Chapter 14
Energy and Greenhouse Gases

14.1 Introduction

This chapter describes the environmental setting and overall regulatory framework for energy and greenhouse gases (GHGs). It also evaluates environmental impacts on energy and climate change that could result from the Lower San Joaquin River (LSJR) alternatives and, if applicable, offers mitigation measures that would reduce significant impacts.

The area of potential effects evaluated in this chapter includes the plan area, described in Chapter 1, *Introduction,* and the Central Valley Project (CVP) and State Water Project (SWP) export service areas. However, once emitted from their sources, GHGs become free to move within the atmosphere and can travel far away from their sources during their lifetimes. In addition, climate change is a global issue and GHGs are global pollutants, unlike criteria air pollutants (such as ozone precursors), which are primarily pollutants of regional and local concern. No single emitter of GHGs is large enough to trigger climate change on its own. Hence, the discussion of GHGs and climate change in this chapter extends outside of the plan area to evaluate the impacts on *climate change* of GHG emissions generated within the plan area.

The extended plan area, also described in Chapter 1, generally includes the area upstream of the rim dams.[1] It also includes the reservoirs on the upper reaches of the Stanislaus, Tuolumne, and Merced Rivers. Unless otherwise noted, all discussion in this chapter refers to the plan area. Where appropriate, the extended plan area is specifically identified.

The LSJR alternatives propose specified unimpaired flow[2] (i.e., 20, 40 or 60 percent) requirements on the three eastside tributaries[3] in February–June. Such requirements could affect reservoir operations, surface water diversions, and the associated timing and amount of hydropower generated by dams on the three eastside tributaries. This chapter evaluates the effects on hydropower production, electric grid reliability, and the resulting increase in energy consumption in the plan area that would result from the LSJR alternatives. This chapter also evaluates the effects of the LSJR alternatives on climate change and GHG emissions.

In Appendix B, *State Water Board's Environmental Checklist*, the State Water Board determined whether the plan amendments[4] would result in any adverse impact on resources in each environmental category in the checklist and provided a brief explanation for its determination. Impacts that are listed as "Potentially Significant Impacts" are discussed in detail in this chapter.

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[1] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

[2] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

[3] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

[4] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

Appendix B, Section VII, identified the alternatives as having potentially significant impacts relating to GHG emissions, because they might: (1) generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment; and (2) conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs. In order to analyze these potential impacts, GHG impacts were generally evaluated on exceedance of regulatory thresholds that could negatively impact the environment and long-term management implications affecting climate change.

As stated in Appendix B, Section VII, the general historical range of salinity in the southern Delta would remain unchanged under the SDWQ alternatives and, thus, would not result in GHG emissions or conflict with an applicable plan, policy or regulation adopted for the purpose of reducing GHG emissions. Therefore, the SDWQ alternatives are not further analyzed in this chapter, except as they relate to the effect of climate change on the alternatives. SDWQ Alternative 2 could result in service providers having to construct and operate new or expanded wastewater treatment or water supply facilities, which would involve changes in energy consumption and GHG emissions, and is evaluated in Chapter 13, *Service Providers*, and Chapter 16, *Evaluation of Other Indirect and Additional Actions.*

The State Water Board determined that additional types of potentially significant adverse impacts that are not listed in the checklist in Appendix B should be evaluated. Accordingly, this chapter also evaluates the LSJR alternatives' impacts on energy resources that either may potentially (1) adversely affect the reliability of California's electric grid, or (2) result in inefficient, wasteful, and unnecessary energy consumption. The detailed discussion regarding the hydropower production on the LSJR's three eastside tributaries, the electric grid reliability, and the surface water diversions is presented in Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*, Chapter 5, *Surface Hydrology and Water Quality*, and Appendix F.1, *Hydrologic and Water Quality Modeling.*

A summary of the potential impacts of the LSJR alternatives on energy and GHG emissions is provided in Table 14-1. As described in Chapter 3, *Alternatives Description*, LSJR Alternatives 2, 3, and 4 each include four methods of adaptive implementation. Table 14-1 also considers the effect of climate change on the LSJR and SDWQ alternatives. This recirculated substitute environmental document (SED) provides an analysis with and without adaptive implementation because the frequency, duration, and extent to which each adaptive implementation method would be used, if at all, within a year or between years under each LSJR alternative, is unknown. The analysis, therefore, discloses the full range of impacts that could occur under an LSJR alternative, from no adaptive implementation to full adaptive implementation. As such, Table 14-1 summarizes impact determinations with and without adaptive implementation.

Impacts related to the No Project Alternative (LSJR/SDWQ Alternative 1) are presented in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* and the supporting technical analysis is presented in Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1).* Impacts related to methods of compliance are discussed in Chapter 16, *Evaluation of Other Indirect and Additional Actions*.

Table 14-1. Summary of Energy and Greenhouse Gases Impact Determinations

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact EG-1: Adversely affect the reliability of California's electric grid			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Less than significant	NA
LSJR Alternatives 2 and 3	Transmission line loadings would not exceed the limits under contingency outage conditions because hydropower generation and reservoir elevation would not be substantially modified. Therefore, adverse effects on the reliability of California's electric grid would not occur.	Less than significant	Less than significant
LSJR Alternative 4	Transmission line loadings would not exceed the limits under contingency outage conditions after re-dispatch of generator facilities to correct a minor violation between Borden and Gregg substations and Gregg and Storey substations. Re-dispatches are regular occurrences in the California energy grid, and they provide a solution to redistribute power. Therefore, adverse effects on the reliability of California's electric grid would not occur.	Less than significant	Less than significant
Impact EG-2: Result in inefficient, wasteful, and unnecessary energy consumption			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Less than significant	NA
LSJR Alternatives 2, 3, and 4	Additional groundwater pumping would not result in inefficient, wasteful, and unnecessary consumption of energy to the extent groundwater pumping is used to meet water supply irrigation demand in accordance with state law. Additional energy generation at other facilities to compensate for a potential loss of hydropower would not be considered inefficient, wasteful, and unnecessary as it is energy that would be generated to maintain the energy supply level that is currently supplied by hydropower. Therefore, there would be no inefficient, wasteful, or unnecessary energy consumption.	Less than significant	Less than significant

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact EG-3: Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Significant	NA
LSJR Alternative 2	Emissions would not exceed 10,000 MT CO_2e threshold, even if adaptive implementation method 1 were implemented on a long-term basis (an increase in the February–June percent of unimpaired flow from 20% up to 30%). Therefore, GHG emissions would not have a significant impact on the environment.	Less than significant	Less than significant
LSJR Alternatives 3 and 4	Emissions exceed 10,000 MT CO_2e threshold with and without adaptive implementation. Therefore, GHG emissions would have a significant impact on the environment.	Significant and unavoidable	Significant and unavoidable
Impact EG-4: Conflict with an applicable plan, policy, or regulation adopted for the purposes of reducing GHG emissions			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Significant	NA
LSJR Alternative 2	Since GHG emissions would not exceed the 10,000 MT CO_2e threshold, even if adaptive implementation method 1 were implemented on a long-term basis, there would be no conflict with applicable plans, policies or regulations adopted for the purpose of reducing GHGs.	Less than significant	Less than significant
LSJR Alternatives 3 and 4	Since GHG emissions would exceed the 10,000 MT CO_2e threshold, with and without adaptive implementation, it is expected there would be a conflict with applicable plans, policies or regulations adopted for the purpose of reducing GHGs.	Significant and unavoidable	Significant and unavoidable
Impact EG-5: Effect of climate change on the LSJR and SDWQ alternatives			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Less than significant	NA

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
LSJR Alternatives 2, 3, and 4	Climate change would not significantly affect the LSJR alternatives because adaptive implementation would allow agencies to respond to changing circumstances with respect to flow and water quality that might arise due to climate change. Furthermore, the required review and update of WQCPs, accounted for in the program of implementation, continually accounts for changing conditions related to water quality and water planning such as climate change.	Less than significant	Less than significant
SDWQ Alternatives 2 and 3	Climate change would not significantly affect the SDWQ alternatives because the required review and update of WQCPs, accounted for in the program of implementation, continually accounts for changing conditions related to water quality and water planning, such as climate change.	Less than significant	NA

MT = metric ton
CO_2e = carbon dioxide equivalent
WQCP = water quality control plan

[a] Four adaptive implementation methods could occur under the LSJR alternatives, as described in Chapter 3, *Alternatives Description*, and summarized in Section 14.4.2, *Methods and Approach,* of this chapter.

[b] The No Project Alternative (LSJR/SDWQ Alternative 1) would result in implementation of flow objectives and salinity objectives established in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

14.2 Environmental Setting

14.2.1 Lower San Joaquin River and Eastside Tributaries Hydropower Production

There are numerous hydropower generation plants on the three eastside tributaries. The major power plants are those associated with the New Melones Reservoir (New Melones Dam) on the Stanislaus River, New Don Pedro Reservoir (New Don Pedro Dam) on the Tuolumne River, and Lake McClure (New Exchequer Dam) on the Merced River. Within the plan area, t~~T~~he total hydropower generation capacity of the three eastside tributaries combined is about 656~~803~~ megawatts (MW), and the three rim dam facilities considered in the most detail here in the environmental setting represent 91~~87~~ percent of the total capacity of the three eastside tributaries in the plan area ~~(Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*)~~. Table 14-2a lists the hydropower facilities in the plan area and extended plan area. Table 14-2b shows the characteristics of the three major hydropower plants on the tributaries—New Melones, New Don Pedro, and New Exchequer. The head for each of the major hydropower plants is the difference between the maximum elevation and tail-water elevation and the corresponding maximum capacity of the power plants.

Table 14-2a. List of Hydropower Facilities

River Basin	Hydroelectric Power Plant Name	Nameplate Capacity (MW)	% of Power Capacity in Basin	Location Relative to Rim Dams
Stanislaus	Woodward	2.85	0.4	Off-stream
	Frankenheimer	5.04	0.6	Off-stream
	Tulloch	17.10	2.2	Inline
	Angels	1.40	0.2	Upstream
	Phoenix	1.60	0.2	Upstream
	Murphys	4.50	0.6	Upstream
	New Spicer	6.00	0.8	Upstream
	Spring Gap	6.00	0.8	Upstream
	Beardsley	9.99	1.3	Upstream
	Sand Bar	16.20	2.1	Upstream
	Donnells-Curtis	72.00	9.2	Upstream
	Stanislaus	91.00	11.6	Upstream
	Collierville Ph	249.10	31.8	Upstream
	New Melones	300.00	38.3	Rim Dam
	Upstream Capacity	457.79	58.5	NA
	Affected Capacity	324.99	41.5	NA
Tuolumne	Stone Drop	0.20	0.0	Off-stream
	Hickman	1.08	0.2	Off-stream
	Turlock Lake	3.30	0.5	Off-stream
	La Grange	4.20	0.7	Inline
	Upper Dawson	4.40	0.7	Upstream
	Moccasin Lowhead	2.90	0.5	Upstream
	Moccasin	100.00	16.6	Upstream
	R C Kirkwood	118.22	19.6	Upstream
	Dion R. Holm	165.00	27.4	Upstream
	Don Pedro	203.00	33.7	Rim Dam
	Upstream Capacity	390.52	64.8	NA
	Affected Capacity	211.78	35.2	NA
Merced	Fairfield	0.90	0.8	Off-stream
	Reta - Canal Creek	0.90	0.8	Off-stream
	Merced ID – Parker	3.75	3.2	Off-stream
	Mcswain	9.00	7.6	Inline
	Merced Falls	9.99	8.4	Inline
	New Exchequer	94.50	79.4	Rim Dam
	Upstream Capacity	0.00	0.0	NA
	Affected Capacity	119.04	100%	NA

Source: Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*, Table J-1.
MW = megawatts
NA = not applicable

Table 14-2b. Elevation and Maximum Capacity at Major Hydropower Plants on Eastside Tributaries

Power Plant	Maximum Elevation (feet)	Tail-water Elevation (feet)	Headwater (feet)	Maximum Capacity (MW)
New Melones	1,088	503	585	300
New Don Pedro	830	310	520	203
New Exchequer	867	400	467	95

Source: Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*.
MW = megawatts

The existing hydropower production was estimated for the various power plants on the three eastside tributaries. Actual hydropower generation in any given period is variable and depends on the amount of surface water captured and stored in the reservoir during wet and dry years; Table 14-3 summarizes the average annual hydropower generation on each of the three eastside tributaries to provide an overall sense of hydropower generation.

Table 14-3. Annual Baseline Hydropower Generation on LSJR Eastside Tributaries

LSJR Tributary	Average Annual Hydropower Generation (GWh)
Stanislaus River	586
Tuolumne River	656
Merced River	408
Project-Wide Total	1,650

Source: Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*. Baseline conditions are those from the baseline WSE model simulation.
GWh = gigawatt hours

14.2.2 Transmission System in Central California

This section provides a brief overview of the transmission systems and the balancing authorities for the areas in which the New Melones, New Don Pedro, and New Exchequer hydropower plants are located. According to the North American Electric Reliability Corporation (NERC), a balancing authority is defined as the responsible entity that integrates resource plans ahead of time, maintains load-interchange-generation balance and supports interconnection frequency in real time. The balancing authorities are listed in Table 14-4 and discussed in the sections below. This information provides context for the capacity reduction calculation and power flow analysis discussed below in Section 14.4.2, *Methods and Approach*.

Table 14-4. Balancing Authority of Major Hydropower Plants on LSJR Eastside Tributaries

Power Plant	Balancing Authority
New Melones	Balancing Authority of Northern California (BANC)
New Don Pedro	Turlock Irrigation District (TID—68%) and Sacramento Municipal Utility District (SMUD)—32%
New Exchequer	California Independent System Operator (CAISO)

Source: Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*.
Note: Don Pedro hydropower plant is jointly owned by TID and Modesto Irrigation District (MID). BANC performs the balancing authority function for MID's portion of the plant, while TID is the balancing authority for its portion. SMUD is a member of BANC.

California Independent System Operator

The New Exchequer hydropower plant lies in the Greater Fresno local capacity areas. These are areas that are transmission-constrained and require a certain minimum amount of local generation for meeting the local load requirements. California Independent System Operator (CAISO) operates the high-voltage, long-distance power lines that make up 80 percent of California's wholesale power grid. It is responsible for system reliability in the local capacity areas and other areas throughout California by scheduling available transmission capacity. The California Public Utilities Commission (CPUC) adopted the Resource Adequacy (RA) program in 2004 with the twin objectives of (1) providing sufficient resources to CAISO to ensure the safe and reliable operation of the grid in real time, and (2) providing appropriate incentives for the siting and construction of new resources needed for reliability in the future (CPUC 2011). Each year CAISO performs the Local Capacity Technical (LCT) Study to identify local capacity requirements (LCRs) within its territory. The results of this study are provided to CPUC for consideration in its RA program. These results are also be used by CAISO for identifying the minimum quantity of local capacity necessary to meet the NERC reliability criteria used in the LCT Study (CAISO 2010). Table 14-5 shows the historical local capacity requirements, peak load, and total dependable local area generation for the Greater Fresno area. The table also shows the local capacity area as a percentage of the total dependable local generation. For example, in 2011, the LCR in Greater Fresno was 2,448 MW, while the peak load stood at 3,306 MW; the LCR was 74 percent of the peak load. At the same time, the total dependable generation stood at 2,919 MW, which meant that the LCR was 84 percent of the total dependable generation. In other words, in 2011, Greater Fresno had sufficient local resources available to meet its local capacity requirements. As previously mentioned, these are minimum generation requirements imposed on transmission-constrained regions within the state.

Table 14-5. Local Capacity Requirements versus Peak Load and Local Area Generation for Greater Fresno Area

Year	Local Capacity (MW)	Peak Load (MW)	Local Capacity as % of Peak Load	Dependable Local Generation (MW)	Local Capacity Area as % of Dependable Local Generation
2006	2,837	3,117	91	2,651	107
2007	2,219	3,154	70	2,912	76
2008	2,382	3,260	73	2,991	80
2009	2,680	3,381	79	2,829	95
2010	2,640	3,377	78	2,941	90
2011	2,448	3,306	74	2,919	84

Source: Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*.
MW = megawatts

In the CAISO board of governors-approved 2010/2011 transmission plan, CAISO identified a number of transmission upgrades that are needed in the Greater Fresno area to maintain system reliability between 2011 and 2020. Pacific Gas & Electric Company (PG&E) proposed a number of projects to maintain system reliability in the area (CAISO 2011).

Balancing Authority of Northern California/Sacramento Municipal Utility District

The Balancing Authority of Northern California (BANC) is a joint powers authority comprised of the Sacramento Municipal Utility District (SMUD), MID, Roseville Electric, Redding Electric Utility and Trinity Public Utility District. The third largest balancing authority in California, BANC, assumed balancing authorities from SMUD in in 2011.

SMUD, established in 1946, is the nation’s sixth largest community-owned electric utility in terms of customers served (approximately 590,000) and covers a 900-square-mile area that includes Sacramento County and a small portion of Placer County. While the New Melones power plant physically resides in the CAISO balancing authority area, Sierra Nevada Region (SNR), Sacramento SMUD, and CAISO operate New Melones as a pseudo-tie generation export from CAISO into the SMUD balancing authority area (Western Area Power Administration 2010). The pseudo-tie generation export arrangement implies that New Melones is electrically and operationally included as part of the SMUD balancing authority area. For purposes of Qualifying Capacity, SNR has designated the New Melones power plant as part of the CVP resource in the SMUD balancing authority area.

As part of the biennial resource adequacy and resource plan assessments for publically owned utilities, the California Energy Commission (CEC) published its biennial report in November 2009 detailing the need and availability of generation resources to meet the future load and planning reserve margin requirements within the territory of publically owned utilities (CEC 2009a). The report indicates that SMUD will be able to meet its resource adequacy requirements in the near term; however, in 2018, SMUD’s generation resources may not be sufficient to meet its load and planning reserve margin obligations. The expected deficiency in 2018 is estimated to be 347 MW, but the CEC does not expect this to be an issue due to the lead time available to resolve the expected deficiency.

SMUD also carries out an annual 10-year transmission planning process to ensure that NERC and Western Electricity Coordinating Council (WECC) Reliability Standards are met each year of the 10-year planning horizon. Major projects that have been proposed in the 2010 transmission plan for the 2016–2020 time period are expected to improve the reliability of SMUD's electric system as well as increase its load-serving capability.

Turlock Irrigation District

The Turlock Irrigation District (TID) operates as a balancing authority located between Sacramento and Fresno in California's Central Valley (California Transmission Planning Group). Westley 230 kilovolt (kV) and Oakdale 115 kV lines provide import access for TID. The TID balancing authority incorporates all 662 square miles of TID's electric service territory as well as a 115 kV loop with three 115 kV substations owned by the Merced Irrigation District (Merced ID). The Merced ID facilities are interconnected to TID's August and Tuolumne 115 kV substations and are located just south of TID's service territory and north of the city of Merced. TID is the majority owner and operating partner of the New Don Pedro power plant with 68.46 percent ownership, and MID has a 31.54 percent ownership. BANC performs the balancing authority function for MID's portion of the plant.

14.2.3 Climate Change

The phenomenon known as the *greenhouse effect* keeps Earth's atmosphere near the surface warm enough for successful habitation by humans and other forms of life. GHGs present in the earth's lower atmosphere play a critical role in maintaining Earth's temperature as they trap some of the long-wave infrared radiation emitted from Earth's surface that otherwise would have escaped to space.

The accelerated increase of fossil fuel combustion and deforestation since the Industrial Revolution of the nineteenth century has exponentially increased concentrations of GHGs in the atmosphere. Increases in the atmospheric concentrations of GHGs in excess of natural ambient concentrations increase the natural greenhouse effect.

This increased greenhouse effect has contributed to global warming, which is the gradual increase of Earth's average surface temperature over a long term. Specifically, increases in GHGs lead to increased absorption of long-wave infrared radiation by the earth's atmosphere and further warm the lower atmosphere, thereby increasing evaporation rates and temperatures near the surface. Warming of Earth's lower atmosphere induces large-scale changes in ocean circulation patterns, precipitation patterns, global ice cover, biological distributions, and other changes to Earth's systems that are collectively referred to as *climate change*.

The Intergovernmental Panel on Climate Change (IPCC) has been established by the World Meteorological Organization and United Nations Environment Programme to assess scientific, technical, and socioeconomic information relevant to the understanding of climate change, its potential impacts, and options for adaptation and mitigation. The IPCC estimates that the average global temperature rise between the years 2000 and 2100 could range from 1.1°C, with no increase in GHG emissions above year 2000 levels, to 6.4°C, with substantial increase in GHG emissions (IPCC 2007). Large increases in global temperatures could have massive deleterious impacts on the natural and human environments.

Principal Greenhouse Gases

GHGs are gases that trap heat in the atmosphere. GHGs are both naturally occurring and artificial. Examples of GHGs that are produced both by natural and anthropogenic (human-made) processes are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Examples of GHGs created and emitted primarily through human activities are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The primary GHGs generated by the LSJR alternatives—CO_2, CH_4, and N_2O—are discussed below.

The IPCC estimates that CO_2 accounts for more than 75 percent of all anthropogenic GHG emissions. Three quarters of anthropogenic CO_2 emissions are the result of fossil fuel burning, and approximately one quarter result from land use change (IPCC 2007). CH_4 is the second largest contributor of anthropogenic GHG emissions and is the result of growing rice, raising cattle, combustion, and mining coal. N_2O, while not as abundant as CO_2 or CH_4, is a powerful GHG. Sources of N_2O include agricultural processes, nylon production, fuel-fired power plants, nitric acid production, and vehicle emissions.

In order to simplify reporting and analysis, methods have been set forth to describe emissions of GHGs in terms of a single gas. The most commonly accepted method to compare GHG emissions is the global warming potential (GWP) defined in the IPCC reference documents (IPCC 1996, 2001). The IPCC defines the GWP of various GHGs on a normalized scale that recasts all GHG emissions in terms of carbon dioxide equivalent (CO_2e). Hence, GWP is a measure of a gas's heat-absorbing capacity and lifespan relative to a reference gas, CO_2 (CO_2 has a GWP of 1, by definition).

Table 14-6 lists the global warming potential of CO_2, CH_4, and N_2O; their lifetimes; and abundances in the atmosphere in parts per million (ppm) and parts per trillion (ppt).

Table 14-6. Lifetime and Global Warming Potentials

GHG	Global Warming Potential (100 years)	Lifetime (years)	Current Atmospheric Abundance (ppm)
CO_2	1	50–200	399
CH_4	28	12.4	1,893
N_2O	265	121	326

Sources: IPCC 2013; Carbon Dioxide Information Analysis Center 2014; CO2Now.org 2015.
GHG = greenhouse gas
ppm = parts per million

Greenhouse Gas Emissions Inventories

A GHG inventory is a quantification of GHG emissions and sinks within a selected physical and/or economic boundary over a specified time. GHG inventories can be performed on a large scale (i.e., for global and national entities) or on a small scale (i.e., for a particular building or person). GHG sinks typically refer to removals of GHGs from the atmosphere as a result of carbon sequestration. Carbon sequestration is the process by which plants absorb and store atmospheric CO_2.

Table 14-7 outlines the most recent global, national, and statewide GHG inventories to help contextualize the magnitude of potential alternative-related emissions. Figures 14-1, 14-2, and 14-3 show global, national, and state GHG emissions by source/sector, respectively.

Table 14-7. Global, National, and State Greenhouse Gas Emissions Inventories

Emissions Inventory	Total GHG Emissions and Sinks in CO_2e (metric tons)
2010 IPCC Global GHG Emissions Inventory	52,000,000,000
2013 USEPA National GHG Emissions Inventory	6,673,000,000
2013 ARB State GHG Emissions Inventory	459,280,000

Sources: IPCC 2014; USEPA 2015a; ARB 2015.
IPCC = Intergovernmental Panel on Climate Change
GHG = greenhouse gas
USEPA = U.S. Environmental Protection Agency
ARB = California Air Resources Board

GHG Emissions in the Plan Area and Extended Plan Area

There is no regional GHG inventory for the plan area or extended plan area. There are some local inventories for individual jurisdictions, but there is currently no assessment of GHG emissions for the Central Valley region or Mountain region as a whole. However, primary sources of GHG emissions in the plan area include those described above under the statewide emissions by source, such as: on-road transportation from vehicle travel, residential and nonresidential building energy use, and agricultural activity including off-road equipment fuel combustion, fugitive emissions from livestock production (enteric fermentation and manure management), and fertilizer application. Primary sources of GHG emissions in the extended plan area are similar to those described above under the statewide emissions by sources and in the plan area; however, there is expected to be less agricultural activity related emissions given the relatively limited amount of agriculture in the extended plan area when compared to the plan area and the rest of the state.

Climate Change Effects on State Climate Trends

Climate change is a complex phenomenon that has the potential to alter local climatic patterns and meteorology. Although modeling indicates that climate change will result in such things as sea level rise and changes in regional climate and rainfall, a high degree of scientific uncertainty still exists with regard to characterizing future climate characteristics and predicting how various ecological and social systems will react to any changes in the existing climate at the local level. Regardless of this uncertainty, it is widely understood that some form of climate change is expected to occur in the future.

Several recent studies have attempted to characterize future climatic scenarios for California. While specific estimates and statistics on the severity of changes vary, sources agree that the San Joaquin Valley and the Delta will witness warmer temperatures, increased heat waves, and changes in rainfall patterns. In addition, reduced snow pack and stream flow in the Sierra Nevada could lead to changes in water supply into the Delta region. Specifically, the CEC estimates that average annual temperatures in the state will increase by approximately 1°C–3°C between 2010 and mid-century, according the model for the Sacramento region. Climatic models also predict that between 2035 and 2064, the number of heat wave days for the Sacramento region will increase by more than 100 days, relative to the previous 30-year period between 2005 and 2034. Annual precipitation may experience a declining trend, but remain highly variable, suggesting that the Sacramento Valley will be vulnerable to increased drought. Warmer temperatures will lead to increased precipitation in the form of rain, both of which will contribute to decreased snowpack in the Sierra Nevada. Such effects will translate into earlier snowmelt and increased potential for flooding as a result of insufficient reservoir capacity to retain earlier snowmelt. (IPCC 2007; California Natural Resources Agency 2009; CEC 2009b; USBR 2016).

Sea level rise during the next 50 years is expected to increase dramatically over historical rates. The CEC predicts that by 2050, sea level rise, relative to the 2000 measurements, will range from 30 to 45 centimeters. Coastal sea level rise could result in saltwater intrusion to the Delta and associated biological impacts in the San Joaquin Valley. Changes in soil moisture and increased risk of wildfires also may dominate future climatic conditions in the area. (IPCC 2007; California Natural Resources Agency 2009; CEC 2009b).

The changes in temperature, precipitation and sea level may have substantial effects on other resources areas. The primary effects of climate change anticipated in California are listed below (California Natural Resources Agency 2009).

- Increased average temperatures (air, water, and soil).
- Reduced or slightly increased annual precipitation amounts.
- Change from snowfall (and spring snowmelt) to rainfall.
- Decreased Sierra snowpack (earlier runoff, reduced maximum storage).
- Increased evapotranspiration.
- Increased frequency and intensity of Pacific storms (flood events).
- Increased severity of droughts.
- Increased frequency and severity of extreme heat events.
- Increased frequency and severity of wildfire events.
- Sea level rise (with increased salt water intrusion in the Delta).
- Changes in species distribution and ranges.
- Decreased number of species.
- Increased number of vector-borne diseases and pests (including impacts on agriculture).
- Altered timing of animal and plant lifecycles (phenology).
- Disruption of biotic interactions (e.g., predator-prey relationships amongst species and increased invasive species abundance).
- Changes in physiological performance, including reproductive success and survival of plants and animals.
- Increase in invasive species.
- Altered migration patterns of fishes, aquatic-breeding amphibians, birds, and mammals.
- Changes in food (forage) base.
- Changes in habitat, vegetation structure, and plant and animal communities.

DWR (2010a) analyzed the flows of the four rivers in the SJR Watershed (Stanislaus, Tuolumne, Merced, and San Joaquin). This report documented that the combined unimpaired runoff from April–July has declined by approximately 7 percent relative to the total water year runoff over the past 100 years. Therefore, while total runoff in these watersheds has decreased, April–July runoff has decreased at a greater rate (DWR 2010a). USBR has also evaluated flows under climate change scenarios within the Sacramento-San Joaquin River Basin concluding that the basin will experience a shift in runoff to more during late fall and winter and less during the spring as a result of more precipitation, higher temperatures during the winter, and less snowpack (USBR 2016). As a result, reservoirs in the basin, including New Melones, New Don Pedro, and Lake McClure, are likely to fill earlier and release excess runoff, thereby potentially limiting overall storage capability and reducing water supply (USBR 2014, 2016). These changes have implications for water quality, water supply, flooding, aquatic ecosystems, energy generation, and recreation throughout the region (USBR 2014, 2016).

Guidance documents have been drafted and published to discuss strategies to protect resources from climate change in California (e.g., the *State of California Sea-Level Rise Interim Guidance Document*, Coastal and Ocean Working Group of the California Climate Action Team 2010). Many federal, state, and local agencies are incorporating adaptive strategies into their planning processes and planning documents to account for the potential changes in water resources and the effect on water supply reliability and other factors (see Sections 14.3.2, *State [Regulatory Background]*, and 14.3.3, *Regional or Local [Regulatory Background]*, regarding state and local planning documents related to climate change).

14.3 Regulatory Background

The legal framework addressing climate change regulatory background is complex and evolving. This section identifies key legislation, executive orders, as well as plans and policies relevant to the environmental assessment of GHG emissions.

14.3.1 Federal

Relevant federal programs, policies, plans, or regulations related to GHG emissions are described below.

Mandatory Greenhouse Gas Reporting Rule

On September 22, 2009, the U.S. Environmental Protection Agency (USEPA) released its final Greenhouse Gas Reporting Rule (Reporting Rule). The Reporting Rule is a response to the fiscal year (FY) 2008 Consolidated Appropriations Act (H.R. 2764; Public Law 110-161), which required USEPA to develop "… mandatory reporting of GHGs above appropriate thresholds in all sectors of the economy…." The Reporting Rule would apply to most entities that emit 25,000 metric tons (MT) of CO_2e or more per year. Starting in 2010, facility owners are required to submit an annual GHG emissions report with detailed calculations of facility GHG emissions. The Reporting Rule also would mandate recordkeeping and administrative requirements in order for USEPA to verify annual GHG emissions reports. All electrical distribution utilities (EDU) except Investor-Owned Utilities (IOUs) must comply with the Reporting Rule. This includes SMUD and TID, which are within the plan area.

Omnibus Public Land Management Act

The Omnibus Public Land Management Act, also known as the SECURE Water Act, was passed by Congress in 2009. This act establishes that Congress finds that adequate and safe supplies of water are fundamental to the health, economy, security, and ecology of the United States although global climate change poses a significant challenge to the protection of these resources. The act authorized USBR to continually evaluate and report on the risks and impacts from a changing climate and to identify appropriate adaptation and mitigation strategies using the best available science in conjunction with stakeholders. USBR has released several reports under the SECURE Water Act, the first of which was released in 2011. The reports address the requirements of the act including: each effect of, and risk resulting from, global climate change with respect to the quantity of water resources located in each major USBR river basin; impact of global climate change with respect to the operations of the secretary in each major river basin; each mitigation and adaptation strategy considered and implemented; each coordination activity conducted by the U.S. Geological Survey, National Oceanic and Atmospheric Administration, U.S. Department of Agriculture, or other resource agency (USBR 2011).

Since USBR maintains and operates reservoirs in the SJR Basin (e.g., New Melones Reservoir) these reports include information regarding the basin and effects of climate change. They also contain a wide variety of recommendations for responding to resource changes under climate changes (USBR 2016). These include the following potential adaptation strategies to address vulnerability: agricultural water use and municipal and industrial water use efficiency, ocean desalination; precipitation enhancement; conjunctive management; improvements of CVP/SWP operations; improvement of tributary and Delta environmental inflows; enhance groundwater recharge; increase San Joaquin Valley surface storage; improve regulatory flexibility and adaptation; improve river temperature management; and improve salinity and nutrient management (USBR 2016).

14.3.2 State

Relevant state laws, programs, policies, plans, or regulations related to GHG emissions are described below.

Executive Order S-3-05

Signed by Governor Arnold Schwarzenegger on June 1, 2005, Executive Order S-3-05 asserts that California is vulnerable to the effects of climate change. To combat this concern, Executive Order S-3-05 established the following GHG emissions reduction targets for state agencies.

- 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.

Executive Order S-13-08

Executive Order S-13-08, signed by Governor Schwarzenegger in November 2008, requires the California Natural Resources Agency to develop a state Climate Adaptation Strategy in coordination with local, regional, state and federal public and private entities. The National Academy of Sciences must convene an independent panel to complete the first California Sea Level Rise Assessment Report, which will advise how California should plan for future sea level rise. The order directs the state's Business, Transportation and Housing Agency to assess the vulnerability of state transportation systems to sea level rise and directs the Governor's Office of Planning and Research (OPR) to provide state land-use planning guidance related to sea level rise and other climate change impacts.

Executive Order B-30-15

Signed by Governor Jerry Brown on April 29, 2015, Executive Order B-30-15 establishes a California GHG reduction target of 40 percent below 1990 levels by 2030.

Assembly Bill 32, California Global Warming Solutions Act of 2006

In September 2006, the California State Legislature adopted Assembly Bill 32, the California Global Warming Solutions Act of 2006 (AB 32). AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the California Air Resources Board (ARB) is required to take the following actions.

- Adopt early action measures to reduce GHGs.
- Establish a statewide GHG emissions cap for 2020 based on 1990 emissions.
- Adopt mandatory report rules for significant GHG sources.
- Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions.
- Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs.

California Climate Adaptation Strategy 2009 and 2014~~3~~ Update

In 2009, California adopted a statewide Climate Adaptation Strategy (CAS). The CAS summarizes climate change impacts and recommends adaptation strategies for seven sectors: public health, biodiversity and habitat, oceans and coastal resources, water, agriculture, forestry, and transportation and energy (California Natural Resources Agency 2009). The California Natural Resources Agency is engaged in updating the CAS to augment strategies in light of advances in climate science.

California Renewables Portfolio Standard (California Senate Bill 1078 and 107)

Established in 2002 under Senate Bill (SB) 1078, and amendments thereto, the California Renewables Portfolio Standard (RPS) requires investor-owned utilities, electric service providers, and community choice aggregators to increase procurement from eligible renewable energy resources to 33 percent of total procurement by 2020. The California Public Utilities "Commission and the California Energy Commission jointly implement the RPS program. SB 107 (2006) accelerated the RPS by requiring electric corporations to increase procurement from eligible renewable energy resources by at least 1 percent of their retail sales annually, until they reach 20 percent by 2010.

California Air Resources Board Climate Change Scoping Plan

The California Global Warming Solutions Act of 2006 (AB 32) required ARB to prepare and adopt a plan that identified measures that would achieve reductions in GHG emissions in the State. In 2008, the ARB first considered the Climate Change Scoping Plan and in 2014 approved the first update to the plan (Scoping Plan). In particular, the Scoping Plan contains six strategies or measures for the water sector to implement that are expected to reduce GHG emissions due to the fact that water use requires significant amounts of energy. The six strategies for the water sector to implement include Water Use Efficiency (Measure W-1), Water Recycling (Measure W-2), Water System Energy Efficiency (Measure W-3), Reuse Urban Runoff (Measure W-4), Increase Renewable Energy Production from Water (Measure W-5), and a Public Goods Charge (Measure W-6). Efficient water conveyance, treatment and use can result in reductions in GHG emissions for those activities. The implementation of Measures W-1 through W-5 is expected to result in a total reduction of 4.8 MMT of CO_2e by 2020. The 2014 update to the Scoping Plan provides a status update of each of the measures but did not change the measures. The State Water Board is a sponsor of climate mitigation measures in the Scoping Plan (State Water Board 2011).

CEQA Statutes and Guidelines

SB 97 of 2007 requires that the Governor's OPR prepare guidelines for adoption by the California Resources Agency (now California Natural Resources Agency) regarding mitigation of GHG emissions or the effects of GHG emissions as required by the California Environmental Quality Act (CEQA). The amendments became effective in 2010.

State CEQA Guidelines Section 15064.4 specifically address how to determine the significance of impacts from GHG emissions. Section 15064.4 calls for a good-faith effort to describe, calculate, or estimate GHG emissions resulting from a project. Section 15064.4 further states that an agency should include certain factors when assessing the significance of GHG emission impacts on the environment, including the extent to which the project would increase or reduce GHG emissions, exceed an applicable threshold of significance, and comply with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of GHG emissions. The revisions also state that a project may be found to have a less-than-significant impact if it complies with an adopted plan consistent with State CEQA Guidelines Section 15183.5 that includes specific measures to sufficiently reduce GHG emissions. (State CEQA Guidelines, § 15064.4, subd. (b)(3.) However, the revised guidelines do not require or recommend a specific analysis methodology or provide quantitative criteria for determining the significance of GHG emissions.

In order to assure that wise and efficient use of energy is considered in project decisions, CEQA requires that environmental impact reports (EIRs) include a discussion of the potential energy impacts of proposed projects, including identifying mitigation measures proposed to reduce inefficient, wasteful, and unnecessary consumption of energy. Appendix F of the State CEQA Guidelines also includes guidelines for evaluating potential energy impacts.

California Water Plan Update 2009 and 2013

The California Water Plan (CWP) is the long-term strategic plan for guiding the management and development of water resources in the state. Since its first publication in 1957, California Department of Water Resources (DWR) has prepared eight water plan updates (known as the Bulletin 160 series). The California Water Code requires that the CWP be updated every 5 years.

CWP Update 2009 incorporated climate change in water plan scenarios to evaluate impacts on California's water resources and to identify and recommend statewide and regional adaptation strategies (DWR 2010b). The State Water Board staff was actively engaged in preparation and review of sections of the CWP Plan Update 2009 (State Water Board 2011).

The CWP Update 2013 includes regionally appropriate and statewide water management and planning adaptation and mitigation strategies, resource management strategies, and decision support for climate change scenarios (California Natural Resources Agency and DWR 2013).

Progress on Incorporating Climate Change into Management of California's Water Resources (Technical Memorandum Report)

In response to Executive Order S-3-05 (described above), DWR developed this report, which describes progress made incorporating climate change into existing water resources planning and management tools and methodologies for California. This report focuses on assessment methodologies and preliminary study results and is primarily focused on the potential effects of climate change on the Central Valley and associated water resource systems (DWR 2010a).

Water Boards' Water Quality Control Plans and Strategic Plan

The State Water Board and Regional Water Quality Control Boards regularly review water quality control plans (WQCP). This planning process provides an opportunity to consider information related to water quality, such as developing information about climate change. The 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (2006 Bay-Delta Plan) identifies climate change as an emerging issue to be addressed in the WQCP planning process. The *2008–2012 State Water Board Strategic Plan* also calls for consideration of climate change in several areas, including the planning process for WQCPs. Under climate change scenarios, it is likely that increased flow variability and shifts in timing of high flows would occur.

Water Conservation Bill of 2009 (SBX7-7)

In 2009, the Legislature enacted a water reform package that included requirements for urban water suppliers and agricultural water suppliers. The Urban Water Management Planning Act requires urban water suppliers to prepare urban water management plans, which must be updated every 5 years. The Agricultural Water Management Planning Act requires agricultural water suppliers to adopt agricultural management plans that describe the quality and quantity of water resources of the supplier, including an analysis of the effect of climate change on future water supplies. Agricultural water suppliers were required to prepare the agricultural water management plans (AWMPs) by December 2012, and update those plans by December 2015 and every 5 years thereafter.

14.3.3 Regional or Local

Relevant regional or local programs, policies, or regulations related to GHG emissions are described below. Although local policies, plans, and regulations are not binding on the State of California, below is a description of relevant ones.

San Joaquin Valley Air Pollution Control District

In December 2009, the San Joaquin Valley Air Pollution Control District (SJVAPCD) formally adopted the region's first GHG thresholds for determining significant climate change impacts in the SJVAPCD. The guidance is intended to streamline CEQA review by pre-quantifying emissions reductions that would be achieved through the implementation of Best Performance Standards (BPS). Projects are considered to have a less-than-significant cumulative impact on climate change if any of the following conditions are met.

1. Comply with an approved GHG reduction plan.
2. Achieve a score of at least 29[5] using any combination of approved operational BPS.
3. Reduce operational GHG emissions by at least 29 percent over business-as-usual (BAU) conditions (demonstrated quantitatively).

SJVAPCD guidance recommends quantification of GHG emissions for all projects in which an EIR is required, regardless of whether BPS achieve a score of 29 (SJVAPCD 2009a). While the thresholds adopted by the SJVAPCD were developed for internal use for projects in which the SJVAPCD is the lead agency, these thresholds also serve as the basis for guidance issued by the SJVAPCD for other agencies that are establishing their own processes for determining significance related to climate change (SJVAPCD 2009b).

Agricultural Water Management Plans

All irrigation districts within the plan area have adopted AWMPs and provided these to DWR as required by SBX7-7 (described in Section 14.3.2, *State [Regulatory Background]*). These plans all have sections that discuss the expected effects of climate change on agriculture within their districts and on the water supply used within the districts. Table 14-8 summarizes those effects and their associated action plans and recommendations as stated in the AWMPs.

Urban Water Management Plans

The municipal water providers within the plan area that receive surface water from the irrigation districts have all prepared urban water management plans (UWMPs) for their respective service areas as required by the California Urban Water Management Plan Act (described in Section 14.3.2, *State [Regulatory Background]*). These municipal water providers, described in Chapter 13, *Service Providers*, are: Stockton East Water District (SEWD); City and County of San Francisco (CCSF); City of Modesto and MID; Contra Costa Water District (Contra Costa WD); City of Manteca (City of Manteca); City of Stockton (Stockton); and City of Tracy (Tracy). Some of the providers' UWMPs have sections that discuss the expected effects of climate change on water demand within their service areas and on the water supply used within their service areas. Table 14-9 summarizes the climate-change related information presented in the UWMPs.

[5] A score of 29 represents a 29 percent reduction in GHG emissions relative to unmitigated conditions (1 point = 1 percent). This goal is consistent with the reduction targets established by AB 32.

Table 14-8. Agricultural Water Management Plans and Climate Change

Water Supplier	Evaluated Climate Change? (Yes/No)	Potential Effects on Agricultural Water Demand	Potential Effects on Agricultural Water Supply	Potential Effects on Water Quality	Planning Recommendations or Actions
South San Joaquin Irrigation District (SSJID)	Yes	• Increased crop water demands due to increased temperatures and other climate change factors. • Increased irrigation requirements to meet increased evapotranspiration demands.	• Reduced total inflows to New Melones Reservoir would increase the probability that total inflows would be less than 600 TAF/y, which would result in supplies less than 300 TAF more often than predicted, based on historical data. • There would be no effect on SSJID's annual water supply allotment due to the shift in runoff to winter because SSJID's annual available supply under the 1988 Agreement (described in Chapter 2, *Water Resources*, Section 2.6.2, *Water Diversion and Use*) is based on total annual inflows to New Melones Reservoir.	• Increased erosion and turbidity would not likely significantly affect the water quality of the Stanislaus River. • Increased water temperatures could result in an increase in aquatic plants within SSJID's distribution system, which could pose challenges to filtering canal water for microirrigation. • There are no known contaminants that could be concentrated to levels that would affect agricultural irrigation if spring runoff decreases, particularly due to dilution in reservoirs upstream of SSJID.	• Implement climate change mitigation strategies identified in the California Water Plan 2009 and 2013 Updates (DWR 2010b and 2013); The California Natural Resources Agency and DWR 2013) and in the California Climate Adaptation Strategy (California Natural Resources Agency 2009), as needed.[a]

Water Supplier	Evaluated Climate Change? (Yes/No)	Potential Effects on Agricultural Water Demand	Potential Effects on Agricultural Water Supply	Potential Effects on Water Quality	Planning Recommendations or Actions
Oakdale Irrigation District (OID)	Yes	• Increased irrigation requirements to meet increased evapotranspiration demands due to increased temperatures. • Increased crop water demands due to increased temperatures and other factors related to climate change. • Changes in the timing of crop planting, development, and harvest due to increased temperatures and other factors related to climate change could result in changes to the timing of irrigation demands during the year.	• The shift in runoff to the winter period could potentially affect surface water supply if sufficient storage is not available to retain winter runoff. Because OID's annual entitlement is based on total annual inflows to New Melones Reservoir, the timing of runoff would not affect OID's annual allotment. • Entitlements less than 300 TAF could occur more often than predicted (based on analysis of historical data) because future reduced total inflows to New Melones Reservoir would increase the probability that total inflows would be less than 600 TAF in any given year.	• Increased erosion and turbidity would not likely significantly affect the water quality of the Stanislaus River. • Increased water temperatures could result in increased algae and other water plant growth, which would pose challenges to filtering OID canal water for microirrigation. • There are no known contaminants that could be concentrated to levels that would affect agricultural irrigation if spring runoff decreases, particularly due to dilution in reservoirs upstream of OID.	• Implement climate change mitigation strategies identified in the California Water Plan 2009 and 2013 Updates (DWR 2010b and 2013); California Natural Resources Agency and DWR 2013) and in the California Climate Adaptation Strategy (California Natural Resources Agency 2009), as needed.[a]

Water Supplier	Evaluated Climate Change? (Yes/No)	Potential Effects on Agricultural Water Demand	Potential Effects on Agricultural Water Supply	Potential Effects on Water Quality	Planning Recommendations or Actions
Turlock Irrigation District (TID)	Yes	• Increased crop evapotranspiration due to increased temperatures. • Increased crop water demands due to increased temperatures.	• The shift in runoff to the winter period and projected reduction in total runoff could potentially affect water supply in the future if sufficient storage is not available to retain winter runoff and provide additional carryover storage from wet to dry years.	• Increased erosion and turbidity would not likely significantly affect the water quality of the Tuolumne River.	• Implement climate change mitigation strategies identified in the California Water Plan 2009 and 2013 Updates (DWR 2010b and 2013); California Natural Resources Agency and DWR 2013)and in the California Climate Adaptation Strategy (California Natural Resources Agency 2009), as needed.[a]
Modesto Irrigation District (MID)	Yes	• Faster plant development, shorter growing seasons, increased evapotranspiration, and potential heat stress for some crops due to increased temperatures. • Increased crop water demands, particularly for fruit crops, due to increased air temperatures. • Increase in water demand. • Impacts on agriculture due to climate change are anticipated to be significant.	• Reduced average annual snowpack due to a rise in the snowline and thinner snowpack in low- and medium-elevation zones. • Changes in the timing, intensity, location, amount, and variability of precipitation, including a shift in snowmelt runoff to earlier in the year, and increased precipitation falling as rain instead of as snow. • Increase in evaporation will require additional water supply.	Not addressed	• Adaptive management of water. • Water conservation. • Improve operational control within MID.

Water Supplier	Evaluated Climate Change? (Yes/No)	Potential Effects on Agricultural Water Demand	Potential Effects on Agricultural Water Supply	Potential Effects on Water Quality	Planning Recommendations or Actions
Merced Irrigation District (Merced ID)	Yes	• Faster plant development, shorter growing seasons, changes to reference evapotranspiration, and potential heat stress for some crops due to increased temperatures. • Fruit crops may require additional water as climate warms to maintain yield and quality. • Increased agricultural water demands due to increased temperatures and evapotranspiration rates. Increased fallow land and retired land acreage.	• Exacerbated groundwater overdraft due to increased demands on groundwater as a result of decreased surface flows. • Additional water storage would be required to ensure water supply reliability due to early spring runoff and a reduction in mean flow.	• Degraded surface and groundwater quality due to lower flows, groundwater overdraft, meadow reduction, and increased drought frequency and severity, and storm events.	• Implement resource management strategies for water management approaches in the region identified in the California Water Plan 2009 and 2013 Updates (DWR 2010b and 2013); California Natural Resources Agency and DWR 2013). • Augmenting crop water requirements by pumping groundwater, improving irrigation efficiency, and shifting to high-value and salt-tolerant crops in response to climate change

Water Supplier	Evaluated Climate Change? (Yes/No)	Potential Effects on Agricultural Water Demand	Potential Effects on Agricultural Water Supply	Potential Effects on Water Quality	Planning Recommendations or Actions
Stockton East Water District (SEWD)	Yes	Not addressed	• Water supply originating from the Stanislaus River could be affected by climate change because a significant portion of that surface water is derived from snow melt. Any decrease in snow melt resulting from climate change would have a significant impact on New Melones Dam storage. • A reduction in rainfall would affect water supply	Not addressed	• Although not specific to water shortages due to climate change, in response to water shortages, SEWD would implement an agricultural water shortage plan for dry year or drought conditions, which includes voluntary reductions in use the first dry year and second subsequent dry year, and potential mandatory reductions in the third subsequent dry year.

Sources: SSJID 2012; OID 2012; TID 2012; MID 2012; Merced ID 2013; SEWD 2014.

TAF/y = thousand acre-feet per year

[a] Many of the climate change mitigation strategies that are applicable to irrigation districts are currently being implemented in some form to meet local and regional water management objectives.

Table 14-9. Urban Water Management Plans and Climate Change

Water Supplier	Evaluated Climate Change? (Yes/No)	Potential Effects on Water Supply	Planning Recommendations or Actions
City of Stockton	Yes	• Water supply originating from the Stanislaus River could be affected by climate change because a significant portion of that surface water is derived from snow melt. Any decrease in snow melt resulting from climate change would have a significant impact on New Melones Dam storage. • A reduction in rainfall would affect water supply.	Although not specific to water shortages due to climate change, in response to a water shortage emergency, the City of Stockton would implement their five-stage rationing plan, which includes both voluntary (10 percent reduction) and mandatory (up to 20 percent in past years) reductions.
City and County of San Francisco	Yes	• A rise in temperature of 1.5°C between 2000 and 2025 would result in less or no snowpack between 6,000 and 6,500 feet (ft) and faster melting of the snowpack above 6,500 ft. • Approximately 7 percent of the runoff currently draining into Hetch Hetchy Reservoir would shift from spring/ summer to fall/winter in the Hetch Hetchy basin by 2025. This percentage is within the current interannual variation in runoff and is within the range accounted for during normal runoff forecasting and existing reservoir management practices.	Prepare climate change modeling and evaluation to inform risk-based decisions for the future and prepare a work plan for the SFPUC climate change assessment of Hetch Hetchy and local watersheds.
Contra Costa Water District	No	NA	NA
City of Manteca	No	NA	NA

Water Supplier	Evaluated Climate Change? (Yes/No)	Potential Effects on Water Supply	Planning Recommendations or Actions
City of Modesto and Modesto Irrigation District	Yes	• Reduced snowpack may shift spring runoff to earlier in the year.	• Implement a water conservation program (Section 11-1.14 of Title XI of the Modesto Municipal Code), including the completing the residential metering program to help reduce water demands and to conserve energy as a result of decreased treatment, conveyance, and pumping requirements. • The City of Modesto's compliance with SBx7-7 and its interim and final per capita water use targets will ensure continued water and energy conservation. • The City of Modesto's increased use of surface water supplies from MID's Modesto Regional Water Treatment Plant Phase Two will help to further diversify Modesto's water supplies and enhance water supply reliability to adapt to the changing hydrologic conditions associated with climate change.
City of Tracy	Yes	• Reduced snowpack may shift spring runoff to earlier in the year.	• For conservative planning/projection purposes, the City of Tracy has reduced the predicted available water supply to 75 percent of the city's Central Valley Project annual entitlement in a normal water year, and 65 percent in a single dry year.

Sources: City of Stockton 2011; SFPUC 2011; Contra Costa WD 2011; City of Manteca 2005; City of Modesto and MID 2011; and City of Tracy 2011.
NA = not applicable

14.4 Impact Analysis

This section identifies the thresholds or significance criteria used to evaluate the potential impacts on energy resources, GHG emissions and climate change. It further describes the methods of analysis used to determine significance. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany the impact discussion, if any significant impacts are identified.

14.4.1 Thresholds of Significance

The thresholds for determining the significance of impacts for this analysis are based, in part, on the State Water Board's Environmental Checklist in Appendix A of the Board's CEQA regulations (Cal. Code Regs., tit. 23, §§ 3720–3781) and Appendix F of the State CEQA Guidelines. The thresholds derived from the checklist have been modified, as appropriate, to meet the circumstances of the alternatives. (Cal. Code Regs., tit. 23, § 3777, subd. (a)(2).) GHG impacts were determined to be potentially significant in the State Water Board's Environmental Checklist (see Appendix B, *State Water Board's Environmental Checklist*) and, therefore, are discussed in this analysis. In addition, this chapter evaluates impacts on energy resources, as recommended by Appendix F of the State CEQA Guidelines, and climate change, as recommended by Appendix G of the State CEQA Guidelines. Although Appendix G calls for a determination of the significance of GHG emissions (as opposed to climate change), *climate change* in this document refers to an assessment of GHG emissions per the guidelines and is used interchangeably in this analysis.

Energy Resources

Energy impacts would be significant if the LSJR alternatives result in any of the following.

- Adversely affect the reliability of California's electric grid.
- Result in inefficient, wasteful, and unnecessary energy consumption.

According to CEQA Appendix F, the goal of conserving energy implies the wise and efficient use of energy. In order to assure that energy implications are considered in project decisions, CEQA requires a discussion of the potential energy impacts of proposed projects and the impacts of avoiding or reducing inefficient, wasteful, and unnecessary consumption of energy.

GHG Emissions/Climate Change

Climate change impacts would be significant if the LSJR alternatives result in any of the following.

- Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.
- Conflict with an applicable plan, policy, or regulation adopted for the purposes of reducing GHG emissions.

Potential changes in electricity generation and distribution could occur; however, local air pollution control districts have not adopted GHG thresholds directly relevant to the alternatives to evaluate climate change impacts.[6] As there is no acceptable GHG reduction plan from which to evaluate project significance consistent with State CEQA Guidelines Sections 15183.5 and 16064.4(b)(3), and local air district thresholds are not directly applicable to the alternatives, a threshold of 10,000 MT of CO_2e per year is used for evaluating the GHG emission impact of the project under CEQA. The threshold of 10,000 MT of CO_2e per year was adopted by the South Coast Air Quality Management District (SCAQMD) and the Bay Area Air Quality Management District (BAAQMD) for industrial projects that would capture 90 percent of all GHG emissions from stationary sources in each air basin. Because the alternatives would affect facilities in several air pollution control districts, the GHG threshold, although conservative, would be appropriate measure to evaluate climate change impacts.

State CEQA Guidelines Section 15126.2(a) states that the CEQA analysis should analyze any significant impact the project might cause by bringing development and people into the area affected and should analyze any potentially significant impacts of locating a project in areas susceptible to hazardous conditions. The California Supreme Court has held that this provision is valid to the extent it calls for evaluating a project's potentially significant exacerbating effects on existing environmental hazards and that CEQA's provisions are best read to focus almost entirely on how the project affects the environment, not how the environment affects the project (*California Building Industry Association v. Bay Area Air Quality Management District* [2015] 62 Cal.4th 367). The alternatives do not involve environmental hazards. Nevertheless, the analysis presented below also evaluates how the LSJR and SDWQ alternatives may be affected by climate change.

14.4.2 Methods and Approach

LSJR Alternatives

This chapter evaluates the potential energy and GHG impacts associated with the LSJR alternatives. Each LSJR alternative includes a February–June unimpaired flow requirement (i.e., 20, 40, or 60 percent) and methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. In addition, a minimum base flow is required at Vernalis during this period. The base flow may be adaptively implemented as described below and in Chapter 3. State Water Board approval is required before any method can be implemented, as described in Appendix K, *Revised Water Quality Control Plan*. All methods may be implemented individually or in combination with other methods, may be applied differently to each tributary, and could be in effect for varying lengths of time, so long as the flows are coordinated to achieve beneficial results in the LSJR related to the protection of fish and wildlife beneficial uses.

The Stanislaus, Tuolumne, and Merced Working Group (STM Working Group) will assist with implementation, monitoring, and assessment activities for the flow objectives and with developing biological goals to help evaluate the effectiveness of the flow requirements and adaptive implementation actions. The STM Working Group may recommend adjusting the flow requirements through adaptive implementation if scientific information supports such changes to reasonably protect fish and wildlife beneficial uses. Scientific research may also be conducted within the adaptive range to improve scientific understanding of measures needed to protect fish and wildlife and reduce scientific uncertainty through monitoring and evaluation. Further details describing the

[6] While the SJVPACD has established thresholds of significance for climate change impacts, there are no BPS that are directly applicable to the alternatives and the SJVAPCD's 29 percent reduction in GHG emissions is not directly applicable to the alternatives, as the alternatives would not have any direct control over GHG generating activities.

methods, the STM Working Group, and the approval process are included in Chapter 3 and Appendix K.

Without adaptive implementation, flow must be managed such that it tracks the daily unimpaired flow percentage based on a running average of 7 days. The four methods of adaptive implementation are described briefly below.

1. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the specified annual February–June minimum unimpaired flow requirement may be increased or decreased to a percentage within the ranges listed below. For LSJR Alternative 2 (20 percent unimpaired flow), the percent of unimpaired flow may be increased to a maximum of 30 percent. For LSJR Alternative 3 (40 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 30 percent or increased to a maximum of 50 percent. For LSJR Alternative 4 (60 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 50 percent.

2. Based on best available scientific information indicating a flow pattern different from what would occur by tracking the unimpaired flow percentage would better protect fish and wildlife beneficial uses, water may be released at varying rates during February–June. The total volume of water released under this adaptive method must be at least equal to the volume of water that would be released by tracking the unimpaired flow percentage from February–June.

3. Based on best available scientific information, release of a portion of the February–June unimpaired flow may be delayed until after June to prevent adverse effects to fisheries, including temperature, which would otherwise result from implementation of the February–June flow requirements. The ability to delay release of flow until after June is only allowed when the unimpaired flow requirement is greater than 30 percent. If the requirement is greater than 30 percent but less than 40 percent, the amount of flow that may be released after June is limited to the portion of the unimpaired flow requirement over 30 percent. For example, if the flow requirement is 35 percent, 5 percent may be released after June. If the requirement is 40 percent or greater, then 25 percent of the total volume of the flow requirement may be released after June. As an example, if the requirement is 50 percent, at least 37.5 percent unimpaired flow must be released in February–June and up to 12.5 percent unimpaired flow may be released after June. ~~If after June the STM Working Group determines that conditions have changed such that water held for release after June should not be released by the fall of that year, the water may be held until the following year.~~ See Chapter 3 and Appendix K for further details.

4. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the February–June Vernalis base flow requirement of 1,000 cfs may be modified to a rate between 800 and 1,200 cfs.

The operational changes made using the adaptive implementation methods above may be approved if the best available scientific information indicates that the changes will be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta and meet any biological goals. The changes may take place on either a short-term (e.g., monthly or annually) or longer-term basis. Adaptive implementation is intended to foster coordinated and adaptive management of flows based on best available scientific information in order to protect fish and wildlife beneficial uses. Adaptive implementation could also optimize flows to achieve the objective, while allowing for consideration of other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. While the measures and processes used to decide upon adaptive implementation actions must achieve the narrative objective for the reasonable protection of fish and wildlife beneficial uses, adaptive implementation could result in flows that would benefit or reduce impacts on other beneficial uses that rely on water. For example, terrestrial riparian species could benefit by receiving additional flows during key germination times in the late spring.

The quantitative results included in the figures, tables, and text of this chapter present Water Supply Effects (WSE) modeling of the specified unimpaired flow requirement for each LSJR alternative (i.e., 20, 40, or 60 percent). The modeling does allow some inflows to be retained in the reservoirs after June, as could occur under adaptive implementation method 3, to prevent adverse temperature effects and this is included in the results presented in this chapter. This use of modeling provides information to support the analysis and evaluation of the effects of the alternatives and adaptive implementation. For more information regarding the modeling methodology and quantitative flow and temperature modeling results, see Appendix F.1, *Hydrologic and Water Quality Modeling*.

However, as part of adaptive implementation, method 1 would allow the required percent of unimpaired flow to change by up to 10 percent if the STM Working Group agrees to adjust it. The highest possible percent of unimpaired flow associated with an LSJR alternative is also evaluated in the impact analysis if long-term implementation of method 1 has the potential to affect a significance determination. For example, if the determination for LSJR Alternative 2 at 20 percent unimpaired flow is less than significant, but the determination for LSJR Alternative 3 at 40 percent unimpaired flow is significant, then LSJR Alternative 2 is also evaluated at the 30 percent unimpaired flow.

Reduction in Hydropower Production

This section summarizes the method to estimate the potential reduction in hydropower generated by power plants on the three eastside tributaries as a result of the LSJR alternatives. Detailed information related to this methodology is in Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*. The method relies on the WSE model to estimate the effects of the LSJR alternatives on reservoir releases and storage (elevations head) and allowable diversions to off-stream generation facilities, and then calculate the associated change in monthly and annual amounts of energy produced in comparison to the baseline model run. Specific details of the LSJR alternatives are provided in Chapter 3, *Alternatives Description*, and are the basis for how the alternatives are modeled in this analysis.

Hydropower facilities on the three eastside tributaries were grouped into four categories (in-stream, rim dam, off-stream, and upstream), based on where they are located relative to the three eastside tributary dams and whether they are in-stream facilities or off-stream facilities.

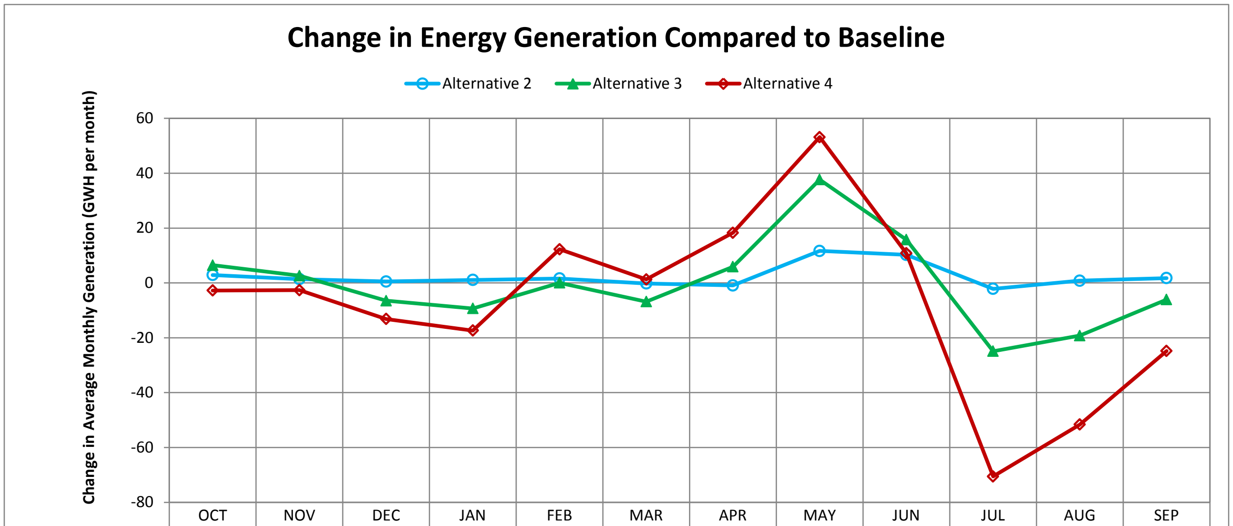
Detailed discussions on calculating hydropower from each of the categories are provided in Appendix J. Table 14-10 contains a summary of the average annual hydropower generation change on each of the three eastside tributaries due to LSJR Alternatives 2, 3, and 4. These changes are also represented as a percent of baseline generation. Generally, as the percent unimpaired flow increases, the amount of power generated annually is reduced. Overall, hydropower generation is expected to increase with LSJR Alternative 2, remain about the same with LSJR Alternative 3, and decrease with LSJR Alternative 4 relative to baseline.

Table 14-10. Change in Average Annual Hydropower Generation from Baseline

Alternative		Stanislaus River (GWh)/(%)	Tuolumne River (GWh)/(%)	Merced River (GWh)/(%)	Plan-wide Total (GWh)/(%)
	Baseline Conditions Power Generation	586 (100)	656 (100)	408 (100)	1,650 (100)
	Change of Hydropower Generation (Alternative minus Baseline)				
LSJR Alternative 2	20% Unimpaired Flow	18 (3)[a]	2 (0)	8 (2)	29 (2)
	Adaptive Implementation Method 1: 30% Unimpaired Flow	11 (2)	0 (0)	4 (1)	15 (1)
LSJR Alternative 3		4 (1)	-6 (-1)	-3 (-1)	-4 (0)
LSJR Alternative 4		-23 (-4)	-41 (-6)	-23 (-6)	-87 (-5)

Source: Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*.
GWh = gigawatt hours
[a] Modeled results indicate that LSJR Alternative 2 would result in an increase in hydropower production.

The monthly pattern of the average change (over 82 years of simulation) in hydropower generation from the plan area when compared to the baseline condition is presented in Figure 14-4. This shows a general increase in energy production in the months of February–June as more flow would be released from the reservoirs to meet the unimpaired flow objectives. For LSJR Alternatives 3 and 4, a decrease in hydropower generation during the summer months of July–September is due to less water being released from the major reservoirs as a result of reduced diversions downstream, as well as lower reservoir elevations. During November–January, a decrease in hydropower generation associated with LSJR Alternatives 3 and 4 is related to lower reservoir elevations and a reduced need for flood control releases. These effects are more pronounced as the percentage of unimpaired flow requirement of the LSJR alternatives increases.



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alternative 2	3	1	1	1	2	0	-1	12	10	-2	1	2
Alternative 3	6	3	-6	-9	0	-7	6	38	16	-25	-19	-6
Alternative 4	-3	-3	-13	-17	12	1	18	53	11	-71	-52	-25

Figure 14-4. Change in Average Monthly Hydropower Generation across 82 Years of Simulation Associated with the LSJR Flow Alternatives Compared to Baseline

Power Flow Assessment

The LSJR alternatives could reduce the hydropower generation in the summer months of July–September because less water would be stored during those months in the reservoirs as a result of being released earlier in the year (e.g., February–June), thereby reducing the amount of water available for hydropower generation. Since California's electric grid is most stressed during the summer months of June–August, with peak demand typically occurring in the month of July, a reduction in hydropower capacity during this time has the potential of stressing the grid even further.

The results of a steady-state power flow assessment of the California grid are used to determine if reduction in hydropower capacities at New Melones, New Don Pedro, and New Exchequer power plants would adversely impact the grid reliability as defined by NERC (see Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*, for discussion of NERC reliability). The reduction in hydropower capacity at the three power plants was calculated using the WSE model for the month of July during the 82-year period (water years 1922–2003) for LSJR Alternatives 2, 3, and 4. July was chosen because it is a peak energy-use month and, therefore, has some of the largest hydropower capacity effects. Detailed discussions on the capacity reduction calculation are presented in Appendix J. LSJR Alternative 2 would lead to no power capacity reduction from the baseline condition and, therefore, is not considered further in this analysis. The power flow assessment was conducted for LSJR Alternatives 3 and 4, assuming a reduction in capacity of 5 percent and 8 percent, respectively (slightly greater impacts than what was estimated with the WSE model, as described in Appendix J).

Detailed discussions of the power assessment are presented in Appendix J. In summary, the study examined the operation of the electric grid under peak summer demand conditions, using the following steps.

- Develop a baseline case and separate change cases for LSJR Alternatives 3 and 4. All cases are developed for both normal and contingency conditions. Under normal conditions, all transmission and generator facilities are assumed to be in service. Contingency conditions refer to the unplanned outage of power system equipment.
- Select analysis contingency conditions for transmission and generator facilities.
- Select the analysis areas based on the transmission line/transformer loadings and substation voltages.
- Model the transmission line/transformer loadings and substation voltages for baseline and LSJR Alternatives 3 and 4 under both normal and contingency conditions.
- Determine the impact of LSJR Alternatives 3 and 4 on the reliability of California's electric grid by comparing the analysis results to baseline.

If the comparison showed that transmission line/transformer loadings or substation voltages are within violation limits in baseline, but outside the limits in LSJR Alternatives 3 and 4, the alternatives could be considered to have an adverse impact on the reliability of California's electric grid.

Generally, a well operated transmission system should have line flows that are within the ratings of the transmission lines and substation voltages that are close to the nominal voltages. Typically, transmission lines have normal and emergency ratings. The analysis uses the normal and long-term emergency ratings (LTE) for the normal and contingency analyses, respectively.

Voltage limits were established relative to the nominal voltages. Under normal conditions, system operators regulate nodal voltages within ±5 percent of their nominal values. Under contingency conditions, this limit is relaxed to ±10 percent of the nominal value. These limits are typically set by the transmission owning utilities and the grid operator. When voltages or line loadings deviate from these limits it is referred to as a reliability violation. The limits used in the study for transmission line/transformer loading were the normal and LTE ratings. Under the normal conditions, transmission line/transformer flows should remain within the normal ratings. Under contingency conditions, transmission line/transformer flows should remain within the LTE ratings. Under normal conditions, substation voltages should remain within ±5 percent limit of the voltages of their nominal values. Under contingency conditions, the substation voltages should remain within ±10 percent limit of the nominal values.

The results of the power flow analysis for LSJR Alternatives 3 and 4 are presented in detail in Appendix J and are summarized below. These results are used to determine significant impacts on California's power grid.

- Under normal operating conditions, neither LSJR Alternatives 3 nor 4 triggered any transmission line or transformer to violate the normal and LTE ratings.
- Under contingency conditions, no line/transformer limit violation was found for LSJR Alternative 3. However, under LSJR Alternative 4, the 230 kV line between Borden and Gregg substations showed a minor violation under the outage of the 230 kV line between Gregg and Storey substations. A re-dispatch of the three Helms generator units (Helms Unit 1, 2, and 3) reduced the minor violation. The new loading of the analysis element after this re-dispatch was 99.81 percent.

- No line/transformer limit violations were found that could be exclusively attributed to LSJR Alternatives 3 or 4 under generator contingencies.
- No voltage violations were found that could be exclusively attributed to the reduced hydropower capacity in LSJR Alternatives 3 or 4.

Increase in Energy Consumption

As described in Chapter 5, *Surface Hydrology and Water Quality*, the LSJR alternatives are expected to change annual water supply from the Stanislaus, Tuolumne, and Merced Rivers. To satisfy the existing water demand for the purpose of identifying energy and climate change impacts, it is assumed that the reduced water supply would be partially compensated by pumping groundwater by the end users. Increases in groundwater pumping associated with LSJR Alternatives 2, 3, and 4 were estimated as described in Chapter 9, *Groundwater Resources*. It was assumed that in times of shortage of surface water supply, the irrigation districts could increase groundwater pumping up to their maximum capacity based on 2009 (baseline) infrastructure. The assumption of partial replacement creates a realistic scenario for energy impacts. Table 14-11 summarizes the increase in average annual groundwater pumping estimated for each of the three eastside tributaries for LSJR Alternatives 2, 3, and 4.

To estimate energy impacts, it is assumed that the compensated pumping would be electric, and the electricity consumption for groundwater pumping is calculated using the rate of 478 kilowatt hours (kWh) per acre-feet (AF). The rate is based on a conservative assumption that the groundwater is at a uniform 189-foot depth (Burt 2011). Table 14-12 summarizes the increased annual electricity consumption for groundwater pumping, while Table 14-13 summarizes annual energy consumption in the service area of the LSJR and three eastside tributaries. It is anticipated that most deep wells are and would be powered by electric pumps, while a smaller portion will be powered by diesel generators. It is currently unknown what proportion of ground water pumping at deep wells would use electric- or diesel-powered pumps because it is unknown exactly which existing wells would pump more under the LSJR alternatives. Electric pumps are more efficient than diesel pumps and produce fewer emissions per unit of power. It is anticipated that, given the same horsepower rating, an electric pump would generate less than 30 percent of the GHG emissions than a diesel pump would (USEPA 2017; Trinity Consultants 2017~~Leib 2012~~). Therefore, it was assumed groundwater wells would be powered by electric pumps.

Table 14-11. Increase in Estimated Average Annual Groundwater Pumping by the Irrigation Districts Relative to Baseline (TAF/y) [Table 14-11 has been replaced to reflect topics raised during the responses to comments process and to provide related clarifications.]

Alternative		Stanislaus River	Tuolumne River	Merced River	Total
	Baseline Groundwater Pumping	91	103	69	262
	Change in Groundwater Pumping (Alternative minus Existing)				
LSJR Alternative 2	20% Unimpaired Flow	-3	2	25	23
	Adaptive Implementation Method 1: 30% Unimpaired Flow	5	9	27	41
LSJR Alternative 3		27	19	64	110
LSJR Alternative 4		78	63	116	257

Source: Derived from information in Chapter 9, *Groundwater Resources*, and Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results* (Table G.3-3).
TAF/y = thousand acre-feet per year

Table 14-12. Increase in Electricity Consumption for Groundwater Pumping [Table 14-12 has been replaced to reflect topics raised during the responses to comments process and to provide related clarifications.]

Alternative		Stanislaus River (GWh)	Tuolumne River (GWh)	Merced River (GWh)	Project-wide Total (GWh)
LSJR Alternative 2	20% Unimpaired Flow	-1	1	12	11
	Adaptive Implementation Method 1: 30% Unimpaired Flow	2	5	13	19
LSJR Alternative 3		13	9	31	53
LSJR Alternative 4		37	30	55	123

GWh = gigawatt hours

Table 14-13. 2010 Annual Electricity Consumption in San Joaquin, Stanislaus, and Merced Counties

	2010 Annual Electricity Consumption by County (GWh)		
Sector	San Joaquin	Stanislaus	Merced
Non-Residential	3,879	2,971	2,962
Residential	1,682	1,634	660
County-Wide Total	5,561	4,505	3,622
Plan Area Total		13,688	

Source: CEC 2012.
GWh = gigawatt hours

GHG Emissions

The majority of the GHGs generated under the LSJR alternatives would result from the increase in power generation and energy consumption, which are described below.

Power Generation to Offset the Reduced Hydropower Production

LSJR alternatives 3 and 4, overall, would cause a reduction in annual hydropower production (although the change associated with LSJR Alternative 3 would be minimal). Table 14-10 summarized the reduction of average annual hydropower produced by each of the three eastside tributaries for LSJR Alternatives 2, 3, and 4 in comparison to the baseline hydropower production. To maintain the power supply for the end users, the lost hydropower would need to be compensated by ramping up other generation facilities by the following providers: PG&E, MID, TID, and Merced ID. The analysis of climate change impacts includes an analysis of GHG emissions associated with other generation facilities to offset the lost hydropower generation associated with the alternatives. The direct GHG emissions generated from the electricity produced by the other offsetting facilities are calculated using the CO_2 emission factor published ~~in the 2008 TID Annual Emissions Report~~by the California Air Pollution Control Officers Association (2017)[7] ~~(CCAR 2009)~~ and the CH_4 and N_2O emission factors published by USEPA (2015b). Table 14-14 lists the emission factors for CO_2, CH_4, and N_2O used to estimate GHG emissions associated with offset power generation. These emission factors are multiplied by the change in electricity generation indicated in Table 14-10 and Table 14-11 to determine the change in GHG emissions associated with the project.

Table 14-14. Greenhouse Gas Emission Factors (lb/MWh)

Area	CO_2	CH_4	N_2O
Turlock Irrigation District Service Areas	790.00[a]	0.03112[b]	0.00567[b]
California Region[c]	650.31	0.03112	0.00567

Sources: [a] ~~CCAR 2009~~CAPCOA 2017; [b] ~~No CH_4 or N_2O emission factors were reported by CCAR 2009. The emission factors published by USEPA are used (USEPA 2015b);~~ [c] USEPA 2015b.
lb/MWh = pounds per megawatt hour
CO_2 = carbon dioxide
CH_4 = methane
N_2O = nitrous oxide

Energy Consumption from Potential Increase in Groundwater Pumping

As shown in Table 14-11, some of the LSJR alternatives would result in an increase in groundwater pumping to satisfy the existing water demand, which could cause an increase in electricity consumption for pumping. Because it is unknown what specific energy providers supply affected end users, the GHG emissions generated from the electricity consumption for the groundwater pumping were calculated by multiplying the GHG factors published by USEPA (2015b) for the California region to represent an average or composite rate of emissions (Table 14-15) by the change in electricity generation indicated in Table 14-10 and Table 14-11.

[7] ~~The California Climate Action Registry (CCAR) does not have published emission factors for MID or Merced ID.~~ While PG&E represents a larger service area than Turlock ID, the emission factor associated with Turlock ID was used in the emissions calculations, as it is larger than the PG&E emission factor and represent a worst-case estimate of the maximum amount of emissions that could be anticipated to result from the project.

The decrease in water available for cropland irrigation could result in a decrease in the acreage of cropland that would be farmed if groundwater pumping did not occur. It is anticipated that some croplands would be removed from active agricultural production; however, this would have the potential to reduce GHG emissions as these lands would no longer require the use of fertilizers, which are a major source of GHG emissions. In addition, fallowed agricultural lands would not require the use of agricultural machinery, which would also reduce emissions of GHGs. Fallow lands would be expected to retain crop stubble cover and would ultimately experience vegetative regrowth, which could result in a net carbon sequestration.

Table 14-15. Estimated Annual Greenhouse Gas Emissions (MT CO_2e/year) [Table 14-15 has been replaced to reflect topics raised during the responses to comments process and to provide related clarifications.]

Alternative		GHGs from Power Generation (to compensate for loss of hydropower)	GHGs from Energy Consumption (to compensate for increased groundwater pumping)	Total GHG Emissions
Baseline Conditions		0	0	0
LSJR Alternative 2	20% Unimpaired Flow	-10,342[a]	3,322	-7,019
	Adaptive Implementation Method 1: 30% Unimpaired Flow	-5,280	5,755	476
LSJR Alternative 3		1,541	15,565	17,106
LSJR Alternative 4		31,285	36,337	67,622

MT CO_2e/year = metric ton carbon dioxide equivalent per year
[a] Modeled results indicate that LSJR Alternative 2 would result in an increase in hydropower production.

However, changes to land use as a result of a decrease in water available for cropland irrigation are considered speculative. The population growth rate, the available water supply, the timing, and alternatives to replace the cropland are uncertain. Consequently, the GHG emission reduction resulting from land use changes were not included in the analysis.

Energy Consumption from Potential Change in Exports

As discussed in Chapter 5, *Surface Hydrology and Water Quality*, and Appendix F.1, *Hydrologic and Water Quality Modeling*, the expected inflow from the LSJR could modify the CVP and SWP exports such that exports are expected to either remain the same or increase. The analysis related to exports and outflow assumes the State Water Board does not change export constraints to protect any increased flows downstream of Vernalis. The State Water Board is currently in the process of reviewing the export restrictions included in the 2006 Bay-Delta Plan as part of its periodic review of the plan. Through that process, the State Water Board will determine what changes, if any, should be made to the export restrictions. The State Water Board will then determine what actions are needed to implement changes to the flow and export objectives. As indicated in the program of implementation, the State Water Board plans to take action to protect the additional flows in future proceedings. As such the potential increase in exports is likely overstated in this analysis but is evaluated to provide a worst case analysis of the potential impacts related to additional exports.

Modeling results presented in Chapter 5 (Table 5-21) and Appendix F.1 (Table F.1.7-2b) indicate annual average exports would increase by 1 percent for LSJR Alternative 3 and 4 percent for LSJR Alternative 4 relative to historic conditions. It is appropriate to use the annual average when considering GHG emissions because GHG emissions are calculated and reported on an annual basis per standard inventorying procedures (e.g., IPCC, USEP). The extent to which a net increase in GHG emissions would occur cannot be quantified. This is because it is currently unknown how increased exports[8] would specifically affect other GHG emission producing activities in the CVP and SWP export service areas (e.g., groundwater pumping) or other energy-intensive water supply activities, such as drinking water treatment or transport. Because the change in groundwater pumping due to increased water exportation cannot be estimated, the net change in GHG emissions associated with water exports (i.e., emissions associated with exports and other activities that could be influenced by changes in exports) cannot be fully quantified. Therefore, impacts associated with a change in exports are discussed qualitatively for each of the LSJR alternatives.

Extended Plan Area

The analysis of the extended plan area generally identifies how the impacts may be similar to or different from the impacts in the plan area (i.e., downstream of the rim dams) depending on the similarity of the impact mechanism (e.g., changes in reservoir levels, reduced water diversions, and additional flow in the rivers) or location of potential impacts in the extended plan area. Where appropriate, the program of implementation is discussed to help contextualize the potential impacts in the extended plan area.

SDWQ Alternatives

As stated in Appendix B, *State Board's Environmental Checklist*, Section VII, the general historical range of salinity in the southern Delta would remain unchanged under the SDWQ alternatives (see also Chapter 5, *Surface Hydrology and Water Quality*) and, thus, would not result in GHG emissions or conflict with an applicable plan, policy or regulation adopted for the purpose of reducing GHG emissions. For the same reason, there would be no impacts related to the reliability of the electric grid or inefficient, wasteful and unnecessary energy consumption. Therefore, the SDWQ alternatives are not further analyzed in this chapter, except as they relate to the effect of climate change on the alternatives (EG-5). SDWQ Alternative 2 could result in service providers having to construct and operate new or expanded wastewater treatment or water supply facilities, which would involve changes in energy consumption and GHG emissions, and is evaluated in Chapter 13, *Service Providers*, and Chapter 16, *Evaluation of Other Indirect and Additional Actions*.

14.4.3 Impacts and Mitigation Measures

Energy Resources

This section evaluates the impact of LSJR alternatives on energy sources. The LSJR alternatives would affect energy by potentially reducing the power production at hydropower facilities along the three eastside tributaries.

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[8] Changes in water exports could influence GHG emissions as increases or decreases in exported water could lead to changes in GHG-generating activities (e.g., groundwater pumping, water transport, water treatment) that would accommodate the changes in water export.

Impact EG-1: Adversely affect the reliability of California's electric grid

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Based on the analysis approach described in Section 14.4.2, *Methods and Approach*, LSJR Alternative 2 would lead to no power capacity reduction for the three hydropower plants. For LSJR Alternatives 3 and 4, grid reliability was assessed by assuming a 5 percent and 8 percent reduction in July hydropower capacity, respectively, at the three plants.

The LSJR alternative substation voltages and line/transformer loadings were modeled and then compared with those of the baseline. If the comparison showed that substation voltages or transmission line/transformer loadings are within limits (defined in Section 14.4.2) under baseline, but outside the limits in the LSJR alternatives, the alternatives could be considered to have an adverse impact on the reliability of California's electric grid.

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

Based on the analysis approach described in Section 14.4.2, *Methods and Approach*, LSJR Alternative 2, with or without adaptive implementation, would lead to no power capacity reduction from baseline. Therefore, this alternative is not expected to affect the reliability of California's electric grid. The impact would be less than significant.

LSJR Alternative 3 (Less than significant/Less than significant with adaptive implementation)

As described above, by comparing the results of LSJR Alternative 3 to baseline, LSJR Alternative 3, with or without adaptive implementation, would not result in any violations of line/transformer limits and substation voltage limits under normal and contingency conditions. Therefore, this alternative is not expected to affect the reliability of California's electric grid. The impact would be less than significant.

LSJR Alternative 4 (Less than significant/Less than significant with adaptive implementation)

As described above, LSJR Alternative 4, specifically the high unimpaired flow requirement of 60 percent of unimpaired flow, could adversely impact the reliability of California's electric grid because of minor violations between Borden and Gregg substations and Gregg and Storey substations. However, the results indicate that a simple re-dispatch of generator facilities would correct the minor violation. This violation of transmission line limit under the contingency outage condition can be easily eliminated through a re-dispatch of the three Helms generator units (Helms Units 1, 2, and 3). The new loading of the analysis element after this re-dispatch was

99.81 percent of the LTE rating. Therefore, there would be no violation after the re-dispatch. Re-dispatches are regular occurrences in the California energy grid and they provide a solution to re-distribute power based on the re-dispatch. Under the various adaptive implementation methods, it is anticipated the re-dispatch would not be needed or would be less given the unimpaired flow requirement is less (i.e., 50 percent unimpaired flow). Therefore, impacts would be less than significant.

Impact EG-2: Result in inefficient, wasteful, and unnecessary energy consumption

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project* Alternative (LSJR Alternative 1 and SDWQ Alternative 1), for the No Project Alternative technical analysis.

LSJR Alternatives

LSJR Alternatives 2, 3, and 4 (Less than significant/Less than significant with adaptive implementation)

Although LSJR Alternatives 2, 3, and 4, with or without adaptive implementation, could result in additional energy consumption by potentially increasing groundwater pumping as shown in Table 14-12, they would not result in inefficient, wasteful, and unnecessary consumption of energy. This is because any additional groundwater pumping would be used to meet the water supply irrigation demand.

Even under the conservative estimates used to project energy consumption associated with a potential increase in groundwater pumping, the LSJR alternatives would only increase the consumption by 0.08 percent (11 GWh), 0.38 percent (52 GWh), and 0.78 percent (107 GWh) under the LSJR Alternatives 2, 3, and 4, respectively, compared to the total annual electricity consumption in San Joaquin, Stanislaus, and Merced Counties (Table 14-13).

In addition to increased energy consumption associated with increased groundwater pumping, the LSJR alternatives could result in additional energy generation at other facilities to compensate for the loss of hydropower predicted by the model results, as shown in Table 14-10. However, by itself, this increased electricity generation is not considered inefficient, wasteful, and unnecessary, as it is energy that would be generated to maintain the energy supply level that is currently supplied by hydropower. LSJR Alternatives 2 and 3 are not expected to cause an overall reduction in hydropower generation. LSJR Alternative 4 would only reduce hydropower generation by 5 percent (87 GWh) compared to baseline. Modeled results indicate that LSJR Alternative 2 would result in an increase in hydropower production by 2 percent (29 GWh), and that LSJR Alternative 3 would result in minimal (4 GWh) change in hydropower production compared to baseline.

Therefore, none of the alternatives, with or without adaptive implementation, result in an inefficient, wasteful, or unnecessary consumption of energy, and none are anticipated to have a significant impact on the energy resources or supplies of the plan area. The impact would be less than significant.

GHG Emissions/Climate Change

This section evaluates the impact of LSJR alternatives on generation of GHG emissions and climate change. The LSJR alternatives would affect GHG emissions by potentially reducing the power production at hydropower facilities along the three eastside tributaries and by potentially reducing surface water supply. The State Water Board is committed to the adoption and implementation of effective actions to mitigate GHG emissions and adaptation of our policies and programs to the environmental conditions resulting from climate change. The State Water Board is a member of the Cal/EPA Climate Action Team, the Water Working Group of Climate Adaptation Strategies Team, and the 20x2020 Agency Team (State Water Board 2011).

Impact EG-3: Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Table 14-15 summarizes the annual GHG emissions generated from (1) the increased power generation at other generation facilities to balance the loss of hydropower production, and (2) the increased energy consumption for groundwater pumping to compensate for the reduction of surface water supply. The total GHG emissions generated by LSJR Alternatives 2, 3, and 4 are compared against the significance threshold of 10,000 MT CO_2e per year to determine the LSJR alternatives' impacts on climate change.

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

As shown in Table 14-15, GHG emissions (~~7,075~~7,019 MT CO_2e/year) are expected to be reduced under LSJR Alternative 2. This is because the increase in hydropower production is anticipated to result in a decrease in power production from other power generation facilities, which reduces GHG emissions. This decrease in emissions outweighs the increase in GHG emissions from the increased energy consumption for groundwater pumping. Furthermore, as identified in Table F.1.7-2b, the average annual exports are not expected to change from baseline under LSJR Alternative 2. Therefore, impacts would be less than significant.

Adaptive Implementation

Based on best available scientific information indicating that a change in the percent of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 1 would allow an increase of up to 10 percent over the 20-percent February–June unimpaired flow requirement (to a maximum of 30 percent of unimpaired flow). A change to the percent of unimpaired flow would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan.*

Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. However, an increase of up to 30 percent of unimpaired flow would potentially result in different effects as compared to 20-percent unimpaired flow, depending upon flow conditions and frequency of the adjustment. If the adjustment occurs frequently or for extended durations, impacts under LSJR Alternative 2 could become more like the impacts under LSJR Alternative 3. At the 30 percent unimpaired flow level, average annual total hydropower generation would be similar to baseline (i.e., slightly less than at the 20 percent unimpaired flow level, Table 14-10) but groundwater pumping would increase by an average total of ~~40~~ 41 thousand acre-feet per year (TAF/y) relative to baseline (17 TAF/y more than LSJR Alternative 2, Table 14-11). The net effect is an increase in the average annual GHG emissions of ~~330~~ 476 MT CO_2e/year (Table 14-15), which is less than the GHG threshold of 10,000 MT CO_2e/year. Consequently, LSJR Alternative 2, with the incorporation of adaptive implementation method 1, would not substantially impact GHG emissions.

Based on best available scientific information indicating that a change in the timing or rate of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 2 would allow changing the timing of the release of the volume of water within the February–June time frame. While the total volume of water released February–June would be the same as LSJR Alternative 2 without adaptive implementation, the rate could vary from the actual (7-day running average) unimpaired flow rate. Method 2 would not authorize a reduction in flows required by other agencies or through other processes, which are incorporated in the modeling of baseline conditions. A change in the timing of the flow releases would not affect diversions or groundwater pumping, and on average it would have little effect on hydropower generation. Therefore, method 2 would not substantially affect GHG emissions. Method 3 would not be authorized under LSJR Alternative 2 since the unimpaired flow percentage would not exceed 30 percent. Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June flow requirement. WSE model results indicate changes due to method 4 under this alternative would rarely alter the flows in the three eastside tributaries or the LSJR, and thus would not affect GHG emissions.

Consequently the impact determination would be the same as described above for LSJR Alternative 2 and would not substantially increase GHG emissions. Impacts would be less than significant.

LSJR Alternative 3 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

As shown in Table 14-15, GHG emissions (~~16,948~~17,106 MT CO_2e/year) would exceed the GHG threshold of 10,000 MT CO_2e/year and impacts would be significant. Most of this increase (~~15,408~~15,565 MT CO2e/year) would come from the predicted increase in groundwater pumping.

As discussed in Section 14.4.2, *Methods and Approach*, the annual average of water exports is expected to increase approximately 1 percent under LSJR Alternative 3 relative to historic export levels. While it is anticipated that this slight increase in water exports would result in a slight increase in the electricity consumption and associated GHG emissions, it is also expected that other water supply activities that may currently generate GHG emissions would be reduced as a result of the slight increase in exports. For example, an increase in water exports would be expected to lead to decreases in groundwater pumping, although the amount by which groundwater pumping would decrease cannot be quantified. In addition, other more energy-intensive means of water transport associated with water supply may decrease if water purveyors use slightly more exported water, depending on economic conditions, because it is less energy intensive. For example, if energy resources currently used to treat a local water supply rise such that treatment and distribution of the local supply is less cost effective than relying on imported water and the treatment is more energy intensive than relying on exported water, then using exported water could reduce cost and reduce energy use. Therefore, it is anticipated the modeled increase in exports would not contribute to a significant increase in GHG emissions.

A substitute environmental document (SED) must identify feasible mitigation measures for each significant environmental impact identified in it. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(3).) A review of GHG mitigation measure guidance documents was conducted to determine if additional actions could be taken to reduce GHGs. These documents include: California Air Resources Board *Climate Change Scoping Plan* (ARB 2008), which was incorporated into the State Water Board's GHG guidance (State Water Board 2009); DWR Draft *Climate Action Plan* (DWR 2012), the Office of the Attorney General (OAG) list of proposed project-level GHG Mitigation Measures (OAG 2010); the California Air Pollution Control Officers Association (CAPCOA) *Quantifying Greenhouse Gas Mitigation Measures* report (CAPCOA 2010); and a number of reports from the USEPA, including the *Water Conservation Plan Guidelines* document (USEPA 1998), the *Control and Mitigation of Drinking Water Losses in Distribution Systems* report (USEPA 2010), the *Energy Management Guidebook for Wastewater and Water Utilities* (USEPA 2008), and the *Energy Efficiency in Water and Wastewater Facilities* report (USEPA 2013). In addition, Federal Energy Regulatory Commission (FERC) pre-application documents were reviewed. Example measures from these documents are listed below.

- Increase water system energy efficiency to reduce energy consumption related to irrigation deliveries (State Water Board 2009).
- Increase water use efficiency to reduce water demand related to agricultural uses (State Water Board 2009).
- Create water-efficient landscapes (e.g., by reducing lawn sizes; planting vegetation with minimal water needs, such as California native species; choosing vegetation appropriate for the climate of the project site; and choosing complementary plants with similar water needs or the ability to provide each other with shade and/or water) (OAG 2010; CAPCOA 2010).
- Reduce turf in landscapes and lawns (CAPCOA 2010).
- Install water-efficient irrigation systems and devices, such as soil moisture-based irrigation controls (OAG 2010).
- Devise a comprehensive water conservation strategy appropriate for the project and location. The strategy may include many of the specific items listed above, plus other innovative measures that are appropriate to the specific project (OAG 2010).
- Implement integrated resource management on both the supply-side (such as source-water protection strategies to conserve water resources and avoid costly new supplies) and the demand-side (such as comprehensive end-use audits) (USEPA 1998).
- Provide education about water conservation, such as through an "informative" water bill (OAG 2010; USEPA 1998).
- Increase energy efficiency of pumps and turbines throughout the SWP system through design, construction, and refurbishment methods (OP-2 Energy Efficiency Improvements) (DWR 2012).

- Improve efficiency of water system operations, such as by installing Supervisory Control and Data Acquisition (SCADA) software, which can increase the efficiency of process monitoring and operating control (USEPA 2013).
- Increase the proportion of energy used to run the SWP with energy supplies from renewable sources (OP 3 Renewable Energy Procurement Plan) (DWR 2012).
- Implement environmental restoration activities that have the potential to improve sequestration of carbon by natural processes (OP-6 Carbon Sequestration Actions) (DWR 2012).
- Use reclaimed water instead of new potable water supplies (CAPCOA 2010)
- Use graywater for non-potable uses instead of new potable water supplies (CAPCOA 2010)
- Use locally-sourced water supplies or water from less energy-intensive sources instead of imported water or other sources of water that have high energy intensities (CAPCOA 2010).
- Implement water pricing, such as metered rates, non-promotional rates, block rates, time-of-day pricing, water surcharges, and seasonal rates (USEPA 1998).
- Increase efficiency of existing hydropower facilities and operations (Merced ID 2008; TID and MID 2011).

Improving irrigation efficiency can be a mitigation measure because the surface water diversions primarily support agriculture in the plan area. Local water suppliers, regional groundwater management agencies, and irrigation districts could require modifications to existing agricultural practices to increase irrigation efficiency. To some extent, irrigation efficiencies have already resulted from the implementation of SBX7-7 requirements (see Section 11.3.1, *State [Regulatory Background]*) and as discussed by climate change mitigation strategies listed in Table 14-8 (e.g., California Water Plan 2009 and 2013 Updates [DWR 2010b]). Improving irrigation efficiency measures will reduce the overall amount of irrigation water needed because the water applied to the crops would have fewer losses to deep percolation and surface runoff. Furthermore, increasing irrigation efficiency may reduce the amount of supplemental groundwater pumping required to replace reduced surface water diversions. Increasing irrigation efficiency reduces the amount of water required for application without reducing the amount available for consumptive use. Increasing the irrigation efficiency could be done using the following methods.

- Increase the use of irrigation management services to better determine how much water is needed by crop and when to apply it.
- Convert current inefficient irrigation systems (e.g., surface irrigation) to more efficient ones (e.g., use of micro irrigation).
- Increase the capability of irrigation water suppliers to provide delivery flexibility, such as the use of irrigation district regulating reservoirs to allow flexible delivery durations, scheduling, and flow rates.

Any quantification of the effects of applying irrigation efficiency measures would be speculative; however, even with well-implemented irrigation efficiency measures, GHG emissions are not expected to be reduced to less-than-significant levels.

Many of the measures identified in the guidance documents are project-level measures appropriate for project-specific development. Individual projects will be subject to the appropriate level of environmental review at the time they are proposed, and mitigation would have to be identified to avoid or reduce significant effects, prior to any project-level action. Some potential actions, however, may not require discretionary approvals, and may not be subject to project-level CEQA review. For example, there is little to no project-level CEQA review of the potential increase in the use of percolating groundwater in areas that do not have a regulatory framework for groundwater management. Nevertheless, local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified above. It is infeasible for the State Water Board to impose mitigation measures at this time because it is undertaking a programmatic analysis of the potential GHG impacts and does not now have specific facts associated with an individual project to legally and technically apply the above mitigation measures in an adjudicative proceeding. The State Water Board will consider and impose these measures where legally supportable as part of individualized water right proceedings to implement the flow objectives.

In addition, while the State Water Board may impose water conservation or efficiency requirements through the adoption of regulations, the amount of time, high cost, and commitment of staff resources associated with such rule-making proceedings also renders adopting the mitigation measures now infeasible. Adopting regulations right now would require considerable staff time to research, formulate and develop, require extensive stakeholder outreach, and require numerous public meetings before the regulations would take effect. The State Water Board currently has limited resources to pursue adoption of such regulations as most of its budget for the water right program is supported by fees imposed on water right permit and license holders, and is used for program activities related to the diversion and use of water subject to the permit and license system. Only a small amount of funding is available for other regulatory activities and it is speculative to anticipate that additional funding will be made available. Therefore, at this time the imposition of the above mitigation measures is infeasible and impacts under LSJR Alternative 3 would remain significant and unavoidable.

Adaptive Implementation

As discussed under LSJR Alternative 2, adaptive implementation methods 2 and 4 are not expected to result in impacts on GHG emissions. Adaptive implementation method 3 would result in a shift in the volume of February–June water available to other parts of the year and is included in the modeling results presented above for LSJR Alternative 3. Because a change in the timing of the flow releases would not affect diversions or groundwater pumping, and on average it would have little effect on hydropower generation, method 3 would not substantially affect GHG emissions.

Adaptive implementation method 1 would allow an increase or decrease of up to 10 percent in the February–June, 40-percent unimpaired flow requirement (with a minimum of 30 percent and maximum of 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. If the specified percent of unimpaired flow were changed from 40 percent to 30 percent or 40 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternatives 2 (less than significant) or 4 (significant and unavoidable), respectively. Because GHG emission impacts under LSJR Alternatives 3 and 4 are considered to be significant and adaptive implementation methods 1, 2, 3, and 4 would not alter this determination, LSJR Alternative 3 with adaptive implementation would cause significant GHG emissions.

The SED must identify feasible mitigation measures for each significant environmental impact identified in. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(3).) As discussed above, guidance documents for possible GHG mitigation measures and possible methods to improve irrigation efficiency were reviewed and identified. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified above. For the reasons stated above, at this time, it is infeasible for the State Water Board to impose the above mitigation measures. Therefore, impacts under LSJR Alternative 3 with adaptive implementation would remain significant and unavoidable.

LSJR Alternative 4 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

As shown in Table 14-15, GHG emissions (~~62,984~~67,622 MT CO_2e/year) would exceed the GHG threshold of 10,000 MT CO_2e/year and impacts would be significant. The increases associated with compensation for loss of hydropower and compensation for the predicted increased groundwater pumping are similar in magnitude (i.e., 31,285 and ~~31,698~~36,337 MT CO_2e/year, respectively). As discussed in Section 14.4.2, *Methods and Approach*, the annual average of water exports is expected to increase approximately 4 percent under LSJR Alternative 4 relative to historic export levels. While it is anticipated that this slight increase in water exports would result in a slight increase in electricity consumption and associated GHG emissions, it is also expected that other water supply activities that may currently generate GHG emissions would be reduced as a result of the slight increase in exports as discussed under LSJR Alternative 3. Therefore, it is anticipated the modeled increase in exports would not contribute to a significant increase in GHG emissions.

The SED must identify feasible mitigation measures for each significant environmental impact identified in in. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(3).) As discussed above, guidance documents (under LSJR Alternative 3) for possible GHG mitigation measures and possible methods to result in better irrigation efficiency were reviewed and identified. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified above. For the reasons stated above under LSJR Alternative 3, at this time, it is infeasible for the State Water Board to impose the above mitigation measures. Therefore, impacts under LSJR Alternative 4 would remain significant and unavoidable.

Adaptive Implementation

As discussed under LSJR Alternatives 2 and 3, adaptive implementation methods 2, 3, and 4 are not expected to result in changes to impacts on GHG emissions. Adaptive implementation method 1 would allow a decrease of up to 10 percent in the February–June, 60-percent unimpaired flow requirement (with a minimum of 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. If the specified percent of unimpaired flow were changed from 60 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternative 3 (i.e., less severe for GHG emissions, but still significant). Similar to the impact determination of LSJR Alternative 3 and 4, impacts would be significant. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified above. For the reasons stated above in LSJR Alternative 3, at this time, it is infeasible for the State Water Board to impose the above mitigation measures. Therefore, impacts under LSJR Alternative 4 with adaptive implementation would remain significant and unavoidable.

Impact EG-4: Conflict with an applicable plan, policy, or regulation adopted for the purposes of reducing GHG emissions

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Clean Air Act (CAA) requirements for GHGs are the GHG emissions standards for vehicles and do not apply to projects that do not generate GHG emissions from vehicles. GHG emissions from the largest stationary sources (such as electricity utilities, refineries, etc.) are typically covered by CAA Prevention of Significant Deterioration (PSD) and Title V Operating Permit Programs. This requires permitting for facilities in excess of 100,000 MT CO_2e/year. The electric utilities that could be affected by the LSJR alternatives as a result of reduced hydropower or increased groundwater pumping would be subject to these permitting requirements regardless of LSJR alternatives, and the LSJR alternatives would not alter or modify these permit requirements. Therefore, the LSJR alternatives would not conflict with the requirements or CAA.

A GHG threshold of 10,000 MT CO_2e per year has been adopted by SCAQMD and BAAQMD and was used for this analysis. In using this threshold for the analysis, the following considerations were made: consistency with a GHG reduction plan,[9] the predicted emissions reductions from statewide regulatory measures and resulting emissions inventories, and the efficacies of GHG mitigation measures. It addresses a broad range of combustion sources and thus provides for a greater amount of GHG reductions to be analyzed and mitigated through the CEQA process. (BAAQMD 2010) Therefore, the LSJR alternatives would conflict with the state goals listed in AB 32 or in any preceding state policies and plans adopted to reduce GHG emissions if the GHG emissions generated by the alternatives are greater than the GHG threshold of 10,000 MT CO_2e per year.

[9] There is no acceptable GHG reduction plan from which to evaluate project significance consistent with State CEQA Guidelines Sections 15183.5 and 16064.4(b)(3).

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

As discussed for Impact EG-3, LSJR Alternative 2 is expected to reduce GHG emissions. Therefore, the alternative is not expected to conflict or be inconsistent with the state goals listed in AB 32 or in any preceding state policies and plans adopted to reduce GHG emissions. This impact would be less than significant.

Adaptive Implementation

As discussed for Impact EG-3, incorporation of adaptive implementation could potentially increase GHG emissions, but emissions would still be well below 10,000 MT of CO_2e per year. Therefore, impacts would be less than significant.

LSJR Alternative 3 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

As discussed for Impact EG-3, LSJR Alternative 3 would generate GHG emissions in excess of 10,000 MT of CO_2e per year, which is considered to be inconsistent with the state goals listed in AB 32 or in any preceding state policies and plans adopted to reduce GHG emissions. This impact would be significant. Implementation of the measures discussed in Impact EG-3 would reduce GHG emissions, but cannot be quantified. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified in Impact EG-3 for LSJR Alternative 3. For the reasons stated in Impact EG-3 for LSJR Alternative 3, at this time, it is infeasible for the State Water Board to impose those mitigation measures. Consequently, this impact would remain significant and unavoidable.

Adaptive Implementation

As discussed for Impact EG-3, incorporation of adaptive implementation could increase GHG emissions if adaptive implementation method 1 results in a long-term increase in the unimpaired flow requirement. Therefore, impacts would be significant. Similar to LSJR Alternative 3, implementation of the measures discussed in Impact EG-3 would reduce GHG emissions but cannot be quantified. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified in Impact EG-3 for LSJR Alternative 3. For the reasons stated above in Impact EG-3 for LSJR Alternative 3, at this time, it is infeasible for the State Water Board to impose those mitigation measures. Consequently, this impact would remain significant and unavoidable.

LSJR Alternative 4 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

As discussed for Impact EG-3, LSJR Alternative 4 would generate GHG emissions in excess of 10,000 MT of CO_2e per year, which is considered to be inconsistent with the state goals listed in AB 32 or in any preceding state policies and plans adopted to reduce GHG emissions. This impact would be significant. Implementation of the measures discussed for Impact EG-3 would reduce GHG emissions, but cannot be fully quantified. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified in Impact EG-3 for LSJR Alternative 3. For the reasons stated Impact EG-3 for LSJR Alternative 3, at this time, it is infeasible for the State Water Board to impose those mitigation measures. Consequently, this impact would remain significant and unavoidable.

Adaptive Implementation

As discussed for Impact EG-3, incorporation of adaptive implementation could increase GHG emissions if adaptive implementation method 1 results in a long-term increase in the unimpaired flow requirement. Therefore, impacts would also be significant. Similar to LSJR Alternative 4, implementation of the measures discussed in Impact EG-3 would reduce GHG emissions but cannot be quantified. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified in Impact EG-3 for LSJR Alternative 3. For the reasons stated Impact EG-3 for LSJR Alternative 3, at this time, it is infeasible for the State Water Board to impose those mitigation measures. Consequently, this impact would remain significant and unavoidable.

Impact EG-5: Effect of climate change on the LSJR and SDWQ alternatives

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

As discussed in Section 14.2.3, *Climate Change*, and Section 14.3, *Regulatory Background,* scientific studies and sources agree that the San Joaquin Valley and the Delta will experience changes to the historical hydrology as a result of climate change. It is expected that climate change will result in higher temperatures, increased heat waves, changes in rainfall patterns, and sea level rise (DWR 2010a, 2010b; USBR 2014, 2016). In addition, reduced snow pack and stream flow in the Sierra Nevada is expected to lead to changes in water supply into the Delta region (DWR 2010a, 2010b; USBR 2014, 2016). Depending on the climate change scenarios evaluated in the scientific studies, it has been predicted that climate change will affect snow pack, runoff, water supply reliability, water quality and quantity, aquatic ecosystems, evapotranspiration, and hydropower. Specifically, from scenarios compiled for the IPCC's Fourth Assessment Report, four climate change scenarios were selected for DWR's climate change studies. The four climate change scenarios consist of two GHG emissions scenarios, A2 and B1, each represented by two different global climate models, the Geophysical Fluid Dynamic Lab (GFDL) model and the Parallel Climate Model (PCM) model, respectively. The A2 emissions scenario assumes high population growth, regional based economic growth, and slow technological changes that results in significantly higher GHG emissions. The B1 scenario represents low population growth, global based economic growth, and sustainable development that results in the lowest increase of GHG emission of the IPCC scenarios. Both models project future warming; however, the GFDL model indicates a greater warming trend than the PCM model.

Hydrology impacts associated with the different climate change scenarios are summarized below. These summaries are based on of the CWP 2013 Update, Chapter 3: *California Water Today, Regional Reports for San Joaquin River Hydrologic Region and Sacramento-San Joaquin Delta*, and Chapter 22: *Ecosystem Restoration* (The California Natural Resources Agency and DWR 2013). The summaries are also consistent with information contained in the *Sacramento and San Joaquin Basins Climate Impact Assessment* (USBR 2014, 2016).

- **Reduced water supply and reliability.** Climate change is anticipated to bring heavier and warmer storms in the winter that result in less snowfall at lower elevations, reduce the total snowpack, and shift the timing of associated runoff, which in turn affects water storage capability in reservoirs and reduces water supply availability and reliability to water users. Much of the state's water infrastructure was designed to capture the slow spring snowmelt and deliver it during the drier summer and fall months. However, as average temperatures continue to increase, the snowpack will melt earlier, resulting in increased winter runoff and reduced spring snowmelt. Intense rainfall events and rapid snowmelt will make water more difficult to capture in reservoirs or retain for groundwater recharge and, therefore, reduce the region's water supply.
- **Increased water demand.** Climate change is expected to increase the water demand for both agricultural and urban use as a result of rising temperatures, increased evapotranspiration, reduced chill-hours in winter, and increased frequency and intensity of droughts. Higher temperatures are likely to extend growing seasons and also increase evapotranspiration, thereby increasing the amount of water that is needed for the irrigation of certain crops, urban landscaping, and environmental needs.
- **Degraded water quality.** Climate change is expected to degrade water quality as a result of rising temperatures and changed precipitation patterns. Higher water temperatures result in reduced dissolved oxygen levels in the water, which can have an adverse effect on water quality. Where river and lake levels fall due to increased evapotranspiration and changed precipitation and runoff patterns, pollutant concentrations in water will increase. Increased frequency and intensity of rainfall result in more direct runoff and flooding, which will produce more pollution and sedimentation in river and lakes. Sea level rise increases sea water intrusion into the Delta, which will further increase salinity in Delta and degrade drinking and agricultural water quality and alter ecosystem conditions in the region.
- **Altered aquatic ecosystems.** Climate change is anticipated to affect aquatic life due to rising temperatures, changes in river flow, and the continued rise in sea level. Higher water temperatures result in reduced dissolved oxygen levels, which can have an adverse effect on aquatic life. In many low- and middle-elevation streams in the region today, summer temperatures often approach the upper tolerance limits for salmon and trout; higher air and water temperatures will exacerbate this problem. Increases in water temperature and reductions in cold water in upstream reservoirs to be released in in spring and summer will also exacerbate this problem and hurt spawning and recruitment success of native fishes. For example, summer water temperatures in the major SJR tributaries upstream from the major reservoirs currently cause stress for coldwater species, such as steelhead/rainbow trout, and also for hardhead and Kern brook lamprey. By 2030, average summer air temperatures are expected to rise as much as 8°F, and water temperatures in the major SJR tributaries and their

reservoirs are expected to measurably increase. Significant increases in water temperatures could significantly impact rainbow trout and land-locked Kokanee that reside in and above the reservoirs. Surface water temperatures are also expected to rise in the reservoirs, but most of the species in the reservoirs are warmwater species that would not be affected by the expected water temperature increases or potential associated decreases in DO concentrations. Juveniles and smolts may become exposed to further reductions in the availability of coldwater habitat below dams and increasing abundance of nonnative warmwater species that prey on salmonids (Katz et al. 2013)

Inflow from the major SJR tributaries is expected to increase during winter months and decrease during spring and early summer months because of reduced snowpack associated with climate change. The changes in seasonal inflows are likely to affect Central Valley fall-run Chinook salmon, Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, Central Valley steelhead, green sturgeon, Sacramento splittail, longfin smelt, and delta smelt. Spawning migrations and other lifecycle processes of these species are adapted to high spring flows in the major SJR tributaries and into the Delta, and reductions in these flows would have significant impacts on several life stages.

Continued rise in sea level and upstream encroachment of salt water will affect aquatic habitat. Average sea levels are expected to rise about 1 foot by 205~~3~~0, which would cause increased salinities in the Delta. Delta smelt and longfin smelt spawn in the fresher water portions of the Delta, and delta smelt remain in areas with low salinities throughout their lifecycle. Increased salinity would be stressful to delta smelt and longfin smelt, particularly during their egg and larval stages. The brackish and fresh aquatic habitats of the Sacramento–San Joaquin Estuary, which are critical to many at-risk species, will be forced to shift upstream and inland.

- **Declined hydropower generation.** The energy sector is also vulnerable to potential impacts of climate change. This vulnerability has been evaluated by a modeling study simulating hydropower generation under regional climate warming in the Sierra Nevada. This study indicates the most substantial decrease of the mean annual hydropower generation will be in the northern Sierra Nevada watersheds as a result of declining runoff. The study also projects that with rising temperatures there will be steady declines in hydropower generation in the southern watersheds.

As discussed in Section 14.3.2, *State [Regulatory Background]*, CWP is the long-term strategic plan for guiding the management and development of water resources in the state. The CWP Update 2009 incorporated climate change in water plan scenarios to evaluate impacts on California's water resources and to identify and recommend statewide and regional adaptation strategies. The current Update 2013 builds on the contents of the Update 2009 and includes regionally appropriate and statewide water management and planning adaptation and mitigation strategies, resource management strategies, and decision support for climate change scenarios. Many of the resource management strategies provide benefits for adapting to climate change in addition to meeting water management objectives. As discussed in Section 14.3.3, *Regional or Local [Regulatory Background]*, the AWMPs prepared by irrigation districts, summarized in Table 14-8, have sections that discuss the expected effects of climate change on water supply, demand, and quality within their irrigation districts and recommend implementation of climate change mitigation strategies identified in the CWP 2009 and 2013 Updates. The UWMPs, summarized in Table 14-9, have sections that discuss the expected effects of climate change on water supply and demand within their service areas and identify planning recommendation or actions to mitigate the effects of climate change. The various strategies aim to reduce water demand include the following.

- **Reduce water demand**: agricultural/urban water use efficiency.
- **Improve operational efficiency**: regional/local conveyance; system reoperation.
- **Increase water supply**: conjunctive management and groundwater; precipitation enhancement; regional/local surface storage.
- **Improve water quality**: pollution prevention; salt and salinity management.
- **Practice resource stewardship**: ecosystem restoration; land use planning and management; recharge area protection; watershed management.

LSJR Alternatives 2, 3, and 4 and SDWQ Alternatives 2 and 3 (Less than significant)

The LSJR alternatives, with or without adaptive implementation, would be subject to climate change impacts discussed above resulting from past, present, and future GHG emissions regardless of the success of local, state, national, or international efforts in reducing future GHG emissions due to the existing concentrations of GHG emissions in the atmosphere and the inevitable additional emissions before GHG reductions plans provide reductions. As mentioned earlier, potential climate change impacts in California and the San Joaquin Valley might include sea level rise, saltwater intrusion, reduced snowpack and water supplies, and increased water demand.

Less snowpack and earlier runoff potentially means that there will be a reduced water supply later in the year because reservoir capacity is limited and water may be released earlier than usual. The problem of low water supply would likely be compounded by higher air temperatures, which would likely result in an increase in the amount of water needed to grow crops. The LSJR alternatives have the potential to exacerbate the water supply condition under climate change because they generally would reduce water supplies (particularly LSJR Alternatives 3 and 4).

Less snowpack and earlier runoff means that runoff from December–March may increase, whereas runoff from April–July may decrease (California Natural Resources Agency and DWR 2013; USBR 2014, 2016) relative to baseline conditions. In general, the earlier runoff would likely result in greater flood control releases from December–March. The increase in February–March flood control releases that may be expected with climate change may be reduced by implementation of the LSJR alternatives. This is because the LSJR alternatives would require increased reservoir releases, which would thereby increase the available storage space in reservoirs.

In the absence of the LSJR alternatives, increased flood control releases would make the flow downstream of the reservoirs closer to the magnitude of the unimpaired flow under climate change. During a large runoff event, flood control releases in the absence of the LSJR alternatives might equal or exceed what would be required by one of the LSJR alternatives. As a result, climate change may help attain February–March flows required by the LSJR alternatives.

The SDWQ alternatives and the program of implementation would maintain the existing Vernalis EC. As such, water would continue to be required to be released from New Melones Reservoir. Similar to the conditions described above with the LSJR alternatives, less snow pack and earlier runoff means that there may be less water later in the season, and it may be more difficult to release water from New Melones Reservoir under climate change conditions.

The LSJR alternatives are based on a percent of unimpaired flow. If the unimpaired flow is less under climate change conditions, then the amount of water required by the LSJR alternatives would also be less. In addition, the adaptive implementation methods of the LSJR alternatives would provide the State Water Board and the Stanislaus, Tuolumne, and Merced Working Group the ability to respond to changing circumstances with respect to flow and water quality that may arise due to climate change (e.g., more rain and less snow pack) as it relates to protecting beneficial uses such as fish and wildlife on the three eastside tributaries and agricultural uses in the southern Delta. Finally, the State Water Board is required to prepare WQCPs and regularly review the plans to update water quality standards, as they are currently doing evaluating the LSJR and SDWQ alternatives. Consistent with this requirement, the program of implementation for the LSJR and SDWQ alternatives includes updates to the 2006 Bay-Delta Plan as information becomes available upon implementation of the objectives, including through monitoring and special studies. As a result, the planning process continually accounts for changing conditions related to water quality and water planning, such as climate change. Because the State Water Board is preparing for the effects of climate change on its programs and adaptive implementation would account for circumstances that arise from climate change, this impact would be less than significant.

14.4.4 Impacts and Mitigation Measures: Extended Plan Area

Bypassing flows, as described in as described in Chapter 5, *Surface Hydrology and Water Quality* could potentially impact energy (hydropower electrical production) resources in upstream reservoirs in the extended plan area on the Stanislaus and Tuolumne Rivers because these two rivers have major reservoirs that are used to produce hydropower. These potential impacts could occur if reservoirs experienced substantial reductions in reservoir volume, especially during drought conditions under LSJR Alternative 3 and LSJR Alternative 4 with or without adaptive implementation. Hydropower production is related to both water discharge volume and reservoir head (elevation difference between the reservoir surface and the hydropower outlet). Lower reservoir volumes would reduce head and could reduce discharge to some extent. However, under baseline conditions these reservoirs undergo substantial annual elevation and volume reduction as hydropower is produced and water is released for instream flow requirements (USGS Reservoir Gage Data). Consequently the hydropower production effects associated with the reservoir volume reduction under LSJR Alternatives 2 and 3 (in most years) would be similar to baseline conditions, even with adaptive implementation. These volume reductions, however, would occur more frequently and be more severe during drought conditions, particularly under LSJR Alternatives 3 and LSJR Alternative 4 with or without adaptive implementation and, to a lesser extent, LSJR Alternative 2 with adaptive implementation. Consequently there could be significant hydropower production reductions at reservoirs under these LSJR alternatives in the extended plan area.

Additional GHG production would occur in the extended plan area if service providers and individuals had to increase groundwater pumping to replace junior water bypassed to achieve the required flows in the Stanislaus, Tuolumne, and Merced Rivers, and the LSJR. However, in these circumstances the volume of bypassed junior water would reduce the amount that downstream users would need to pump from groundwater. Therefore, the amount of additional GHG production related to upstream groundwater pumping impacts in the extended plan area would be offset by equivalent reductions in the downstream plan area. GHG production could also be affected by potentially reducing hydropower production at reservoirs in the extended plan area if hydropower is replaced by non-renewable energy sources, which produce greater amounts of GHGs. As noted above, there is the potential there could be adverse hydropower production impacts at reservoirs under LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation in the extended plan area. Consequently, there could be related adverse GHG production impacts in the extended plan area.

The increased frequency of lower reservoir levels resulting from the LSJR alternatives and the associated physical changes in hydropower and GHGs, however, would be limited by the program of implementation under each of the LSJR alternatives. The program of implementation requires minimum reservoir carryover storage targets or other requirements to help ensure that providing flows to meet the flow objectives will not have adverse temperature or other impacts on fish and wildlife or, if feasible, on other beneficial uses (e.g., hydropower). Other requirements, for example, include, but are not limited to, limits on required bypass flows for reservoirs that store water only for non-consumptive use so that some water can be temporarily stored upstream. The program of implementation also states that the State Water Board will take actions as necessary to ensure that implementation of the flow objectives does not impact supplies of water for minimum health and safety needs, particularly during drought periods. Accordingly, when the State Water Board implements the flow objectives in a water right proceeding, it will consider impacts on fish, wildlife, and other beneficial uses, such as hydropower, and health and safety needs, along with water right priority. Until the State Water Board assigns responsibility to meet the flow objectives in the Bay-Delta Plan, it is speculative to identify the exact extent, scope and frequency of reduced diversions, reduced reservoir levels and their effects on hydropower and GHG emissions, in the extended plan area. When implementing the flow objectives, the State Water Board would identify project-specific impacts and avoid or mitigate significant impacts of lower reservoir levels on hydropower and GHGs in accordance with CEQA.

At the time of preparation of this programmatic analysis, it is unclear to what extent any significant impacts could be fully mitigated to hydropower and GHG. Thus, the potential exists for significant impacts. Therefore, this analysis conservatively concludes that impacts associated with lower reservoir levels under LSJR Alternatives 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation are significant. The following mitigation measure is proposed: When considering carryover storage and other requirements to implement the flow water quality objectives in a water right proceeding, the State Water Board shall ensure that reservoir levels upstream of the rim dams do not cause significant hydropower and GHG impacts, unless doing so would be inconsistent with applicable laws. The impact is considered significant even with mitigation, because the mitigation may not fully mitigate the impact in all situations.

14.5 Cumulative Impacts

For the cumulative impact analysis, refer to Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources.*

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