River Region that includes most of Sacramento, San Joaquin, Stanislaus, Merced, and Madera counties, and the Tulare Lake Region that includes Fresno, Kings, Tulare, and Kern counties.

Modeling predicts that irrigated acreage in the San Joaquin River Region would be the same as the No Action Alternative in critical years. Average annual value of production would decrease about $4.8 million in critical years relative to the No Action Alternative. The Sacramento Valley Region, as the impact discussion above describes, and Tulare Lake Region, described below, receive more water under Alternative 2, which increases production and drives the price of crops down. The SWAP model simulates statewide demand and capture price effects across regions. Because effects in the Sacramento Valley and Tulare Lake regions reduce crop prices, they would also be lower in the San Joaquin River Region. Lower crop prices would decrease the value of production, which would decrease employment, income, and output in the regional economy. This would be an adverse effect to this region. Table 13-28 summarizes the total economic effect on the regional economy in the San Joaquin Region in critical water years.

Table 13-28. Agricultural Economic Effects in Critical Water Years in the San Joaquin River Region of Alternative 2

	Employment (jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Direct Effect	-27	-$1.67	-$2.75	-$4.84
Indirect Effect	-17	-$0.54	-$0.71	-$1.12
Induced Effect	-12	-$0.49	-$0.96	-$1.53
Total Effect	-55	-$2.71	-$4.42	-$7.48

Alternative 2 would not result in economic effects to value of production or the San Joaquin River Region economy in wet and above normal years. Effects in below normal and dry years would be less than those in critical years. Average annual value of production would decrease by $0.6 million in below normal years and $0.9 million in dry years. Impacts to the regional economy in below normal and dry would be proportionate to those shown in Table 13-28 for critical years.

Increased water supplies for agricultural uses in the Tulare Lake Region would increase irrigated acreage and value of production. Irrigated acreage in the Tulare

Lake Region would increase by about 34,000 acres in critical years. Annual value of production would increase by about $43.2 million in critical years. Increased value of production would increase employment, value added, labor income, and output in the crop sectors and the overall regional economy through indirect and induced impacts. This would be a positive effect to the regional economy.

Table 13-29 summarizes the total economic effect on the regional economy in the Tulare Lake Region.

Table 13-29. Agricultural Economic Effects in Critical Water Years in the Tulare Lake Region of Alternative 2

	Employment (jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Direct Effect	95	$6.80	$12.24	$43.24
Indirect Effect	172	$5.88	$10.65	$20.25
Induced Effect	64	$2.39	$4.89	$7.95
Total Effect	332	$15.08	$27.78	$71.44

Alternative 2 would not result in economic effects to value of production or the Tulare Lake Region economy in wet and above normal years. Effects in below normal and dry years would be less than those in critical years. Average annual value of production would increase by $0.4 million in below normal years and $39.8 million in dry years. Positive effects to the regional economy in below normal and dry would be proportionate to those shown in Table 13-29 for critical years.

Providing equal allocations to agricultural and M&I water service contractors could change groundwater pumping costs for agricultural water users. Increased water supplies to agricultural CVP contractors would decrease the need for groundwater pumping as additional surface water supply would be available for irrigation needs. Modeling estimates that annual groundwater pumping costs would decrease by about $2.4 million in critical years in the San Joaquin River Region and $1.5 million in critical years in the Tulare Lake Region relative to the No Action Alternative. Decreased pumping costs would reduce production costs for growers, which would increase net revenues. This would be a positive effect to growers' incomes. They would likely spend a portion of the increased income in the regional economy, which would be a minor positive effect to output, sales and income in the region. Positive effects would be greater in wetter hydrologic conditions because more surface water would be available, and less groundwater pumping would be necessary for irrigation.

13.2.3.4 Bay Area Region

Providing equal allocations to agricultural and M&I water service contractors could result in economic effects to M&I water users and the regional economy. Alternative 2 would result in reduced water supplies to M&I water service contractors with implementation of the M&I WSP. Effects to M&I water service contractor CVP deliveries are evaluated in Chapter 4 and effects to groundwater are evaluated in Chapter 6. Appendix B, Water Operations Model Documentation, and Appendix D, Statewide Agricultural Production Model Documentation, include information on assumptions of future water supply conditions. As a result of reduced supplies, water contractors would need to obtain alternate water supplies to provide water to customers. LCPSIM estimates that implementation of Alternative 2 would increase water supply costs in the Bay Area Region by an average of about $6.6 million annually, relative to the No Action Alternative.

The increased water supply cost represents increased costs to the water contractors in the Bay Area Region for alternate water supplies. These costs would be passed on to customers through increased water rates. The resulting economic effect is a reduction in customers' discretionary income available to spend in the region. Table 13-30 summarizes the adverse regional economic effects of a reduction in household spending in the Bay Area Region. These effects would be a small change relative to the baseline regional economy.

Table 13-30. Average Annual M&I Economic Effects in the Bay Area Region of Alternative 2

	Employment (jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Economic Effect	-37	-$2.0	-$3.5	-$5.4

In the Bay Area Region, some CVP contractors are in a better position to respond to reductions in CVP water allocations than others. Some contractors do not have accessible alternate water supplies to replace large reductions in CVP water deliveries. As discussed in Chapter 4, Surface Water, this could result in unmet PHS need impacts. PHS demands are not fully met in 17 percent of the 81 modeled water years (see Figure 4-22 in Chapter 4). If alternate water supplies were not available, there may be additional economic effects than those described above. Effects could include businesses decisions to reduce production or employment, or site facilities outside of the region to avoid potential water supply impacts. These would be adverse impacts to the regional economy of the Bay Area.

13.2.3.5 Indirect Effects

Implementation of cropland idling water transfers under of Alternative 2 could result in indirect economic effects. M&I water contractors would seek alternate water supplies if CVP supplies are reduced under this alternative. Chapter 3 discusses potential actions that may be taken by these contractors. M&I contractors could purchase water transfers through cropland idling in the Sacramento Valley. Cropland idling transfers would occur with willing sellers that are agricultural water contractors in the Sacramento Valley. For cropland idling transfers, growers within the selling districts would idle crop fields and sell surface water supplies to agencies interested in purchasing water for transfer.

Indirect economic effects could result in the counties in the Sacramento Valley as a result of cropland idling transfers to M&I water contractors. For a cropland idling transfer, growers would receive revenues from the transfers, but would not purchase inputs from agricultural support businesses or employ farm laborers. Value of agricultural production would also decrease. These would be adverse economic effects in the regional economies where cropland idling would occur.

13.2.4 Alternative 3: Full M&I Allocation Preference

13.2.4.1 Sacramento Valley Region

Implementation of the Full M&I Allocation Preference Alternative could result in economic effects to M&I water users and the regional economy. Alternative 3 would increase average CVP water supply deliveries to M&I water service contractors in the Sacramento Valley Region when the M&I WSP is implemented. As a result, shortage and water costs would decrease relative to the No Action Alternative. OPWEM estimates that implementation of Alternative 3 would decrease water costs in the Sacramento Valley Region by an average of about $1.1 million annually, relative to the No Action Alternative. The entire amount of reduced water supply cost would be a reduced cost to the CVP water contractor, which would be passed on to the customers through reductions in water rates. This would be a positive regional economic effect. Customers would have increased discretionary income available to spend in the region, which would result in increased induced spending. IMPLAN estimates the effects of increased household spending in the regional economy.

Table 13-31 summarizes the regional economic effects in the Sacramento Valley Region. These would be minor positive effects relative to the baseline economy.

Table 13-31. Average Annual M&I Economic Effects in the Sacramento Valley Region of Alternative 3

	Employment (jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Economic Effect	7	$0.24	$0.48	$0.75

Implementation of the Full M&I Allocation Preference Alternative could result in economic effects to crop value of production and the regional economy. Implementation of Alternative 3 would decrease water supplies to agricultural water users in the Sacramento Valley Region. As a result, growers would decrease irrigated acreage and crop production, which would adversely affect the regional economy. Modeling predicts that irrigated acreage would decrease by about 4,000 acres in critical years. In addition, there would be a total decrease in annual value of production of about $16.1 million in critical years. Decreased value of production would decrease employment, value added, labor income, and output in the regional economy through indirect and induced impacts. Some employment and regional effects may be offset if workers go to other farms within the region. Table 13-32 summarizes the total economic effect on the regional economy in the Sacramento Valley. These would be adverse effects to the regional economy.

Table 13-32. Agricultural Economic Effects in Critical Water Years in the Sacramento Valley Region of Alternative 3

	Employment (jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Direct Effect	-98	-$5.33	-$9.35	-$16.14
Indirect Effect	-53	-$1.81	-$2.35	-$3.49
Induced Effect	-34	-$1.23	-$2.51	-$3.97
Total Effect	-185	-$8.37	-$14.21	-$23.60

Modeling estimates that value of production would be the same in wet and above normal years relative to the No Action Alternative. Economic effects in below normal and dry years would be less than adverse effects in critical years because water supply and irrigated acreage would not decrease as much. Average annual value of production would decrease by $3.0 million in below normal years and $6.3 million in dry years. Adverse effects to the regional economy in below normal and dry would be proportionate to those shown in Table 13-25 for critical years.

Implementation of the Full M&I Allocation Preference Alternative could change groundwater pumping costs for agricultural water users. Decreased water supplies to agricultural CVP contractors would increase the need for groundwater pumping for irrigation. Modeling estimates that annual groundwater pumping costs would increase by about $0.1 million in critical years in the Sacramento Valley Region relative to the No Action Alternative. Increased pumping would increase production costs for growers, which would decrease net revenues. This would be an adverse effect to growers' incomes. They would likely spend less money in the regional economy, which would be a minor adverse effect to output, sales and income in the region.

13.2.4.2 American River Region

Implementation of the Full M&I Allocation Preference Alternative could result in economic effects to M&I water users and the regional economy. Similar to the Sacramento Valley Region, OPWEM estimates that implementation of Alternative 3 would decrease shortage and water costs in the American River Region by an average of approximately $4.6 million, which would be passed on to the customers through reductions in water rates. This would be a positive regional economic effect. Customers would have increased discretionary income available to spend in the region.

Table 13-33 summarizes the regional economic effects of an increase in household spending in the American River Region. These would be a minor positive effect relative to the baseline economy.

Table 13-33. Average Annual M&I Economic Effects in the American River Region of Alternative 3

	Employment (jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Economic Effect	30	$1.3	$2.5	$3.8

13.2.4.3 San Joaquin Valley Region

Implementation of the Full M&I Allocation Preference Alternative could result in economic effects to M&I water users and the regional economy. OPWEM estimates that implementation of Alternative 3 would decrease water supply costs to M&I contractors in the San Joaquin Valley Region by an average of approximately $3.8 million, which would be passed on to the customers through reductions in water rates. This would be a positive regional economic effect. Customers would have increased discretionary income available to spend in the region.

Table 13-34 summarizes the regional economic effects of an increase in household spending in the American River Region. These would be a minor positive effect relative to the baseline economy.

Table 13-34. Average Annual M&I Economic Effects in the San Joaquin Valley Region of Alternative 3

	Employment (jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Economic Effect	23	$0.89	$1.8	$3.0

Implementation of the Full M&I Allocation Preference Alternative could result in economic effects to crop value of production and the regional economy. For this agricultural analysis, the San Joaquin Valley Region is split into the San Joaquin River Region that includes most of Sacramento, San Joaquin, Stanislaus, Merced, and Madera counties, and the Tulare Lake Region that includes Fresno, Kings, Tulare, and Kern counties.

Modeling predicts that irrigated acreage in the San Joaquin River Region would be the same as the No Action Alternative. Average annual value of production would increase about $5.2 million in critical years relative to the No Action Alternative. The Sacramento Valley Region (described above) and Tulare Lake Region (described below) receive less water under Alternative 3, which decreases production and drives the price of crops up. The SWAP model simulates statewide demand and capture price effects across regions. The crop prices would be high in the San Joaquin River Region as a result of higher crop prices in the Sacramento Valley and Tulare Lake regions, which increases value of production. The increased value of production would increase employment, income, and output in the regional economy. This would be a positive economic effect to this region. Table 13-35 summarizes the effects on the regional economy in the San Joaquin Region in critical water years.

Table 13-35. Agricultural Economic Effects in Critical Water Years in the San Joaquin River Region of Alternative 3

	Employment (jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Direct Effect	22	$1.90	$3.00	$5.19
Indirect Effect	18	$0.57	$0.76	$1.19
Induced Effect	14	$0.55	$1.08	$1.72
Total Effect	54	$3.02	$4.85	$8.10

Table 13-35 shows economic effects in critical water years. Alternative 3 would not result in economic effects in the San Joaquin River Region to value of production or the regional economy in wet and above normal years. Effects in below normal and dry years would be less than those in critical years. Average annual value of production would increase by $0.4 million in below normal years and $0.3 million in dry years. Positive effects to the regional economy in below normal and dry would be proportionate to those shown in Table 13-35 for critical years.

Table 13-36 summarizes the effects on the regional economy in the Tulare Lake Region in critical water years. Decreased water supplies for agricultural uses in the Tulare Lake Region would decrease irrigated acreage and value of production. Irrigated acreage in the Tulare Lake Region would decrease by about 23,000 acres in critical years. Annual value of production would decrease by about $45.9 million in critical years. Decreased value of production would decrease employment, value added, labor income, and output in the crop sectors and the overall regional economy through indirect and induced impacts. This would be an adverse effect to the regional economy.

Table 13-36. Agricultural Economic Effects in Critical Water Years in the Tulare Lake Region of Alternative 3

	Employment (jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Direct Effect	-233	-$12.23	-$20.50	-$45.92
Indirect Effect	-177	-$5.45	-$9.19	-$15.67
Induced Effect	-91	-$3.38	-$6.91	-$11.22
Total Effect	-501	-$21.04	-$36.60	-$72.81

Alternative 3 would not result in economic effects in the Tulare Lake Region to value of production or the regional economy in wet and above normal years. Effects in below normal and dry years would be less than those in critical years. Average annual value of production would decrease by $0.8 million in below normal years and $26.3 million in dry years. Impacts to the regional economy in below normal and dry would be proportionate to those shown in Table 13-36 for critical years.

Implementation of the Full M&I Allocation Preference Alternative could change groundwater pumping costs for agricultural water users. Decreased water supplies to agricultural CVP contractors would increase the need for groundwater pumping for irrigation. Modeling estimates that annual groundwater pumping costs would increase by about $1.3 million in critical years in the San Joaquin River Region and $0.8 million in critical years in the Tulare Lake Region relative to the No Action Alternative. Increased pumping would increase production costs for growers, which would decrease net revenues. This would be an adverse effect to growers' incomes. They would likely spend less money in the regional economy, which would be a minor adverse effect to output, sales and income in the region.

13.2.4.4 Bay Area Region

Implementation of the Full M&I Allocation Preference Alternative could result in economic effects to M&I water users and the regional economy. Alternative 3 would result in increased CVP water supplies to M&I water service contractors under implementation of the M&I WSP. As a result, water contractors would have reduced costs relative to the No Action Alternative because of the availability of less expensive water supplies. LCPSIM estimates that implementation of Alternative 3 would decrease costs in the Bay Area Region by an average of about $7.9 million annually, relative to the No Action Alternative.

These costs would be passed on to customers through reduced water rates. The resulting economic effect is an increase in customers' discretionary income available to spend in the region. Table 13-37 summarizes the regional economic effects of an increase in household spending in the Bay Area Region. These effects would be a small positive effect relative to the baseline regional economy.

Table 13-37. Average Annual M&I Economic Effects in the Bay Area Region of Alternative 3

	Employment (jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Economic Effect	44	$2.4	$4.1	$6.5

13.2.4.5 Indirect Effects

Implementation of cropland idling water transfers under of Alternative 3 could result in indirect economic effects. M&I water contractors would buy less alternate water supplies if CVP supplies are increased under this alternative. However, agricultural CVP contractors may need to purchase additional water supplies because agricultural water supplies would be reduced. Chapter 3 discusses potential actions that may be taken by these contractors. Indirect economic effects could result from cropland idling that occurs in counties in the Sacramento Valley. Cropland idling transfers would occur with willing sellers that are agricultural water contractors in the Sacramento Valley. For a cropland idling transfer, growers in the selling districts would receive revenues from the transfers, but would not purchase inputs from agricultural support businesses or employ farm laborers. Value of agricultural production would also decrease. These would be adverse economic effects in the regional economies where cropland idling would occur.

13.2.5 Alternative 4: Updated M&I WSP

Implementation of the Updated M&I WSP would result in the same economic effects as the No Action Alternative. Allocations under Alternative 4 would be similar to those under the No Action Alternative, with the exception for how historical use is calculated. Allocation methodology for both agricultural and M&I water service contractors would be the same as under the No Action Alternative; therefore, economic effects generated by Alternative 4 would be identical to the economic effects of the No Action Alternative.

13.2.6 Alternative 5: CVP M&I Contractor Suggested WSP

Implementation of the CVP M&I Contractor Suggested WSP could result in similar economic impacts as the No Action Alternative. Allocations under Alternative 5 would be similar to those under the No Action Alternative; therefore, economic effects generated by Alternative 5 would be similar to or less that the economic effects of the No Action Alternative.

13.3 Mitigation Measures

No mitigation measures are identified for the adverse impacts anticipated in Alternatives 2 and 3.

13.4 Unavoidable Adverse Impacts

None of the action alternatives would result in unavoidable adverse impacts on regional economics.

13.5 Cumulative Effects

The timeline for the socioeconomics cumulative effects analysis extends from 2010 through 2030, a 20-year period. The relevant geographic study area for the cumulative effects analysis is the same area of analysis as shown in Figure 13-1. The following section analyzes the cumulative effects using the project and projection method, which is further described in Chapter 20, Cumulative Effects Methodology.

13.5.1 Alternative 2: Equal Agricultural and M&I Allocation

Providing equal allocations to agricultural and M&I water service contractors, in combination with other cumulative projects, could result in economic effects to M&I water users and the regional economy. The Bureau of Reclamation, California Department of Water Resources, and local water agencies are implementing water management activities that could result in cumulative effects to M&I water contractors in combination with the M&I WSP. Activities could affect water supplies and costs for M&I water contractors and their customers. State and Federal projects considered as part of this cumulative analysis include Long-Term Water Transfers, SWP transfers, Bay-Delta Conservation Plan (BDCP), Shasta Lake Water Resources Investigation, Upper San Joaquin Storage Investigation, San Luis Low Point Improvement Project, North of Delta Off-Stream Storage Investigation, and the San Joaquin River Restoration Program.

The cumulative projects listed above are being implemented to improve water management, supplies, and reliability, among other purposes, such as ecosystem restoration. Improved water supplies would benefit urban areas by providing more reliable water supplies for existing and new business and residential developments. Increase water supply reliability could attract businesses and residents to the region, which would increase output, employment, and income in the regional economies. Improved water supplies would also maintain indoor and outdoor water uses, which could attract new residents to the area.

Depending on the financing of the projects, customer water rates could increase as a result of these cumulative projects, which would reduce discretionary income in the region. This would reduce spending in the regional economy, which would be an adverse impact. The positive effects from increased business and residential development would likely offset these adverse effects in the regional economy.

Long-term water transfers and SWP transfers would be an additional water supply option for M&I water service contractors during dry and critical years. Transfers are typically annual transactions to supplement existing water supplies. Transfers would have similar effects as described above, but would be only occur during the year of the transfer. Transfers would not occur in all years.

Population growth would also contribute to cumulative economic impacts. Table 13-39 shows population projections in the Bay Area Region counties.

Table 13-39. Population Projections in the Bay Area and American River Regions

County	2015 Population	2030 Population	Total Growth Rate (%) 2015 to 2030
Alameda	1,577,938	1,657,567	5%
Contra Costa	1,093,171	1,254,205	15%
San Benito	57,512	69,215	20%
Santa Clara	1,874,604	1,986,545	6%
Sacramento	1,477,479	1,708,114	16%
Placer	371,536	442,505	19%
El Dorado	184,195	234,485	27%

Source: California Department of Finance 2013

Population growth would increase the demand for housing and services, resulting in new construction and urban development. Urban development would be associated with new businesses in the area, which would increase county revenues and provide employment opportunities. This would result in positive economic effects under the cumulative condition.

Alternative 2 would reduce water supplies to M&I contractors in dry and critical years because of the equal allocation with agricultural contractors. This would be an adverse cumulative impact to the M&I water users and the regional economy. The cumulative projects listed above would offset some of these effects by providing increased water supplies, particularly during dry and critical years. Increased population growth would also benefit the regional economy. The incremental cumulative impacts of Alternative 2 on M&I water users and the regional economy would be minor.

Providing equal allocations to agricultural and M&I water service contractors, in combination with other cumulative projects, could result in economic effects to crop value of production and the regional economy. Projects considered as part of this cumulative analysis include Long-Term Water Transfers, SWP transfers, the BDCP, Shasta Lake Water Resources Investigation, Upper San Joaquin Storage Investigation, San Luis Low Point Improvement Project, North of Delta Off-Stream Storage Investigation, and the San Joaquin River Restoration Program. These projects could increase water supplies for CVP agricultural water contractors. With increased and more reliable water supplies, growers could increase crop acreage planted or switch to higher value crops. Crop value of production would increase output, employment, and income in the regional economy. These projects would result in cumulative benefits to the regional economy in areas where agricultural water supplies are increased.

Population growth would also contribute to cumulative economic impacts. Table 13-40 shows projected population growth in counties with agricultural CVP contractors. Population growth would increase the demand for housing and services, resulting in new construction and urban development. Urban development would include new businesses in the area, which would increase county revenues and provide employment opportunities. The counties could use new revenues to provide services, including programs to train unskilled workers. Overall, population growth and urban development would boost the regional economies under the cumulative condition.

Table 13-40. Population Projections in Counties in the Sacramento Valley and San Joaquin Valley Regions

County	2015 Population	2030 Population	Total Growth Rate (%) 2015 to 2030
Shasta	181,792	220,019	21%
Tehama	64,733	77,437	20%
Glenn	28,871	33,552	16%
Colusa	22,417	29,023	29%
Yolo	209,198	250,414	20%
San Joaquin	725,884	1,004,147	38%
Stanislaus	540,853	674,859	25%
Madera	161,556	229,277	42%
Merced	273,156	366,352	34%
Fresno	988,970	1,241,773	26%
Kings	157,314	205,627	31%
Kern	911,750	1,341,278	47%
Tulare	473,785	630,303	33%

Source: California Department of Finance 2013

Urban development would increase agricultural land conversions and permanently remove land from agricultural production. Agricultural to urban land conversions would affect incomes and employment for farm workers and agricultural businesses in the area as crop production decreased. However, crop yield increases might outpace agricultural land conversions, conversions to higher-value crops would increase value of production, and some share of urban development will include agricultural service industries. Even with land conversion, agriculture is very likely to remain a dominant sector in the regional economy in the San Joaquin Valley and Sacramento Valley under the cumulative condition.

Long-term water transfers and SWP transfers would include some level of cropland idling transfers, which would temporarily idle cropland in the Sacramento Valley during dry and critical years when transfers are implemented. Cropland idling transfers would reduce output, employment, and income in the regional economy due to less acreage being planted.

Alternative 2 in combination with other cumulative projects would increase water supplies during dry and critical years to CVP agricultural water contractors. Increased water supplies would benefit the regional economy by increasing value of production. This would be a cumulative benefit.

13.5.2 Alternative 3: Full M&I Allocation Preference

Providing equal allocations to agricultural and M&I water service contractors, in combination with other cumulative projects, could result in economic effects to M&I water users and the regional economy. The cumulative condition associated with other projects in the region would be the same as described for Alternative 2. Alternative 3 would increase water supplies to M&I water contractors during dry and critical years. Increased water supplies would contribute to the regional economic benefits of the other cumulative projects.

Similar to Alternative 2, water rates could increase as projects are implemented to improve future water supplies. Improved water supplies under the M&I WSP would reduce the need for CVP M&I contractors to purchase additional water supplies during dry conditions. This could reduce operational costs for M&I water contractors, a benefit which could be passed on to consumers. This would be a minor benefit to customers under the cumulative condition.

Providing equal allocations to agricultural and M&I water service contractors, in combination with other cumulative projects, could result in economic effects to crop value of production and the regional economy. The cumulative condition would be the same as described for Alternative 2. Alternative 3 in combination with other cumulative projects would decrease water supplies during dry and critical years to CVP agricultural water contractors. Decreased water supplies would adversely affect the regional economy by decreased value of production. Other cumulative projects would work to increase agricultural water supplies; however, there still may be water shortages for agricultural water service contractors in consecutive dry and critical years. This would be an adverse cumulative impact. Alternative 3 would contribute to this cumulative effect.

13.5.3 Alternative 4: CVP Updated M&I WSP

Changes in CVP water allocations under the CVP Updated M&I WSP alternative, in combination with other cumulative projects, could affect the regional economy.

The cumulative condition associated with other projects in the region would be the same as described for Alternative 2. Allocations under Alternative 4 would be similar to those under the No Action Alternative, with the exception for how historic use is calculated. Project-related impacts would be the same as those described for Alternative 2; therefore, this alternative would not contribute to cumulative impacts.

13.5.4 Alternative 5: CVP M&I Contractor Suggested WSP

Changes in CVP water allocations under the CVP M&I Contractor Suggested WSP alternative, in combination with other cumulative projects, could affect the regional economy.

The cumulative condition associated with other projects in the region would be the same as described for Alternative 2. Allocations under Alternative 5 are expected to change only slightly from the No Action Alternative. Project-related impacts would be the same as or less than those described for Alternative 2; therefore, this alternative would not contribute to cumulative impacts.

13.6 References

California Department of Finance. 2013. *Interim Population Projections for California and Its Counties 2010-2060.* Accessed on: on: 07/23/2014. Available: http://www.dof.ca.gov/research/demographic/reports/projections/P-1/.

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