Chapter 7.0 Climate Change and Greenhouse Gas Emissions

This chapter describes the environmental and regulatory settings for climate change and GHG emissions, as well as environmental consequences and mitigation, as they pertain to implementation of program alternatives. The discussion of climate change and the potential impacts of the program alternatives on climate change encompasses the San Joaquin River from Friant Dam to the Merced River (the Restoration Area), the San Joaquin River from the Merced River to the Delta, , and the Delta.

This chapter focuses on the contribution of the program alternatives to the buildup of GHGs in the atmosphere, which has been shown to contribute to climate change (IPCC 2007a). It is unlikely that any single project by itself could have a significant impact on the environment with respect to GHGs. However, the cumulative effect of human activities has been clearly linked to quantifiable changes in the composition of the atmosphere, which has in turn been shown to be the main cause of global climate change (IPCC 2007a). Therefore, analysis of the environmental effects of GHG emissions from implementing the Settlement will be addressed as a cumulative impact analysis.

In addition to the program's potential to contribute to the cumulative impacts of climate change, scientific evidence suggests that many climactic conditions are already changing and will continue to change in the future. Therefore, expected future climate changes that have the potential to affect implementation and performance of the program will also be considered. These impacts would result from changes in snowpack and timing and magnitude of snowmelt runoff and flood flows, which would in turn influence storage, delivery, and release actions. Furthermore, sea level rise could affect San Francisco Bay, and conditions in the Delta constraining CVP/SWP operations in the Delta, and also lead to changes in upstream operations in the San Joaquin Basin. Potential implications of projected regional climate change and sea level rise for future CVP/SWP operations are separately described in detail in an attachment to Appendix I, "Supplemental Hydrologic and Water Operations Analyses."

7.1 Environmental Setting

The environmental setting for climate change analysis is global, with State and local implications. The following discussion provides a background overview of global climate change, and climate trends and associated impacts at the global and State levels are then described. The local climate of the SJVAB is also discussed, followed by an overview of GHG emissions sources in California and in SJVAB.

7.1.1 Background on Global Climate Change

Global warming is the name given to the increase in the average temperature of the Earth's near-surface air and oceans since the mid-20th century and its projected continuation. Warming of the climate system is now considered to be unequivocal (IPCC 2007a), with global surface temperature increasing approximately 1.33°F over the last 100 years. Continued warming is projected to increase global average temperature between 2°F and 11°F over the next 100 years.

The causes of this warming have been identified as both natural processes and human actions. The Intergovernmental Panel on Climate Change (IPCC) concludes that variations in natural phenomena such as solar radiation and volcanoes produced most of the warming from preindustrial times to 1950 and had a small cooling effect afterward. However, after 1950, increasing GHG concentrations resulting from human activity, such as fossil fuel burning and deforestation, have been responsible for most of the observed temperature increase (CEC 2006). These basic conclusions have been endorsed by more than 45 scientific societies and academies of science, including all of the national academies of science of the major industrialized countries. Since 2007, no scientific body of national or international standing has maintained a dissenting opinion.

Increases in GHG concentrations in the Earth's atmosphere are thought to be the main cause of human-induced climate change. GHGs naturally trap heat by impeding the exit of solar radiation that has hit the Earth and is reflected back into space. Some GHGs occur naturally and are necessary for keeping the Earth's surface inhabitable. However, increases in the concentrations of these gases in the atmosphere during the last 100 years have decreased the amount of solar radiation that is reflected back into space, intensifying the natural greenhouse effect and resulting in the increase of global average temperature.

The principal GHGs are CO_2, methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), perfluorocarbons (PFC), hydrofluorocarbons (HFC), and water vapor. Each of the principal GHGs has a long atmospheric lifetime (1 year to several thousand years). In addition, the potential heat-trapping ability of each of these gases varies significantly from one another. CH_4 is 23 times as potent as CO_2, while SF_6 is 22,200 times more potent than CO_2. Conventionally, GHGs have been reported as CO_2 equivalents (CO_2e). CO_2e takes into account the relative potency of non-CO_2 GHGs and converts their quantities to an equivalent amount of CO_2 so that all emissions can be reported as a single quantity.

The primary man-made processes that release these gases include: burning of fossil fuels for transportation, heating and electricity generation; agricultural practices that release methane such as livestock grazing and crop residue decomposition; and industrial processes that release smaller amounts of high global warming potential gases such as SF_6, PFCs, and HFCs. Deforestation and land cover conversion have also been identified as contributing to global warming by reducing the Earth's capacity to remove CO_2 from the air and altering the Earth's albedo or surface reflectance, allowing more solar radiation to be absorbed.

7.1.2 Global Climate Trends and Associated Impacts

The rate of increase in global average surface temperature over the last hundred years has not been consistent; the last three decades have warmed at a much faster rate – on average 0.32°F per decade. Eleven of the 12 years from 1995 to 2006, rank among the

12 warmest years in the instrumental record of global average surface temperature (going back to 1850) (IPCC 2007a).

During the same period over which this increased global warming has occurred, many other changes have occurred in other natural systems. Sea levels have risen on average 1.8 mm/year; precipitation patterns throughout the world have shifted, with some areas becoming wetter and other drier; tropical cyclone activity in the North Atlantic has increased; peak runoff timing of many glacial and snow-fed rivers has shifted earlier; as well as numerous other observed conditions. Though it is difficult to prove a definitive cause and effect relationship between global warming and other observed changes to natural systems, there is high confidence in the scientific community that these changes are a direct result of increased global temperatures (IPCC 2007a).

7.1.3 California Climate Trends and Associated Impacts

Maximum (daytime) and minimum (nighttime) temperatures are increasing almost everywhere in California but at different rates. The annual minimum temperature averaged over all of California has increased 0.33°F per decade during the period 1920 to 2003, while the average annual maximum temperature has increased 0.1°F per decade (Moser et al. 2009).

With respect to California's water resources, the most significant impacts of global warming have been changes to the water cycle and sea level rise. Over the past century, the precipitation mix between snow and rain has shifted in favor of more rainfall and less snow (Mote et al. 2005, Knowles 2006) and snow pack in the Sierra Nevada is melting earlier in the spring (Kapnick and Hall 2009). The average early spring snowpack in the Sierra Nevada has decreased by about 10 percent during the last century, a loss of 1.5 million acre-feet of snowpack storage (DWR 2008). These changes have significant implications for water supply, flooding, aquatic ecosystems, energy generation, and recreation throughout the state. During the same period, sea levels along California's coast rose seven inches (DWR 2008). Sea level rise associated with global warming will continue to threaten coastal lands and infrastructure, increase flooding at the mouths of rivers, place additional stress on levees in the Sacramento-San Joaquin Delta, and will intensify the difficulty of managing the Sacramento-San Joaquin Delta as the heart of the state's water supply system.

These trends in California's water supply could impact the SJRRP by further straining the scarce resources needed to implement appropriately-timed Restoration Flows, while balancing the need to irrigate cropland and supply drinking water to large numbers of Californians. Increased surface temperatures may affect stream quality for fish and their prey, changing the biological conditions under which the SJRRP operates. In addition, increased frequency and severity of flood events could negatively impact fragile or restored areas such as gravel bars and riparian habitat.

7.1.4 Local Climate

Climate is the accumulation of daily and seasonal, or average, weather events over a period of time ranging from months to millions of years; whereas, weather is defined as the condition of the atmosphere at any particular time and place (IPCC 2007a, Ahrens

2003). The Restoration Area is located in a climatic zone characterized as dry-summer subtropical or Mediterranean in the Köppen climate classification system. The Köppen system's classifications are based primarily on annual and monthly averages of temperature and precipitation.

The climate in the SJVAB is characterized by hot, dry summers and cool, rainy winters. Periods of dense and persistent low-level fog that are most prevalent between storms are characteristic of winter weather in the SJVAB. The extreme summer aridity of the Mediterranean climate is caused by sinking air of subtropical high-pressure regions. The ocean has less influence in the SJVAB than in coastal areas, giving the interior Mediterranean climate more seasonal temperature variation (Ahrens 2003).

Most precipitation in the area results from air masses that move in from the Pacific Ocean during winter. These storms usually move from the west or northwest. More than half the total annual precipitation falls during the winter rainy season (November through February).

7.1.5 Greenhouse Gas Emissions Sources and Inventory

Human activities contribute to climate in many ways, but primarily by causing changes in the atmospheric concentrations of GHGs and aerosols. The largest anthropogenic contribution to climate change is the burning of fossil fuels, which releases CO_2 and other GHGs to the atmosphere. Since the start of the industrial era (about 1750), the use of fossil fuels has increased through activities such as transportation, building heating and cooling, and the manufacture of cement and other goods. Land use changes, such as wide-scale deforestation, the use of fertilizers, and draining of wetlands also contribute to GHG emissions worldwide. The rate of increase in GHG concentrations has increased during the last century, with an increase of 70 percent between 1970 and 2004 alone (IPCC 2007a). During this period, the two largest sectors of GHG emissions were the energy supply (with an increase of over 145 percent) and transportation (with a growth of over 120 percent) sectors. The slowest growth during the 1970 to 2004 period was in the agricultural sector with 27 percent growth and the residential/commercial buildings sector at 26 percent (IPCC 2007b).

California is the 12th to 16th largest emitter of CO_2 in the world (CEC 2006). In California, the transportation sector is the largest emitter of GHGs, followed by electricity generation (CEC 2006). California produced 484 million gross metric tons (mt) of CO_2 equivalent in 2004.Combustion of fossil fuel in the transportation sector was the single largest source of California's GHG emissions in 2004, accounting for 41 percent of total GHG emissions in the State (CEC 2006). This sector was followed by the electric power sector (including both in-State and out-of-State sources) (22 percent) and the industrial sector (21 percent) (CEC 2006). No GHG emissions inventory has been conducted for the SJVAB at this time.

7.2 Regulatory Setting

Air quality within the Restoration Area is regulated by EPA, ARB, the SJVAPCD; Fresno, Madera, and Merced counties; and the cities of Fresno and Firebaugh. Each of these agencies develops rules, regulations, policies, and/or goals to comply with applicable legislation. Although EPA regulations may not be superseded, both State and local regulations may be more stringent.

7.2.1 Federal

Federal laws and regulations pertaining to air quality are discussed below.

Mandatory GHG Reporting Rule

On September 22, 2009, EPA released its final Greenhouse Gas Reporting Rule (Reporting Rule). The Reporting Rule is a response to the fiscal year (FY) 2008 Consolidated Appropriations Act (House of Representatives 2764; Public Law 110-161), that required EPA 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 mtCO_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 would also mandate recordkeeping and administrative requirements in order for EPA to verify annual GHG emissions reports.

Environmental Protection Agency Endangerment and Cause or Contribute Findings

On December 7, 2009, the Administrator signed two distinct findings regarding GHGs under section 202(a) of the CAA:

- **Endangerment Finding:** the current and projected concentrations of the six key well-mixed GHGs – CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6 – in the atmosphere threaten the public health and welfare of current and future generations.

- **Cause or Contribute Finding:** The Administrator finds that the combined emissions of these well-mixed GHGs from new motor vehicles and new motor vehicle engines contribute to the GHG pollution which threatens public health and welfare.

CEQ Draft NEPA Guidelines. Because of uneven treatment of climate change under NEPA, International Center for Technology Assessment, NRDC, and Sierra Club filed a petition with CEQ in March 2008, requesting inclusion of climate change analyses in all Federal environmental review documents. In response to the petition, as well as Executive Order 13514, CEQ issued new draft guidance on when and how to include GHG emissions and climate change impacts in environmental review documents under NEPA. CEQ's guidance (issued on February 18, 2010) suggests that Federal agencies should consider opportunities to reduce GHG emissions caused by proposed Federal actions and adapt their actions to climate change impacts throughout the NEPA process and to address these issues in their agency NEPA procedures. In the context of addressing climate change in environmental documentation, the two main considerations are as follows:

1. the effects of a proposed action and alternative actions on GHG emissions; and
2. the impacts of climate change on a proposed action or alternatives. CEQ notes that “significant” national policy decisions with “substantial” GHG impacts require analysis of their GHG effects, i.e., if a proposed action causes “substantial” annual direct emissions, or if a Federal agency action implicates energy conservation, reduced energy use or GHG emissions, and/or promotes renewable energy technologies that are cleaner and more efficient.

In these circumstances, information on GHG emissions (qualitative or quantitative) that is useful and relevant to the decision should be used when deciding among alternatives.

CEQ suggests that if a proposed action causes direct annual emissions of greater than 25,000 $mtCO_2e$, a quantitative and qualitative assessment may be meaningful to decision makers and the public. If annual direct emissions are less than 25,000 $mtCO_2e$/year, CEQ encourages Federal agencies to consider whether the action’s long-term emissions should receive similar analysis.

7.2.2 State of California

State laws and regulations pertaining to air quality are discussed below.

Summary of Laws and Executive Orders

The ARB is the agency responsible for coordination and oversight of State and local air pollution control programs. Various statewide initiatives to reduce the State’s contribution to GHG emissions have raised awareness that, even though the various contributors to and consequences of global climate change are not yet fully understood, global climate change is under way, and real potential exists for severe adverse environmental, social, and economic effects in the long term. Table 7-1 summarizes major State laws and executive orders addressing climate change. The most significant laws and orders are discussed in more detail after the table.

Table 7-1.
Summary of State Laws and Executive Orders that Address Climate Change

Legislation Name	Signed into Law/ Ordered	Description	CEQA Relevance
SB 1771	09/2000	Establishment of California Climate Registry to develop protocols for voluntary accounting and tracking of GHG emissions.	In 2007, DWR began tracking GHG emissions for all departmental operations.
AB 1473	07/2002	Directs ARB to establish fuel standards for noncommercial vehicles that would provide the maximum feasible reduction of GHGs.	Reduction of GHG emissions from noncommercial vehicle travel.
SB 1078, 107, EO S-14-08	09/2002, 09/2006, 11/2008	Establishment of renewable energy goals as a percentage of total energy supplied in the State.	Reduction of GHG emissions from purchased electrical power.
EO S-3-05, AB 32*	06/2005, 09/2006	Establishment of statewide GHG reduction targets and biennial science assessment reporting on climate change impacts and adaptation and progress toward meeting GHG reduction goals.	Projects required to be consistent with statewide GHG reduction plan and reports will provide information for climate change adaptation analysis.
SB 1368	9/2006	Establishment of GHG emission performance standards for base load electrical power generation.	Reduction of GHG emissions from purchased electrical power.
EO S-1-07	01/2007	Establishment of Low Carbon Fuel Standard.	Reduction of GHG emissions from transportation activities.
SB 97	08/2007	Directs OPR to develop guideline amendments for the analysis of climate change in CEQA documents.	Requires climate change analysis in all CEQA documents.
SB 375	09/2008	Requires metropolitan planning organizations to include sustainable communities strategies in their regional transportation plans.	Reduction of GHG emissions associated with housing and transportation.
EO S-13-08	11/2008	Directs the Natural Resources Agency to work with the National Academy of Sciences to produce a California Sea Level Rise Assessment Report and directs CAT to develop a California Climate Adaptation Strategy.	Information in the reports will provide information for climate change adaptation analysis.

Note:

*Most significant laws and orders include SB 97 and EO S-13-08, elaborated further below.

Key:

AB = Assembly Bill
ARB = California Air Resources Board
CAT = Climate Action Team
CEQA = California Environmental Quality Act
DWR = California Department of Water Resources
EO = Executive Order
GHG = GHG
OPR = Office of Planning and Research
SB = Senate Bill

California Environmental Quality Act and SB 97

CEQA requires lead agencies to consider the reasonably foreseeable adverse environmental effects of projects they are considering for approval. GHG emissions have the potential to adversely affect the environment because they contribute to global climate change. In turn, global climate change has the potential to: raise sea levels, affect rainfall and snowfall, and affect habitat.

Senate Bill 97. The provisions of Senate Bill (SB) 97, enacted in August 2007 as part of the State Budget negotiations and codified at Section 21083.05 of the PRC, directed the Office of Planning and Research (OPR) to propose CEQA Guidelines "for the mitigation of GHG emissions or the effects of GHG emissions." SB 97 directed Office of Planning and Research (OPR) to develop such Guidelines by July 2009, and directed the State Resources Agency (now Natural Resources Agency), the agency charged with adopting the CEQA Guidelines, to certify and adopt such Guidelines by January 2010. In April 2009, OPR prepared draft CEQA Guidelines and submitted them to the Natural Resources Agency (see below). On July 3, 2009, the Natural Resources Agency began the rulemaking process established under the Administrative Procedure Act. Following a public comment period and public hearings, The Natural Resources Agency proposed revisions to the text of the proposed Guideline amendments and transmitted the adopted amendments and the entire rulemaking file to the Office of Administrative Law (OAL) on December 31, 2009. The Natural Resources Agency recommended amendments for GHGs fit within the existing CEQA framework for environmental analysis, which calls for lead agencies to determine baseline conditions and levels of significance, and to evaluate mitigation measures. On February 16, 2010 the OAL approved the amendments, and filed them with the Secretary of State for inclusion in the California Code of Regulations. The Amendments became effective on March 18, 2010.

The guideline amendments do not identify a threshold of significance for GHG emissions nor do they prescribe assessment methodologies or specific mitigation measures. The guidelines amendments encourage lead agencies to consider many factors in performing a CEQA analysis, but preserve the discretion that CEQA grants lead agencies to make their own determinations based on substantial evidence.

CEQA Guidelines Section 15064.4, *Determining the Significance of Impacts from Greenhouse Gas Emissions*, encourages lead agencies to consider three factors to assess the significance of GHG emissions: (1) will the project increase or reduce GHGs as compared to baseline; (2) will the project's GHG emissions exceed the lead agency's threshold of significance; and (3) does the project comply with regulations or requirements to implement a statewide, regional, or local GHG reduction or mitigation plan. CEQA Guidelines Section 15064.4 also recommends that lead agencies make a good-faith effort, based on available information, to describe, calculate or estimate the amount of GHG emissions associated with a project.

CEQA Guidelines Section 15126.4, *Consideration and Discussion of Mitigation Measures Proposed to Minimize Significant Effects*, includes considerations for lead agencies related to feasible mitigation measures to reduce GHG emissions, including but not limited to project features, project design, or other measures which are incorporated into the project to substantially reduce energy consumption or GHG emissions; compliance with the requirements in a previously approved plan or mitigation program for the reduction or sequestration of GHG emissions, which plan or program provides specific requirements that will avoid or substantially lessen the potential impacts of the project; and measures that sequester carbon or carbon-equivalent emissions. In addition, the amended CEQA Guidelines Section 15126.4 includes a requirement that where mitigation measures are proposed for reduction of GHG emissions through off-site measures or purchase of carbon offsets, these mitigation measures must be part of a reasonable plan of mitigation that the relevant agency commits itself to implementing.

In addition, as part of the CEQA Guideline amendments and additions, a new set of environmental checklist questions (VII. *Greenhouse Gas Emissions*) to the CEQA Guidelines Appendix G were developed. The new set asks whether a project would:

a) Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment?

b) Conflict with any applicable plan, policy or regulation of an agency adopted for the purpose of reducing the emissions of GHGs?

Preliminary Draft Staff Proposal: Recommended Approaches for Setting Interim Significance Thresholds for Greenhouse Gases under CEQA. CEQA gives discretion to lead agencies to establish thresholds of significance based on individual circumstances. To assist in that exercise, and because OPR believes the unique nature of GHGs warrants investigation of a statewide threshold of significance for GHG emissions, OPR engaged the California Air Resources Board (ARB) technical staff to recommend a methodology for setting thresholds of significance. In October 2008, ARB released a Preliminary Draft Staff Proposal: Recommended Approaches for Setting Interim Significance Thresholds for Greenhouse Gases under the CEQA (ARB 2008a). This draft proposal included a conceptual approach for thresholds associated with industrial, commercial, and residential projects. With respect to nonindustrial projects, the steps to presuming a less-than-significant impact related to climate change generally include analyzing whether the project is exempt under existing statutory or categorical exemptions, complies with a previously approved plan or target, meets specified minimum performance standards and falls below an as yet unspecified annual emissions level (ARB 2008a). The performance standards focus on construction activities, energy and water consumption, generation of solid waste, and transportation. For industrial projects, the draft proposal recommends a tiered analysis procedure similar to non-industrial projects. However, for industrial projects a quantitative annual emissions limit for less than significant impacts is established at approximately 7,000 $mtCO_2e$/year. To date, these standards have not been adopted or finalized as a basis to evaluate the significance of a project's contribution to climate change.

Executive Order S-3-05

Executive Order (EO) S-3-05 made California the first state to formally establish GHG emissions reduction goals. EO S-3-05 includes the following GHG emissions reduction targets for California:

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

The final emission target of 80 percent below 1990 levels would put the state's emissions in line with estimates of the required worldwide reductions needed to bring about long-term climate stabilization and avoidance of the most severe impacts of climate change (IPCC 2007a).

EO S-3-05 also dictated that the Secretary of the California Environmental Protection Agency coordinate oversight of efforts to meet these targets with the Secretary of the Business, Transportation and Housing Agency; Secretary of the Department of Food and Agriculture; Secretary of the Resources Agency; Chairperson of the Air Resources Board; Chairperson of the Energy Commission; and the President of the Public Utilities Commission. This group was subsequently named the Climate Action Team (CAT).

As laid out in the EO, the CAT has submitted biannual reports to the governor and State legislature describing progress made toward reaching the targets. The CAT is in the process of finalizing their second biannual report on the effects of climate change on California's resources.

Assembly Bill 32

In 2006, California passed the California Global Warming Solutions Act of 2006 (AB 32; California Health and Safety Code Division 25.5, Sections 38500, et seq., or AB 32). AB 32 further details and puts into law the mid-term GHG reduction target established in EO S-3-05—reduce GHG emissions to 1990 levels by 2020. AB 32 also identifies ARB as the state agency responsible for the design and implementation of emissions limits, regulations, and other measures to meet the target.

The statute lays out the schedule for each step of the regulatory development and implementation, as follows:

- By June 30, 2007, ARB had to publish a list of early-action GHG emission reduction measures.

- Prior to January 1, 2008, ARB had to: identify the current level of GHG emissions by requiring statewide reporting and verification of GHG emissions from emitters and identify the 1990 levels of California GHG emissions.

- And by January 1, 2010, ARB had to adopt regulations to implement the early-action measures.

In December 2007, ARB approved the 2020 emission limit (1990 level) of 427 million mtCO$_2$e/year of GHGs. The 2020 target requires the reduction of 169 million mtCO$_2$e/year, or approximately 30 percent below the state's projected "business-as-usual" 2020 emissions of 596 million mtCO$_2$e/year.

Also in December 2007, ARB adopted mandatory reporting and verification regulations pursuant to AB 32. The regulations became effective January 1, 2009, with the first reports covering 2008 emissions. The mandatory reporting regulations require reporting for major facilities, those that generate more than 25,000 $mtCO_2e$/year. To date ARB has met all of the statutorily mandated deadlines for promulgation and adoption of regulations.

Climate Change Scoping Plan

On December 11, 2008, pursuant to AB 32, ARB adopted the Climate Change Scoping Plan. This plan outlines how emissions reductions will be achieved from significant sources of GHGs via regulations, market mechanisms, and other actions. Six key elements, outlined in the scoping plan, are identified below to achieve emissions reduction targets:

- Expanding and strengthening existing energy efficiency programs as well as building and appliance standards;
- Achieving a statewide renewable energy mix of 33 percent;
- Developing a California cap-and-trade program that links with other Western Climate Initiative partner programs to create a regional market system;
- Establishing targets for transportation-related GHG emissions for regions throughout California, and pursuing policies and incentives to achieve those targets;
- Adopting and implementing measures pursuant to existing state laws and policies, including California's clean car standards, goods movement measures, and the Low Carbon Fuel Standard; and
- Creating targeted fees, including a public goods charge on water use, fees on high global warming potential gases, and a fee to fund the administrative costs of the state's long-term commitment to AB 32 implementation.

The Climate Change Scoping Plan also included recommended 39 measures that were developed to reduce GHG emissions from key sources and activities while improving public health, promoting a cleaner environment, preserving our natural resources, and ensuring that the impacts of the reductions are equitable and do not disproportionately impact low-income and minority communities. These measures also put the state on a path to meet the long-term 2050 goal of reducing California's GHG emissions to 80 percent below 1990 levels. The measures in the approved Scoping Plan will be developed over the next 2 years and be in place by 2012.

Executive Order S-13-08

EO S-13-08, issued November 14, 2008, directs the California Natural Resources Agency, DWR, Office of Planning and Research, Energy Commission, State Water Resources Control Board, State Parks Department, and California's coastal management agencies to participate in a number of planning and research activities to advance California's ability to adapt to the impacts of climate change. The order specifically directs agencies to work with the National Academy of Sciences to initiate the first California Sea Level Rise Assessment and to review and update the assessment every two years after completion; immediately assess the vulnerability of the California transportation system to sea level rise; and to develop a California Climate Change Adaptation Strategy.

California Climate Change Adaptation Strategy

In cooperation and partnership with multiple state agencies, the 2009 California Climate Adaptation Strategy summarizes the best known science on climate change impacts in seven specific sectors (public health, biodiversity and habitat, ocean and coastal resources, water management, agriculture; forestry, and transportation and energy infrastructure) and provides recommendations on how to manage against those threats.

Office of Planning and Research Technical Advisory

In June 2008, OPR published a technical advisory on CEQA and Climate Change to provide interim advice to lead agencies regarding the analysis of GHGs in environmental documents (OPR 2008). The advisory encourages lead agencies to identify and quantify the GHGs that could result from a proposed project, analyze the impacts of those emissions to determine whether they would be significant, and to identify feasible mitigation measures or alternatives that would reduce any adverse impacts to a less-than-significant level. The advisory recognizes that OPR will develop, and the Natural Resources Agency will adopt amendments to the CEQA Guidelines pursuant to SB 97.

The advisory provides OPR's perspective on the emerging role of CEQA in addressing climate change and GHG emissions and recognizes that approaches and methodologies for calculating GHG emissions and determining their significance are rapidly evolving. OPR concludes in the technical advisory that climate change is ultimately a cumulative impact realizing that no individual project could have a significant impact on global climate. Thus, projects must be analyzed with respect to the incremental impact of the project when added to other past, present, and reasonably foreseeable probable future projects. In order to make a determination of cumulative significance, OPR recommends that lead agencies undertake an analysis, consistent with available guidance and current CEQA practice (OPR 2008).

The technical advisory points out that neither CEQA nor the CEQA Guidelines prescribe thresholds of significance or particular methodologies for performing an impact analysis. "This is left to lead agency judgment and discretion, based upon factual data and guidance from regulatory agencies and other sources where available and applicable" (OPR, 2008). OPR recommends that "the global nature of climate change warrants investigation of a statewide threshold of significance for GHG emissions" (OPR, 2008). Until such a standard is established, OPR advises that each lead agency should develop its own approach to performing an analysis for projects that generate GHG emissions (OPR, 2008).

OPR sets out the following process for evaluating GHG emissions. First, agencies should determine whether GHG emissions may be generated by a proposed project, and if so, quantify or estimate the emissions by type or source. Calculation, modeling or estimation of GHG emissions should include the emissions associated with vehicular traffic, energy consumption, water usage and construction activities (OPR 2008).

Agencies should then assess whether the emissions are “cumulatively considerable” even though a project’s GHG emissions may be individually limited. OPR states: “Although climate change is ultimately a cumulative impact, not every individual project that emits GHGs must necessarily be found to contribute to a significant cumulative impact on the environment” (OPR 2008). Individual lead agencies may undertake a project-by-project analysis, consistent with available guidance and current CEQA practice (OPR 2008).

Finally, if the lead agency determines emissions are a cumulatively considerable contribution to a significant cumulative impact, the lead agency must investigate and implement ways to mitigate the emissions (OPR 2008). OPR states: “Mitigation measures will vary with the type of project being contemplated, but may include alternative project designs or locations that conserve energy and water, measures that reduce vehicle miles traveled (VMT) by fossil-fueled vehicles, measures that contribute to established regional or programmatic mitigation strategies, and measures that sequester carbon to offset the emissions from the project” (OPR 2008). OPR concludes that “A lead agency is not responsible for wholly eliminating all GHG emissions from a project; the CEQA standard is to mitigate to a level that is “less than significant” (OPR 2008). The technical advisory includes a list of GHG reduction measures in Attachment 3 to the technical advisory that can be applied on a project-by-project basis.

California Air Pollution Officers Association

In January 2008, the California Air Pollution Control Officers Association (CAPCOA) issued a “white paper” on evaluating and addressing GHGs under CEQA (CAPCOA, 2008). This resource guide was prepared to support local governments as they develop their climate change programs and policies. Though not a guidance document, the paper provides information about key elements of CEQA GHG analyses, including a survey of different approaches to setting quantitative significance thresholds. Some of the thresholds discussed include:

- Zero (all emissions are significant);
- 900 mtCO_2e/year (90 percent market capture for residential and non-residential discretionary development);
- 10,000 mtCO_2e/year (potential ARB mandatory reporting level for Cap and Trade program);
- 25,000 mtCO_2e/year (the ARB mandatory reporting level for the statewide emissions inventory);

- Unit-based thresholds – based on identifying thresholds for each type of new development and quantifying significance by a 90 percent capture rate.

7.2.3 Regional and Local

The ARB Scoping Plan (January 2009) ("The Scoping Plan") states that local governments are "essential partners" in the effort to reduce GHG emissions. The Scoping Plan also acknowledges that local governments have "broad influence and, in some cases, exclusive jurisdiction" over activities that contribute to significant direct and indirect GHG emissions through their planning and permitting processes, local ordinances, outreach and education efforts, and municipal operations. Many of the proposed measures to reduce GHG emissions rely on local government actions. The Scoping Plan encourages local governments to reduce GHG emissions by approximately 15 percent from current levels by 2020 (ARB 2008b).

Regional and local plans and policies pertaining to air quality are discussed below.

San Joaquin Air Pollution Control District

San Joaquin Air Pollution Control District (SJVAPCD) has jurisdiction over most air quality matters in SJVAB and implements certain programs and regulations required by the Federal CAA and the California CAA. As a public agency, SJVAPCD takes an active part in the intergovernmental review process under CEQA, and assists governmental agencies and project proponents in understanding air quality analysis methodologies, applicable rules, and how to reduce or mitigate impacts, if any.

The SJVAPCD has not officially adopted a significance threshold for generation of GHGs by restoration projects to assess the level at which a project's incremental contribution is considered cumulatively considerable. However, in December 2009, the District adopted their "*Guidance for Valley Land-Use Agencies in Addressing GHG Emission Impacts for New Projects under CEQA"* (Guidance). In this Guidance document, SJVAPCD recommends that quantification of GHG emissions be conducted for development projects that are required to conduct an EIR and do not implement Best Performance Standards (BPS) . BPS's are defined as the most cost effective achieved-in-practice means of reducing or limiting GHG emissions from a GHG emissions source. Projects implementing BPS in accordance with the Guidance would be determined to have a less than significant individual and cumulative impact on global climate change and would not require project specific quantification of GHG emissions (SJVAPCD 2009).

7.3 Environmental Consequences and Mitigation Measures

This section describes the effects that the action alternatives could have on concentrations of GHGs in the atmosphere. The significance of the effects is evaluated based on criteria informed by Federal, State, and local laws, regulations, and policies. The effects of the action alternatives are compared with the No-Action Alternative. GHG emissions associated with the action alternatives could contribute to the cumulatively considerable impact of climate change. The discussion below reviews potential generation of GHG emissions under each of the program alternatives, and their cumulative contribution to global climate change. For the purpose of this analysis, only changes in GHG emissions cause by humans are discussed. The impacts discussion is divided into program-level and project-level impacts, as follows:

- **Program-level** actions under the action alternatives with the potential to create GHG emissions would include construction and maintenance activities in the Restoration Area (Alternatives A1 through C2), and on the San Joaquin River between the Merced River and the Delta (Alternatives C1 and C2). These emissions, and the associated program-level impacts, would vary among the action alternatives.

- **Project-level** actions under the action alternatives with the potential to create GHG emissions are identical under all action alternatives, and include operational activities for the release and recapture of Interim and Restoration flows in the Restoration Area and in the Delta. Additional recapture at existing or potential facilities between the Merced River and the Delta under Alternatives B1 through C2 are program-level actions; however, the effects of recapture operations at these facilities are described at a project level of detail because sufficient information is available to do so.

The program alternatives evaluated in this chapter are described in detail in Chapter 2.0, “Description of Alternatives,” and summarized in Table 7-2. Potential impacts to climate change and associated mitigation measures are summarized in Table 7-3.

Table 7-2.
Actions Included Under Action Alternatives

Level of NEPA/CEQA Compliance	Actions[1]		Action Alternative					
			A1	A2	B1	B2	C1	C2
Project-Level	Reoperate Friant Dam and downstream flow control structures to route Interim and Restoration flows		✓	✓	✓	✓	✓	✓
	Recapture Interim and Restoration flows in the Restoration Area		✓	✓	✓	✓	✓	✓
	Recapture Interim and Restoration flows at existing CVP and SWP facilities in the Delta		✓	✓	✓	✓	✓	✓
Program-Level	Common Restoration actions[2]		✓	✓	✓	✓	✓	✓
	Actions in Reach 4B1 to provide at least:	475 cfs capacity	✓	✓	✓	✓	✓	✓
		4,500 cfs capacity with integrated floodplain habitat		✓		✓		✓
	Recapture Interim and Restoration flows on the San Joaquin River downstream from the Merced River at:	Existing facilities on the San Joaquin River			✓	✓	✓	✓
		New pumping infrastructure on the San Joaquin River					✓	✓
	Recirculation of recaptured Interim and Restoration flows		✓	✓	✓	✓	✓	✓

Note:

[1] All alternatives also include the Physical Monitoring and Management Plan and the Conservation Strategy, which include both project- and program-level actions intended to guide implementation of the Settlement.

[2] Common Restoration actions are physical actions to achieve the Restoration Goal that are common to all action alternatives and are addressed at a program level of detail.

Key:
CEQA = California Environmental Quality Act
cfs = cubic feet per second
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
NEPA = National Environmental Policy Act
PEIS/R = Program Environmental Impact Statement/Report
SWP = State Water Project

Table 7-3.
Summary of Impacts and Mitigation Measures – Climate Change

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Climate Change: Program-Level[1]				
CLM-1: Construction-Related Emissions of GHGs	A1	PS	CLM-1: Implement All Feasible Measures to Reduce Emissions	PSU
	A2	PS		PSU
	B1	PS		PSU
	B2	PS		PSU
	C1	PS		PSU
	C2	PS		PSU
CLM-2: Operational Emissions of GHGs	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
Climate Change: Project-Level[1]				
CLM-3: Construction-Related Emissions of GHGs	A1	No Impact	--	No Impact
	A2	No Impact	--	No Impact
	B1	No Impact	--	No Impact
	B2	No Impact	--	No Impact
	C1	No Impact	--	No Impact
	C2	No Impact	--	No Impact
	A1	No Impact	--	No Impact
CLM-4: Operational Emissions of GHGs	A1	PS	CLM-1: Implement All Feasible Measures to Reduce Emissions	PSU
	A2	PS		PSU
	B1	PS		PSU
	B2	PS		PSU
	C1	PS		PSU
	C2	PS		PSU

Note:

[1] Because analysis of the environmental effects of GHG emissions from the program alternatives is addressed as a cumulative impact analysis, and the No-Action Alternative by definition cannot contribute to a cumulative impact, no significance determination is made for the No-Action Alternative.

Key:
-- = not applicable
GHG = greenhouse gas
LTS = less than significant
PS = potentially significant
PSU = potentially significant and unavoidable
SU = significant and unavoidable

7.3.1 Impact Assessment Methodology

Both short-term construction and long-term operation of each action alternative would generate emissions of GHGs. Construction emissions would be associated with engine exhaust from construction equipment, material transport trips, and employee commute trips. Operational emissions would be associated with the use of pumping infrastructure to recapture flows, maintenance activities, and recreational uses. Mobile-source GHG emissions would include project-generated vehicle trips associated with maintenance in the study area and visits by the public for recreational purposes.

GHG emissions associated with the Settlement would consist primarily of CO_2. CO_2 emissions persist in the atmosphere substantially longer than criteria air pollutants, such as ozone and PM_{10}. Emissions of other GHGs, such as CH_4 and N_2O, are important factors contributing to global climate change; however, emission levels of these GHGs for sources associated with the action alternatives are relatively low compared with CO_2 emissions, even considering their higher Global Warming Potential (GWP). GHG emissions from energy consumption were estimated using the General Reporting Protocol version 3.1 (CCAR 2009) developed by the California Climate Action Registry (CCAR), and emission factors from eGrid (EPA 2011, The Climate Registry 2011).

There are several sources of uncertainty in this analysis, including how GHG emissions are calculated, how the program-level actions might ultimately be implemented, and how the physical and biological setting might change in the future in response to the SJRRP or other programs, because of societal or regulatory changes outside the SJRRP. Some of the key assumptions leading to theses uncertainties are described below.

As described in Chapter 13.0, “Hydrology – Surface Water Supplies and Facilities Operations,” CalSim-II was used to evaluate the water supply reliability of the CVP and SWP at current and future levels of development (e.g., 2005, 2030), including water recapture opportunities under all alternatives. Under this analysis, the average annual increase in south-of-Delta deliveries is assumed to represent the upper limit of the potential return for Alternative A1. The potential return of recaptured water to Friant, however, pursuant to Paragraph 16(a), is not explicitly modeled in CalSim-II. Alternatives B1, B2, C1, and C2 each also include recapture upstream from the Delta via exchange or direct diversion in the CalSim-II model. This water is not returned to Friant but also is not delivered to other CVP and SWP contractors in the model. No attempt was made to allocate the potential return to individual years or months because the mechanism and facilities, either existing or new, required for implementing the return are unknown at this time. However, surface water supplies not delivered to the Friant Division could be delivered to other south-of-Delta contractors, potentially offsetting current emissions through reduced groundwater pumping; this mechanism is not accounted for in this analysis.

Results of the CalSim-II analysis were post-processed to meet the needs of other resource impact analyses, including analyses of changes in energy consumption, as described in Appendix H, “Modeling.” Changes in energy generation and consumption within the CVP and SWP are described in Chapter 19.0, “Power and Energy,” and were used in this analysis of GHG emissions. The changes in energy generation and consumption within the CVP and SWP are based on a set of assumptions inherent in the models used to evaluate hydrology and energy generation and consumption, including the levels of demand, patterns of use, and facilities available for generating power and circulating water within the CVP and SWP. Changes that affect these assumptions, such as additional regulatory changes affecting water recapture opportunities in the Delta or on the San Joaquin River, would also affect the accuracy of the GHG emissions quantities presented in this chapter. Construction of new infrastructure, or modifications of existing infrastructure, could also occur that is not included in the analysis at this time. This could include improvements to hydroelectric power generation at Friant Dam, as proposed by Orange Cove ID and described in Chapter 19.0, "Power and Energy." This project would increase installed capacity at Friant Dam from 1.8 to 7.0 MW and hydraulic capacity from 130 to 370 cfs (FERC 2010). This facility, if constructed, would increase the energy generated at Friant Dam over that presented in this Draft PEIS/R, and could reduce the effects presented in this chapter.

As described in Chapter 12.0, "Hydrology – Groundwater," the maximum potential increase in groundwater pumping was assumed to be equivalent to the changes in surface water deliveries within each district. This assumes a linear relationship between contractor-area-wide pumping and annual aquifer drawdown, or that groundwater supplies exist in each district to make up for the average annual net reductions in surface water deliveries resulting from program alternatives. However, it is recognized that projected drawdown in an aquifer may not be sustainable in some contractor areas within the Friant Division. Conversely, changes in land and water management practices in the Friant Division, including higher efficiency water application, sowing of different crops, fallowing of land, reduction of irrigated acreage, and water purchases and transfers, could potentially result in reduced demand for water supply and, thus, reduced GHG emissions.

In addition to the analytical assumptions described above, existing regulatory programs or future changes in the regulatory environment may change the GHGs emitted as a result of implementing the Settlement. These include regulations specific to GHG emissions and climate change, as well as regulations that would affect the extent of certain actions under the Settlement. Regulations specific to GHG emissions that address energy sources or modifications to transmission facilities could reduce GHG emissions or improve efficiency at the State level, include regulatory actions by ARB to achieve the GHG reduction goals of AB 32. Similarly, EPA has issued regulatory actions under the CAA aimed at reducing GHG emissions and improving energy efficiency nationally. Regulations that would affect the extent of certain actions under the Settlement could also affect GHG emissions, such as reduced recapture opportunities in the Delta due to changes in the Delta regulatory environment, which would result in less pumping from the Delta but could result in increased pumping of groundwater in the Friant Division.

Finally, the program-level actions described in this Draft PEIS/R include a range of potential implementation. While this chapter includes an analysis and discussion of the maximum potential GHG emissions that could occur as a result of implementing the Settlement, the subsequent site-specific studies of the program-level actions would determine the actual magnitude of actions that could cause GHG emissions. During subsequent study, the magnitude of GHG emissions from construction-related activities could be reduced from that evaluated in this chapter. Conversely, the level of carbon sequestration that could occur as a result of vegetation established under the SJRRP would depend on many factors, including the incidence of precipitation and the level of maintenance activities performed to remove vegetation for flow conveyance.

For the reasons discussed above, while the analysis of GHG emissions presented in this chapter are the estimated maximum GHG emissions that could occur under the action alternatives, there are several sources of uncertainty in the analysis. Therefore, the actual GHG emissions that could result from implementing the Settlement could be substantially lower than the maximum disclosed in this chapter.

7.3.2 Significance Criteria

Reclamation, DWR, and SJVAPCD have not established a quantitative significance threshold for GHG emissions; instead, each project is evaluated on a case-by-case basis using the most up-to-date calculation and analysis methods. However, by adopting AB 32, the State has established statewide GHG reduction targets. Further, the State has determined that GHG emissions, as they relate to global climate change, are a source of adverse environmental impacts in California and should be addressed under CEQA. AB 32 did not amend CEQA, although the legislation identifies the myriad environmental problems in California caused by global warming (Health and Safety Code, Section 38501(a)). SB 97, in contrast, added explicit requirements that CEQA analysis address the impacts of GHG emissions (PRC Sections 21083.05 and 21097). Finally, as previously mentioned, no individual project can have a significant impact on global climate (California Natural Resources Agency 2009). Therefore, analysis of the significance of GHG emissions is a cumulative impacts analysis.

According to the CEQA Guidelines, Appendix G (2010), a project could result in a significant impact if it would do either of the following:

- Generate GHG emissions, either directly or indirectly, that may have a significant cumulative impact on the environment.
- Generate GHG emissions that would conflict with any applicable plan, policy or regulation of an agency adopted for the purpose of reducing the emissions of GHGs, including the State goal of reducing GHG emissions in California to 1990 levels by 2020, as set forth by the timetable established in AB 32, the California Global Warming Solutions Act of 2006.

Based on the CEQA Guidelines, Appendix G criteria listed above, and on the size, scope, and purpose of the program alternatives, the following significance criteria are used to determine the significance of GHG emissions from the program alternatives:

- Whether the proposed project has the potential to conflict with or is consistent with plans to reduce or mitigate GHGs, including the following:
    - The six key elements of the Climate Change Scoping Plan (previously described)

  - ARB's 39 recommended actions in the *Climate Change Scoping Plan* (ARB 2008b)
  - Regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of GHG emissions
  - Whether the proposed project is part of a plan that includes overall reductions in GHG emissions
- Whether the relative amounts of GHG emissions over the life of the proposed project are small compared to the amount of GHG emissions for major facilities that are required to report GHG emissions (25,000 $mtCO_2e$/year)
- Whether the proposed project has the potential to contribute to a lower carbon future, such as the following:
  - Whether the design of the proposed project is inherently energy-efficient
  - Whether all applicable best management practices (SJVAPCD BPS requirements) that would reduce GHG emissions are incorporated into the proposed project design
  - Whether the proposed project implements or funds its fair share of a mitigation strategy designed to alleviate climate change
  - Whether there are process improvements or efficiencies gained by implementing the proposed project

7.3.3 Program-Level Impacts and Mitigation Measures

This section provides a program-level evaluation of the direct and indirect effects of the program alternatives on cumulative GHG emissions, including the potential effects of recapture of Interim and Restoration flows using existing facilities on the San Joaquin River between the Merced River and the Delta; from construction and operation of new pumping infrastructure below the confluence of the Merced River; and from changes in groundwater pumping practices in the Friant Division in response to changes in the quantity of water recirculated to the Friant Division as a result of program-level actions. These actions could affect GHG emissions during the modification or construction of facilities or during Restoration actions such as improving levees or creating integrated floodplain habitat. As previously mentioned, the maximum potential increase in groundwater pumping in the Friant Division as a result of implementing the Settlement would occur if none of the water released as Interim and Restoration flows was recirculated to the Friant Division; this project-level impact is described separately in Section 7.3.4.

With respect to the significance criteria established at the beginning of this section, the information currently available is not sufficient to determine whether the action alternatives would meet these criteria. Therefore, the potential for the alternatives to result in GHG emissions is described qualitatively in the following sections.

No-Action Alternative

Emissions of GHGs occur at local and landscape scales, but are distributed globally. As described in Section 7.1, GHG emissions have increased greatly over the past 100 years and are linked to increases in global temperature and other climate changes. The impact of these increased atmospheric concentrations of GHGs constitutes a substantial existing and ongoing adverse impact. As previously mentioned, analysis of the environmental effects of GHG emissions from the program alternatives is addressed as a cumulative impact analysis, only. Because the No-Action Alternative by definition cannot contribute to a cumulative impact, no significance determination is made for the No-Action Alternative.

Alternatives A1 and B1

Program-level actions under Alternatives A1 and B1 with the potential to create GHG emissions would include short-term construction and long-term maintenance activities in the Restoration Area.

Impact CLM-1 (Alternatives A1 and B1): ***Construction-Related Emissions of GHGs – Program-Level.*** Construction activities performed under Alternatives A1 and B1 could generate substantial quantities of GHGs. Construction-related emissions would be short-term in duration. Emissions would be generated by engine exhaust from construction equipment, material transport trips, and employee commute trips during levee enhancement work (as described in Chapter 4.0, "Air Quality"). An estimate of GHG emissions from these activities is not possible at this time; however, it is likely that construction under Alternatives A1 and B1 could result in a considerable contribution to a significant cumulative impact and, therefore, the impact would be **potentially significant**.

Mitigation Measure CLM-1 (Alternatives A1 and B1): ***Implement All Feasible Measures to Reduce Emissions – Program-Level.*** The project proponent will provide a complete quantitative project-level analysis of GHG emissions as part of the subsequent environmental review for each individual project. The GHG analysis for each project shall be based on the types, locations, numbers, and operations of equipment to be used; the amount and distance of material to be transported; worker trips required; and electricity generation. The project proponent will be required to implement all feasible measures for reducing GHG emissions such as those listed in the Office of Planning and Research (OPR) *Technical Advisory on CEQA and Climate Change* (2008), and the SJVAPCD Guidance document (SJVAPCD 2009).

Implementing this mitigation measure would help reduce GHG emissions by individual projects, and could result in a less-than-significant impact. However, without specific project-level information, the levels of GHG emissions after mitigation cannot be quantified at this time. Thus, without relying on speculation, it is assumed that construction-generated GHG emissions could be a considerable contribution to a significant cumulative impact and, therefore, the impact would be **potentially significant and unavoidable.**

Impact CLM-2 (Alternatives A1 and B1): ***Operational Emissions of GHGs – Program-Level.*** Direct program-level GHG emissions from mobile, area, and stationary sources associated with Alternatives A1 and B1 would be minor (most operational emissions under Alternatives A1 and B1 would occur because of project-level actions, and are described separately in Section 7.3.4). Maintenance performed under Alternatives A1 and B1 would result in a minor increase in vehicle trips and associated GHG emissions from these mobile sources. The levee system would not require extensive landscape maintenance or other activities that would result in a substantial increased use of power equipment and associated GHG emissions. The project proponent would provide a complete quantitative project-level analysis of GHG emissions as part of the subsequent environmental review for each individual project. In addition, increased riparian habitat would be developed under this alternative. While the exact quantity of vegetation that would be developed is uncertain, any increase in vegetation could lead to increased carbon sequestration, effectively offsetting some of the GHG emissions created through operation and maintenance activities. Although uncertainty remains as to the operational GHG emissions that would occur as a result of Alternatives A1 and B1, the scope of these activities would not be anticipated to result in a considerable contribution to a significant cumulative impact and, therefore, the impact would be **less than significant**.

Alternatives A2 and B2

Program-level actions under Alternatives A2 and B2 with potential to create GHG emissions would include short-term construction and long-term maintenance activities in the Restoration Area.

Impact CLM-1 (Alternatives A2 and B2): ***Construction-Related Emissions of GHGs – Program-Level.*** This impact would be similar to Impact CLM-1 under Alternatives A1 and B1; however, the magnitude of construction activities would be greater under Alternatives A2 and B2 than under Alternatives A1 and B1 because of the additional levee work that would be needed to increase Reach 4B1 channel capacity to at least 4,500 cfs, resulting in additional GHG emissions. An estimation of GHG emissions from these activities is not possible at this time; however, it is likely that construction under Alternatives A2 and B2 could result in a considerable contribution to a significant cumulative impact and, therefore, the impact would be **potentially significant**.

Mitigation Measure CLM-1 (Alternatives A2 and B2): ***Implement All Feasible Measures to Reduce Emissions – Program-Level.*** This mitigation measure is identical to Mitigation Measure CLM-1 (Alternatives A1 and B1). This impact could be a considerable contribution to a significant cumulative impact and, therefore, the impact would be **potentially significant and unavoidable.**

Impact CLM-2 (Alternatives A2 and B2): ***Operational Emissions of GHGs – Program-Level.*** This impact would be similar to Impact CLM-2 under Alternatives A1 and B1; however, the magnitude of maintenance activities could be greater or less because of the potential for different levels of vegetation growth and maintenance requirements associated with routing all Interim and Restoration flows through Reach 4B1 under Alternatives A2 and B2. Although uncertainty remains as to the operational GHG emissions that would occur as a result of Alternatives A2 and B2, the scope of these activities would not be anticipated to result in a considerable contribution to a significant cumulative impact and, therefore, the impact would be **less than significant.**

Alternative C1

Program-level impacts from GHG emissions that would be expected to occur as a result of Alternative C1 would include those described for Alternatives A1 and B1. Additional GHG emissions would occur under Alternative C1 because of construction of a new pumping plant between the Merced River and the Delta for additional recapture capacity (additional operational emissions under Alternative C1 would occur because of recapture of Interim and Restoration flows, as described separately in Section 7.3.4).

Impact CLM-1 (Alternative C1): ***Construction-Related Emissions of GHGs – Program-Level.*** This impact would be similar to Impact CLM-1 under Alternatives A1 and B1; however, the magnitude of construction activities would be greater under Alternative C1 than under Alternatives A1 and B1 because of the construction of additional pumping infrastructure between the Merced River and the Delta. An estimate of GHG emissions from these activities is not possible at this time; however, it is likely that construction under Alternative C1 could result in a considerable contribution to a significant cumulative impact and, therefore, the impact would be **potentially significant**.

Mitigation Measure CLM-1 (Alternative C1): ***Implement All Feasible Measures to Reduce Emissions – Program-Level.*** This mitigation measure is identical to Mitigation Measure CLM-1 (Alternatives A1 and B1). This impact could be a considerable contribution to a significant cumulative impact and, therefore, the impact would be **potentially significant and unavoidable**.

Impact CLM-2 (Alternative C1): ***Operational Emissions of GHGs – Program-Level.*** This impact would be similar to Impact CLM-2 under Alternatives A1 and B1 (additional operational emissions under Alternative C1 would occur because of recapture of Interim and Restoration flows, as described separately in Section 7.3.4). Although uncertainty remains as to the operational GHG emissions that would occur as a result of Alternative C1, the scope of these activities would not be anticipated to result in a considerable contribution to a significant cumulative impact and, therefore, the impact would be **less than significant**.

Alternative C2

Program-level construction-related impacts from GHG emissions that would be expected to occur as a result of Alternative C2 would be the same as for Alternative C1. Program-level operational GHG emissions under Alternative C2 would be identical to those described for Alternatives A2 and B2 (additional operational emissions under Alternative C2 would occur because of recapture of Interim and Restoration flows, as described separately in Section 7.3.4).

Impact CLM-1 (Alternative C2): Construction-Related Emissions of GHGs – Program-Level. This impact would be similar to Impact CLM-2 under Alternative C2. An estimate of GHG emissions from these activities is not possible at this time; however, it is likely that construction under Alternative C2 could result in a considerable contribution to a significant cumulative impact and, therefore, the impact would be **potentially significant**.

Mitigation Measure CLM-1 (Alternative C2): ***Implement All Feasibility Measures to Reduce Emissions – Program Level.*** This mitigation measure is identical to Mitigation Measure CLM-1 (Alternatives A1 and B1). This impact could be a considerable contribution to a significant cumulative impact and, therefore, the impact would be **potentially significant and unavoidable.**

Impact CLM-2 (Alternative C2): Operational Emissions of GHGs – Program-Level. This impact would be similar to Impact CLM-2 under Alternatives A1 and B1 (additional operational emissions under Alternative C2 would occur because of recapture of Interim and Restoration flows, as described separately in Section 7.3.4). Although uncertainty remains as to the operational GHG emissions that would occur as a result of Alternative C2, the scope of these activities would not be anticipated to result in a considerable contribution to a significant cumulative impact and, therefore, the impact would be **less than significant.**

7.3.4 Project-Level Impacts and Mitigation Measures

This section provides a project-level evaluation of the direct and indirect effects of GHG emissions from project-level actions under the program alternatives. The project-level actions would directly affect GHG emissions by altering surface water deliveries to the Friant Division, and by altering operations at Friant Dam and at existing pumping facilities to recapture Interim Flows in the Restoration Area and in the Delta. The project-level actions also could affect GHG emissions indirectly through an increase in traffic volumes associated with expanded recreation opportunities in the Restoration Area.

No-Action Alternative

As discussed previously for program-level impacts, emissions of GHGs occur at local and landscape scales, but are distributed globally. As described in Section 7.1, GHG emissions have increased greatly over the past 100 years and are linked to increases in global temperature and other climate changes. The impact of these increased atmospheric concentrations of GHGs constitutes a substantial existing and ongoing adverse impact. As previously mentioned, analysis of the environmental effects of GHG emissions from the program alternatives is addressed as a cumulative impact analysis, only. Because the No-Action Alternative by definition cannot contribute to a cumulative impact, no significance determination is made for the No-Action Alternative.

Alternatives A1 Through C2

The following project-level impacts from GHG emissions would be expected to occur as a result of Alternatives A1 through C2.

Impact CLM-3 (Alternatives A1 through C2): ***Construction-Related Emissions of GHGs – Project-Level.*** No short-term construction activity or related GHG emissions would occur as a result of the release of Interim and Restoration Flows under Alternatives A1 through C2. Thus, there would be **no impact**.

Impact CLM-4 (Alternatives A1 through C2): ***Operational Emissions of GHGs – Project Level.*** GHG emissions from flow releases related to Alternatives A1 through C2 were evaluated and found to be substantial. As a result of project-level actions, GHG emissions could be increased through traffic from increased recreational visitors, and increased by increased groundwater pumping and changes in CVP/SWP energy generation and consumption. These impacts, as well as potential effects of the project that could offset or decrease GHG emissions, are discussed in greater detail below. Overall, this is potentially a considerable contribution to a significant cumulative impact and, therefore, the impact would be **potentially significant**.

Recreational activities related to additional water flows may increase; therefore, the number of visitors to the Restoration Area also would be expected to increase from current levels. Approximately 628 additional vehicles per day are expected to travel to the Restoration Area for recreation. Local residents (trips less than 20 miles) would account for 84 percent of additional trips and 16 percent would be attributed to nonlocal residents (trips of 100 miles). Using these estimates, an additional 2,627 mtCO$_2$e/year could be produced due to increased recreational opportunities. Project-level GHG emissions from mobile sources associated with Alternatives A1 through C2 would be less than the mobile source emissions in the Restoration Area.

Implementing Interim or Restoration flows under Alternatives A1 through C2 would not result in any new stationary or area sources of GHGs. Mobile GHG emissions could occur because of increased numbers of visitors to the Restoration Area. Hydroelectric power generation at the Millerton Hydroelectric Power Plant is expected to remain similar to existing conditions. Although carbon sequestration due to an increase in riparian vegetation is anticipated, the amount is uncertain and, thus, none was assumed in this analysis.

Alternatives A1 through C2 would result in increased use of groundwater pumps due to changes in water availability (as described in Chapter 13.0, “Hydrology – Groundwater”). Although 80 to 90 percent of the groundwater pumps in the Friant Division are operated with electric motors (CEC 2003, The California Center for Irrigation Technology 2002), potentially substantial GHG emissions could occur as an indirect result of increased groundwater pumping in the Friant Division. GHG emissions related to increased groundwater pumping were estimated using the General Reporting Protocol version 3.1 (CCAR 2009) developed by the CCAR, and also using emissions factors from eGrid (EPA 2011, The Climate Registry 2011). This estimate was based on the amount of electricity needed to operate groundwater pumps above what would occur under the existing conditions or the No-Action Alternative, as described in Chapter 19.0, "Power and Energy," and shown in Table 7-4 and 7-5.

If no water released as Interim and Restoration flows was recaptured under the action alternatives, and these supplies were entirely replaced through increased pumping of groundwater in the Friant Division, increased energy consumption could result in GHG emissions of up to 77,302 mtCO_2e/year above existing conditions under all action alternatives (77,187 mtCO_2e/year above the No-Action Alternative), as shown in Tables 7-4 and 7-5. These emission levels have been estimated to capture the maximum potential effects, and could potentially be lower, depending on water recapture and recirculation actions, and on the multiple sources of uncertainty in the basis of these estimates and assumptions applied in the analysis, as previously described.

Recapture of any flows through existing facilities in the Restoration Area and the Delta (Alternatives A1 through C2), through existing facilities on the San Joaquin River between Merced River and the Delta (Alternatives B1 and B2), or at new facilities on the San Joaquin River between Merced River and the Delta (Alternatives C1 and C2), would reduce the quantity of groundwater that could be pumped because of the release of Interim and Restoration flows and, therefore, reduce the maximum amount of GHG emissions anticipated to occur through groundwater pumping. The operation of existing or new facilities to recapture water on the San Joaquin River between Merced River and the Delta would also change CVP/SWP energy generation and consumption, as described in Chapter 19.0, "Power and Energy," and as shown in Tables 7-4 and 7-5. The maximum increase in net CVP/SWP operational GHG emissions anticipated under the action alternatives at the current level of demand would range from 26,974 mtCO_2e/year for Alternatives A1, A2, C1, and C2, to up to 28,214 mtCO_2e/year for Alternatives B1 and B2 above existing conditions. At the future level of demand, the maximum increase in net CVP/SWP GHG emissions anticipated would range from 22,943 mtCO2e/year for Alternatives A1 through B2, to 23,564 mtCO_2e/year for Alternatives C1 and C2 above the No-Action Alternative.

Table 7-4.
Greenhouse Gas Emissions from Energy Consumption Under Program Alternatives

Greenhouse Gas Emissions	Existing Level (2005)				Future Level (2030)			
	Existing Conditions	Alt A1 and A2	Alt B1 and B2	Alt C1 and C2	No-Action	Alt A1 and A2	Alt B1 and B2	Alt C1 and C2
Net CVP/SWP operational GHG emissions[1] (mtCO$_2$e/year)	186,958	213,932	215,172	213,932	335,470	358,414	358,414	359,034
Maximum Friant Division GHG emissions for groundwater pumping[2] (mtCO$_2$e/year)	168,499	241,150	238,843	233,116	168,615	241,151	238,041	229,725
Maximum GHG emissions, full recapture of Interim and Restoration flows[3] (mtCO$_2$e/year)	186,958	213,932	215,172	213,932	335,470	358,414	358,414	359,034
Maximum GHG emissions, no recapture of Interim and Restoration flows (mtCO$_2$e/year)	355,457	432,759	430,452	424,725	504,085	581,272	578,162	569,846
Maximum change in GHG emissions from existing conditions/No-Action Alternative (mtCO$_2$e)	NA	77,302	74,995	69,268	148,629	77,187	74,076	65,760

Notes:

[1] Quantities of net CVP/SWP operational GHG emissions are based on energy consumption, as described in Chapter 19.0, “Power and Energy.” Includes energy generation at Friant Dam.

[2] Quantities of net Friant Division GHG emissions for groundwater pumping are based on “High” groundwater pumping, as described in Chapter 12.0, “Hydrology – Groundwater,” and assumes that no water released as Interim and Restoration flows is recirculated to Friant Division long-term contractors.

[3] Includes energy generation within the CVP/SWP, including Friant Dam.

Key:
Alt = Alternative
CVP/SWP = Central Valley Project/State Water Project
GHG = greenhouse gas
mtCO$_2$e/year = metric tons carbon dioxide equivalent per year
NA = not applicable

Table 7-5.
Factors Used to Estimate Total Carbon Dioxide Equivalents

Factor	Carbon Dioxide	Methane	Nitrous Oxide
Emission Factor (lb/MWh)	681.01	0.02829	0.00623
Global Warming Potential	1	21	310

Sources: EPA 2011, The Climate Registry 2011.

Key:
lb/MWh = pounds per megawatt-hour

In addition to changes in energy consumption and associated emissions of GHGs, the action alternatives have the potential to directly or indirectly offset GHG emissions through changes in land use and vegetation. Fallowing or idling of cropland that could occur as an indirect result of the project would likely result in a net reduction in emissions from reduced operation of machinery and reduced fertilizer use. Long-term sequestration from fallowing of farmland would be negligible because any carbon sequestered during the fallowing period would likely be released within a few years of the land being brought back into cultivation. The reduction in acres planted would reduce the amount of fertilizer and heavy-duty farming equipment operations in the SJVAB. Using the U.S. GHG Cropland Calculator (MSU 2011), fallowing of 1,000 acres of land in Fresno County, California, would result in an overall reduction of 383 $mtCO_2e$/year. This calculation includes emission factors from reduced fuel, fertilizer, N_2O, and soil emissions (see Appendix H, "Modeling," for a complete breakdown of emission factors for each individual component). Project-level GHG emissions from Alternatives A1 through C2 would therefore likely be beneficial in terms of net GHG emissions resulting from the fallowing of agricultural acreage.

An increase in carbon sequestration by riparian vegetation in the Restoration Area is also anticipated. Reoperation of Friant Dam could potentially result in nearly 1,700 acres of additional riparian forest (see simulated increases in Appendix N "Geomorphology, Sediment Transport, and vegetation Assessment," and existing acreages in Chapter 6, "Biological Resources – Vegetation and Wildlife"). Because riparian forest sequesters an estimated 53 $mtCO_2e$/year per acre over a 10-year period (COLE Development Group 2011), riparian restoration could offset more than 9,129 $mtCO_2e$/year in the study area during the first decade following reoperation of Friant Dam. However, because ongoing levee maintenance and other management activities may conflict with development of much of this riparian forest, it is difficult to estimate exactly how much riparian forest would be developed. Thus, conservatively, no net increase in riparian carbon sequestration is assumed.

As a result of project-level actions, GHG emissions could be reduced by up to 383 $mtCO_2e$/year from idling of agricultural fields, increased by up to 2,627 $mtCO_2e$/year from increased numbers of recreational visitors, and increased by up to 77,302 net $mtCO_2e$/year emissions from increased groundwater pumping and changes in CVP/SWP energy generation and consumption. Although it is not assumed to occur in this analysis, GHG emissions could be offset by up to 9,129 $mtCO_2e$/year from sequestration in riparian vegetation, depending on the amount of riparian habitat restored.

Overall, GHG emissions from operational activities from project-level activities would increase by a maximum of 77,302 $mtCO_2e$/year. These emission levels have been estimated to capture the maximum potential effects, and could potentially be much lower. In addition, and as previously discussed, multiple sources of uncertainty in the basis of these estimates and assumptions are applied in the analysis.

With respect to the significance criteria established at the beginning of this section, and based on the analysis above, the action alternatives would:

- **Not have the potential to conflict or be inconsistent with plans to reduce or mitigate GHGs** – The action alternatives would not have the potential to conflict or be inconsistent with plans to reduce or mitigate GHGs. Project-level actions are not explicitly addressed in existing plans to reduce or mitigate GHGs; therefore, project-level actions would not be in conflict with or inconsistent with those plans, because the project-level actions would not preclude the attainment of the goals or objectives of applicable plans. For example, this project would not affect the sectors addressed by AB 32 such that a goal or objective of the plan would no longer be attainable. According to this significance criterion, project-level impacts would be less than cumulatively considerable.

- **Could result in GHG emissions that would be large in comparison to the amount of GHG emissions for major facilities that are required to report GHG emissions** – The maximum estimated GHGs emitted under the action alternatives indicate that emissions would be substantially larger than 25,000 $mtCO_2e$/year. According to this significance criterion, project-level impacts could be cumulatively considerable.

- **Would have limited potential to contribute to a lower carbon future** – Development of riparian vegetation and potential fallowing or idling of agricultural land could potentially reduce GHG emissions. These reductions are unlikely to offset all of the increased emissions from the release and recapture of Interim and Restoration flows under the alternatives. Therefore, the action alternatives would have limited potential to contribute to a lower carbon future (e.g., increased sequestration through increased riparian vegetation). According to this significance criterion, the project-level impacts could be cumulatively considerable.

Because the action alternatives could result in GHG emissions that would be large in comparison to the amount of GHG emissions for major facilities that are required to report GHG emissions and because this impact would have only a limited potential to contribute to a lower carbon future, it could result in a cumulatively considerable contribution to a significant cumulative impact and, therefore, the impact would be potentially significant.

Mitigation Measure CLM-1 (Alternatives A1 through C2): ***Implement All Feasible Measures to Reduce Emissions – Project-Level.*** Reclamation will implement applicable mitigation strategies to reduce GHG emissions. Mitigation strategies that may be applicable include those shown in Table 7-6.

Table 7-6.
Potential Mitigation Strategies

Mitigation Strategy	Mitigation Mechanism
Renewable Energy Generation projects	Reduce emission rates through sources such as solar, wind, hydroelectric, geothermal, biomass, or tidal
Carbon Offset Purchasing	Would fund projects to reduce emissions or sequester carbon through an offset program certified by the California Air Resources Board or comparable entity
Sequestration Projects	Would remove carbon directly from the atmosphere

In addition to mitigation measures that Reclamation will implement to reduce GHG emissions, existing or future regulatory programs may further reduce GHGs emitted as a result of the project-level actions. Existing regulatory programs with the potential to influence future conditions, and future regulatory programs aimed at reducing GHG emissions and improving energy efficiency throughout the State, are listed in Table 7-7.

Table 7-7.
Existing and Future Regulatory Programs

Regulatory Program	California Regulatory Authority
Energy Efficiency	AB 32
Renewables Portfolio Standard	AB 32, SB 1078, SB 107, EO S-14-08
Renewable Electricity Standard	AB32, SB 1078, SB 107, EO S-14-08, EO S-21-09, ARB Resolution 10-23
California Cap-and-Trade Program	AB 32
High GWP Reductions from Stationary Sources	AB 32, 17 CCR Section 95320 – 95326, 95340 – 95346
Mitigation Fee on High GWP Gases	AB 32

Key:
AB = Assembly Bill
ARB = California Air Resources Board
CCR = California Code of Regulations
EO = Executive Order
GWP = global warming potential
SB = Senate Bill

GHG emissions that would result from the project-level actions after implementation of this mitigation measure would be less than the maximum estimated amount, but the emissions that would ultimately occur remain uncertain. Given the uncertainty of ultimate emissions, and their potential magnitude, this impact could result in a considerable contribution to a significant cumulative impact and, therefore, the impact is assumed to be **potentially significant and unavoidable**.

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Chapter 8.0 Cultural Resources

This chapter describes the environmental and regulatory settings of cultural resources, as well as environmental consequences and mitigation, as they pertain to implementation of the program alternatives. The discussion of cultural resources conditions and the potential impacts of the program alternatives on cultural resources encompasses the San Joaquin River upstream from Friant Dam, the Restoration Area, and along the San Joaquin River downstream from the Restoration Area. Implementation of the Settlement is not anticipated to cause impacts to cultural resources in the Delta or in CVP/SWP service areas. Therefore, these areas were eliminated from detailed environmental analysis.

More detailed discussion, including methods employed, is presented in the archaeological and historic architectural technical report (Byrd et al. 2009) and the Native American ethnographic report (Davis-King 2009) prepared for SJRRP. Neither of these reports are publically available documents, as they contain confidential information on the location of cultural resources.

8.1 Historic Context

Cultural resources are defined as prehistoric and historic-era archaeological sites, Traditional Cultural Properties, Sites of Religious and Cultural Significance, and architectural properties (e.g., buildings, bridges, and structures). This definition includes historic properties as defined by the National Historic Preservation Act (NHPA). The study area for this resource includes the San Joaquin River upstream from Friant Dam, the San Joaquin River from Friant Dam to the Merced River (Restoration Area), and the San Joaquin River from the Merced River to the Delta. Since no construction activities or changes in the landscape would occur in the Delta or SWP/CVP service areas under the program alternatives, these geographic areas are not considered further in this analysis.

The following discussion summarizes the historic context of the Restoration Area.

8.1.1 Prehistoric Era

Prehistoric archaeological investigations have been limited within the San Joaquin River area of the Central Valley and this area is considered by many to be one of the least understood regions in California, with respect to prehistoric conditions (Moratto 1984, Riddell 2002, Rosenthal et al. 2007). As a result, archaeologists working in this area have been forced to borrow chronologies from nearby areas, particularly the foothills to the west (the eastern foothills of the Diablo Range) and to the east (the western slope of the Sierra Nevada) (Moratto 1972, Olsen and Payen 1969). These investigations of the western Sierra Nevada foothills have resulted in the formulation of local chronologies, notably the Chowchilla River/Buchanan Reservoir sequence.

Native American prehistoric occupation of the region began near the end of Pleistocene (circa 13,500 years ago) and continued until Spanish contact (in the late 1700s) (Rosenthal et al. 2007). Terminal Pleistocene (13,500 to 11,600 years ago) occupation in the region is represented by wide-ranging, mobile hunters and gatherers who periodically exploited large game. Throughout California, the prehistoric conditions of the Terminal Pleistocene are minimally represented and poorly understood. However, there is a probable Terminal Pleistocene site near Tulare Lake at the southern end of the Central Valley, and isolated artifacts dating to this era have been recovered within this area (Moratto 1984:81-82, Riddell and Olsen 1969).

Evidence of early Holocene (11,600 to 7,700 years ago) human settlement is only rarely encountered in the Central Valley (Rosenthal et al. 2007). Infrequent early Holocene sites in the foothills appear to have been seasonally occupied and include a robust ground stone assemblage focused on the processing of nuts. The lack of documented Central Valley early Holocene sites is undoubtedly due to sedimentation that has buried paleosurfaces of the time period (Rosenthal and Meyer 2004). In the foothills, middle Holocene (7,700 to 3,800 years ago) sites are dominated by expedient cobble tools for various purposes including grinding, chopping, and pounding, and preserved plant remains are mainly represented by acorns and pine nuts. A relative lack of middle Holocene evidence in the Central Valley is due in large part to the archaeological record being deeply buried by later sedimentation. Well-dated sites of this age in the Central Valley are typically in buried contexts.

By 4,500 years ago, distinctive lowland and upland adaptive patterns emerged in the region (Rosenthal et al. 2007). Throughout the late Holocene (after 3,800 years ago) the Central Valley was characterized by a complex socioeconomic strategy focused on riverine and marsh resources and extremely elaborate material culture (Moratto 1984). Notable attributes included dart points, mortars and pestles; use of acorns and pine nuts; new fishing technologies and numerous fish remains; basketry and cordage; ceramic items; diverse personal accoutrements of stone, bone and shell; and large, formal cemeteries areas.

Around 2,300 years ago, large populations were concentrated in major settlements along the San Joaquin River. Material culture included large dart points, mortars and pestles, milling stones, and bone spear points. Subsistence was concentrated on hunting and fishing and, based on secondary evidence, included hard seeds, with more limited use of acorns. Wide-ranging trade networks are documented and a non-egalitarian social organization and ascribed status may have emerged. With extended occupation at key settlements, large mounded villages were created. By 500 years ago populations were much higher than previously, and noted developments in material culture include smaller arrow points and new types of items of personal adornment.

8.1.2 Native Peoples at the Time of European Contact

At the time of contact with European settlers, the study area was occupied by the Northern Valley Yokuts, who had lived in the region for some 4,500 years (Kroeber 1925; Latta 1949, 1977; Powers 1877; Wallace 1978). The Yokuts were hunter-gatherers who divided themselves into named tribes, each with a dialect, territory, and discrete settlements. Each tribe was politically autonomous and occupied a permanent area, usually on high ground along a major drainage course. The San Joaquin River and its main eastern tributaries formed the core of the Northern Valley Yokuts' homeland. Settlements west of the river tended to be in the foothills, concentrated along watercourses.

According to fragmentary information, the Yokuts exploited local subsistence resources from principal villages located on or near the San Joaquin River and other major streams (Cook 1955, 1960; Gayton 1936; Wallace 1978). Villages were composed of large, semisubterranean, round or oval dwellings. Some of the more major establishments also included larger communal dance houses. These villages were supported to a large extent by the riverine resources and by a variety of terrestrial plants, most importantly the acorn. Occupation was essentially sedentary, with dispersals occurring only seasonally for the acquisition of particular resources (Wallace 1978). Trade was focused along the river, where tule rafts were used for transportation. The Yokuts reportedly traded dogs to their Miwok neighbors in exchange for baskets and blankets. They acquired abalone and mussel shells from the coast and obsidian from the eastern slope of the Sierra Nevada.

Yokut populations at the time of Spanish contact have been estimated at about 41,000, with perhaps 5,000 living along the east side of the valley between the Merced and Kings rivers (Cook 1955:52). These numbers dropped drastically as native people here and throughout California were decimated by European and Euro-American diseases in the early nineteenth century and by the tremendous influx of nonnative people during the local gold-mining period from the mid-nineteenth and into the twentieth centuries (Wallace 1978). Today there are still several bands of Yokuts Indians living in the San Joaquin Valley, though none are known to practice the traditional, pre-contact way of life.

8.1.3 Historic Era

For some time only sporadic interaction took place between Native Californians and Europeans (Beck and Haase 1974, Clough and Secrest 1984, Hayes 2007). The first Spanish expedition into the San Joaquin Valley was led by Pedro Fages in 1772 who sought a new route between San Diego and Monterey. In the 1820s, the objective of inland expeditions had changed from scouting new mission sites to punitive forays against the San Joaquin Valley Indians, both Yokuts and Miwoks. The Indians had engaged in sorties on missions, towns, and ranchos to steal livestock for food and transportation since the early 1800s. A cycle of raids and reprisals across the coastal mountains continued until American settlers took up permanent residence in the valley in the mid-1840s (Beck and Haase 1974, Broadbent 1974, Cook 1976).

While Mexican troops engaged in punitive expeditions against the San Joaquin Valley tribes, American trappers and explorers made their first journeys into the region. The first was Jedediah S. Smith in 1827. Other trappers from the Hudson's Bay Company passed through the Central Valley, as well as Kit Carson and Peter Ogden Skene. Perhaps the most famous explorer in the region at this time was John C. Fremont who was in the vicinity in 1844 (Clough and Secrest 1984, Fremont 1852, Smith 1977). Fremont also remarked on the abundance of wild horses on the west side of the San Joaquin River, and the difficulty of travel because of the swampy terrain and sloughs.

Two small Spanish settlements developed in the study area near Fresno Slough in the early decades of the 1800s called *Pueblo de Las Juntas* and *Rancho de los Californios* (California Ranch) (Clough and Secrest 1984, Durham 1998, Wallace 1978). Officially sanctioned colonial settlement of the San Joaquin Valley began in the 1840s when the Mexican government issued its first land grants to individuals who petitioned for land. Two Mexican ranchos were successfully patented at the northwest end of the study area on the west side of the San Joaquin River (Rancho Sanjon de Santa Rita and Orestimba Rancho), and a third claim in the foothills near Friant was rejected (Rancho Rio del San Joaquin).

In response to the gold rush, Americans quickly built a line of towns and roadside stations north and south across the 250-mile floor of the San Joaquin Valley, with Stockton as the central distributing point (Moehring 2004). The few towns in the study area established during the second half of the nineteenth century all have their origins as favorable places to cross the San Joaquin River. A few were later sustained by agriculture or industry. For example, the settlement at the current site of Friant, on the San Joaquin River just below the Friant Dam, began as a ferry crossing on the San Joaquin River around 1854. Beginning in the early twentieth century, gravel mining emerged as a major industry in the vicinity of Friant; several companies opened mines and the town benefitted economically. Boom times came with the construction of Friant Dam in the 1940s and gravel mines have continued to operate into recent years.

During the 1870s, the Central Pacific Railroad, and later the Southern Pacific Railroad, spawned a network of some 50 railroad stations, of which 24 became railroad town sites. About eight of these town sites became strategic trading centers stretching from Stockton south to Bakersfield; among them were towns in and near the study area at Merced (1871), Sycamore (1872), and Fresno (1872). The modern day town of Herndon, about 10 miles northwest of downtown Fresno on the banks of the San Joaquin River, was originally known as Sycamore and had its start as a railroad station stop on Southern Pacific’s rail line along the east side of the San Joaquin Valley. Other early settlements emerged in the Central Valley more as a consequence of the Stockton-Los Angeles Road and Butterfield Overland Stage Company line, which ran between the major urban centers of the state. For example, the town of Firebaugh in the western part of the study area on the San Joaquin River began in 1852 when a ferry was built at the site; it later had a toll road from the river crossing and a stage route also passed through Firebaugh.

Gold in the southern Sierra Nevada Foothills attracted the first large influx of settlers to what is now Madera, Merced, and Fresno counties beginning in 1849. Towns like Millerton, now under Millerton Lake, were established at this time. Soon thereafter, settlers began to occupy the eastern San Joaquin Valley in this area. These were luckless miners and newcomers who recognized the agricultural potential of the valley and the need for food in the mining camps. Numerous individuals purchased land and established ranches on the vast and largely vacant plains by the mid-1850s. Although private ranches of several hundred acres existed, much of the land was unreserved public domain and cattle grazed freely on an open range from the Sierra Nevada Foothills to the Coast Range.

Livestock ranching grew and prospered into the late 1860s. A large number of immigrants from the Ohio Valley and Missouri settled in the San Joaquin Valley during this era; many drove cattle with them across the plains from the Midwest. Along with their cattle, they brought with them the Anglo ranching traditions from the Midwest characterized by favoring European breeds, keeping fenced pastures, raising hay for winter feed, maintaining mixed herds of dairy cows and beef cattle, practicing selective breeding, and employing Anglo cowboys and ranch hands. Immigrants also established farms on the plains between the foothills and San Joaquin River lowlands where they primarily raised wheat during the 1860s and 1870s.

The need for water to irrigate the arid San Joaquin Valley became a priority for the economic development of Central Valley towns, especially those laid out along Southern Pacific's railroad track. In 1873, the California State Legislature passed a "No Fence Law," which established agriculture's dominance over ranching. By the late 1880s small-scale irrigated agriculture was in the ascendancy and irrigation companies, colonies, and districts were formed to help promote agriculture, for which the first canals were completed in the 1870s. Passage of the Wright Act in 1887 provided a legal mechanism for landowners to create public irrigation districts and finance major irrigation works to divert water from the major streams flowing west from the Sierra. Successful irrigation enterprises, including land colonies, in the Central Valley allowed specialty crop agriculture to flourish and redefined the region's economy (Tinkham 1923). While crops such as grapes continued to be common in the early twentieth century, the small farm tradition established by the agricultural colonies began to fade.

Early agriculture on the lower part of the study area was dominated by the huge cattle ranching operation conducted by Henry Miller and Charles Lux. Miller and Lux developed massive ranching and farming operations on their property along the San Joaquin River lower (downstream from Mendota) portion of the study area, including 140,000 acres in Madera County, more than 150,000 acres in Fresno County, and more than 250,000 acres in Merced County. Miller and Lux also became owners of a host of related subsidiary businesses, including stores, banks, hotels, irrigation systems, and public utilities. Miller and Lux were also pioneers in making use of a large-scale industrial labor force employed in a rural and agricultural setting.

Some of the oldest and most important irrigation works constructed within the study area were built in the lower part of the study area and west of the San Joaquin River in 1871. The central unit of this vast canal and ditch system, constructed by Miller and Lux, was the so-called "Main Canal" of the San Joaquin and Kings River Canal and Irrigation Company. The Main Canal was the first canal built in Fresno County and one of the earliest large irrigation canals in California (Wallace W. Elliot and Co. 1882). The Main Canal was unique in that it required large amounts of capital and engineering skill, and irrigated thousands of acres. Its construction and success contributed to the nineteenth century agricultural development on the west side of the San Joaquin Valley (Jackson et al. 1990, Harding 1960, Pisani 1984). Miller and Lux also built the Dos Palos and

Temple Slough canals by 1882 from the west bank of the San Joaquin. Over time, canals became increasingly important and extensive.

Irrigation districts started in California after passage of the Wright Act in 1887, which allowed for public tax-supported and democratically controlled irrigation districts. Progressive legislation passed in 1911 through 1913 increased State supervision over district organization and financing and made investing in irrigation district bonds more attractive. Demand for agriculture products also grew around this time and remained high throughout World War I. These conditions contributed to a flurry of district formation in California and to the formation of the Fresno Irrigation District and the Madera Irrigation District.

The CVP was devised by the State, and ultimately built by the Federal government, to resolve California's chronic water shortage problem. Studies undertaken between 1927 and 1931 resulted in a plan calling for a vast system of canals, massive dams, and reservoirs throughout the state, including most of what became the CVP (Hundley 1992). In 1935, Reclamation was charged with construction of the CVP, which was completed in the early 1950s (Cooper 1968, Hundley 1992, Reclamation 1981). Reclamation designed the CVP as five fundamental units, operating as an integrated system: Shasta Dam, the Delta-Mendota Canal, Friant Dam, the Madera and Friant-Kern canals, and the Contra Costa Canal. The core of the system involved the coordinated operation of the other four units for the purpose of delivering Sacramento River water to the arid San Joaquin Valley.

Other water-related projects also flourished in the twentieth century. These include the San Joaquin Hatchery, which is situated 1 mile below the Friant Dam, and extensive levee construction to minimize flooding. Major levee construction efforts to minimize flooding along the lower San Joaquin River were related to state-wide flood control efforts. In 1913, with formation of the Sacramento and San Joaquin Drainage District, the San Joaquin River and its tributaries also came under jurisdiction of a Federal flood control plan (Bonte 1931). Flood control works on the San Joaquin River in the study area did not begin to take shape until after World War II when the California State Reclamation Board began purchasing easements and rights-of-way for large overflow areas along the San Joaquin River. In 1955, the State created the LSJLD, which acted as a liaison with USACE, the California State Reclamation Board, and DWR regarding construction of the Lower San Joaquin Flood Control Project. Important aspects of the Lower San Joaquin Flood Control Project include the Chowchilla Bypass, the Eastside Bypass, and the Mariposa Bypass, all of which were completed by 1966 (California State Reclamation Board 1966, Hedger 1960).

Throughout the historic era, transportation was an important focus of infrastructure development. Over time, foot travel and transportation by horse or stage coach gave way to river, railroad, and ultimately automobile travel. In the early decades of the twentieth century the popularity of the automobile led to road improvements and a new State road building program. The main arterial along the eastside of the valley became the Golden State Highway in 1913 and then SR 99. Around the same time, the east/west SR 152 was also built, which crosses the study area in the vicinity of Santa Rita Park. The north/south running Madera Avenue SR 145 also crosses the San Joaquin River.

8.1.4 San Joaquin River Upstream from Friant Dam

Surveys of the Millerton Lake State Recreation Area (SRA) have identified 19 sites that lie below the maximum water level and above the low water level of Millerton Lake (Byrd and Wee 2008, Theodoratus and Crain 1962). These are all prehistoric sites, including 13 bedrock milling sites, 4 residential sites, and 1 lithic scatter. The most notable of these is MAD-98, since it was previously excavated (Hines 1988).

These sites are currently seasonally inundated by Millerton Lake; the sites may be completely submerged, partially submerged, or not submerged at all depending on the water levels in Millerton Lake. Currently, only two known sites (MAD-8 and FRE-71) are fully inundated by the lake at all times. Both are large prehistoric residential sites recorded by Hewes in the 1930s (1941). Unrecorded sites may also exist.

8.1.5 San Joaquin River from Friant Dam to Merced River

This section discusses known cultural resources within the Restoration Area.

Ethnographic Compilation Results

Based on both historic and current ethnographic information, and upon information supplied by Native Americans at a series of meetings, there are several places in the Restoration Area of importance to the various Yokuts tribes in particular (Davis-King 2009). Of primary significance is the Dumna “place of origin” cave that is rooted in oral history and current ceremony. This location has several associated “sites” where ceremonial activities occur, and where the people fished for salmon. Salmon fishing places appear to have the greatest number of sites in the Restoration Area, and some were known as central council or meeting places for a number of tribes. Burial areas, some of which are large formal cemeteries, and some for individual families, are known. Some of the sites are close to the river. Major areas of resource concentrations appear to be in Firebaugh, Friant, the lower river from Fremont Ford to the Stanislaus County line, Herndon, Lanes Bridge, various current and former river alignments in the Sanjon de Santa Rita, and a number of sloughs and river locales north of San Luis Island.

For the most part, Native Americans were reluctant to reveal specific site locations for this stage in the SJRRP, preferring to provide information for construction-related actions during anticipated subsequent site-specific studies of individual projects.

Historical Compilation Results

Historic resources for this analysis were identified solely through archival documentation. No new fieldwork was used to confirm the presence or absence of sites, nor has any new survey evaluation work been done to assess significance of existing historic-period resources within the Restoration Area.

Historic period resources identified through formal recordation on site records, property inventory forms, or though other state or local landmark inventory programs are referred to in this evaluation as “known” or “previously recorded” resources. In order to develop a sensitivity assessment, archival research and historic mapping were undertaken. The presence or integrity of historic period architectural resources identified only through archival research and historic mapping is unknown, and these are referred to in this evaluation as “identified resources.”

Cultural resource archival records are relatively limited within the Restoration Area (Byrd et al. 2009). Based largely on the Central California and San Joaquin Valley Information Centers records search results, 213 cultural resources studies have been documented. Archaeological surveys have inventoried 12 percent of the Restoration Area, as summarized in Table 8-1.

Table 8-1.
Summary of Cultural Resources Results by Reach in the Restoration Area

Resource	**Reach**					**Bypasses**	**Total**
	1	**2**	**3**	**4**	**5**		
Acreage	47,883	23,667	23,600	43,821	17,678	12,750	169,399
Archeological Survey	24.6%	5.1%	1.6%	9.7%	8.3%	11.7%	12.25
Recorded Archaeological Sites (Resources with trinomials)							
Historic	15	1	0	2	0	0	18
Prehistoric	42	7	0	12	18	5	84
Prehistoric/Historic	5	0	0	2	0	0	7
Total	62	8	0	16	18	5	109
Recorded Historic Architecture							
Primary Number Only[1]	20	0	1	1	3	0	25
Caltrans Bridge Inventory	4	0	0	0	1	0	5
Partially Documented	10	0	0	0	0	0	10
Archaeological Sites with Architecture [2]	3	1	0	2	0	0	6
From Fresno County Historic Places List [3]	--	--	--	--	0	0	10
Total	37	1	1	3	4	0	56
Potential Prehistoric Surface Site Distribution[4]							
Using Survey Results by Reach	171	59	52 d	82	156	17	536
Buried Prehistoric Site Potential[6]							
Very Low-Low	31%	41%	14%	41%	38%	73%	35%
Moderate	0%	0%	6%	20%	4%	22%	8%
High-Very High	57%	54%	78%	37%	55%	3%	51%
Potentially Sensitive Historic-Era Archaeological Sites							
Number	139	20	23	26	6	0	214
Percent	65%	9.3%	10.7%	12.1%	2.8%	0%	99.9%
Potential Historic-Era Architectural Resources							
Number	841	90	101	94	121	14	1,242
By Weighted Value	942	123	141	138	121	13	--

Notes:

[1] Primary number only indicates limited information recorded at these sites

[2] Also counted in archaeological site numbers.

[3] Locations uncertain

[4] Conservative estimate - higher densities indicated by landform age data

[5] Average density for Reaches 2 and 4 (2.2) used to generate this value

[6] Potential determined based on the age of the landform and the probability that any one spot on that landform was occupied at some time in the past.

Key:

-- = Not Available

% = percent

Known and Recorded Resources

A total of 109 archaeological sites have been recorded within the Restoration Area, as shown in Table 8-1 (Byrd et al. 2009). This includes 84 prehistoric sites, 18 historic-era sites, and 7 sites with both historic-era and prehistoric components. Most are concentrated in Reach 1 (57 percent) where inventory efforts have been the most rigorous, while Reach 3 lacks documented sites (with only 2 percent surveyed).

The components of the 84 prehistoric sites include 35 major residential sites, 11 residential sites, 28 bedrock milling localities, 11 artifact scatters, 3 artifact scatters with bedrock milling, 2 lithic scatters, and 1 site with a single house pit (individual sites may include multiple components). Seven of the major residential sites have mounds, 21 have house pit depressions on the surface, and 17 have human remains. Human remains have also been noted at six other sites.

The components of the 18 historic-era archaeological sites include eight refuse deposits, seven structural remains, four structural remains with refuse deposits, four water-related resources (two check dams, one ditch, and one canal with refuse), and two railroad grades (individual sites may include multiple components). Those with structural remains include residential and commercial buildings, the Dickerson's Ferry, and ranches.

Excavations have taken place at 13 sites, including nine prehistoric sites, two historic-era sites, and two sites with prehistoric and historic-era components. Notably, investigations at five prehistoric sites (major residential sites with thick midden deposits, diverse artifact assemblage, and numerous burials) have provided insight into the outstanding potential for prehistoric sites within the Restoration Area to contribute significantly to the prehistory of one of the most poorly understood regions within California.

The historic architectural database was compiled from site records and Department of Parks and Recreation 523 forms provided by the Information Centers, California Historic Information System list of historic resources, county historic resource inventories, and state historic landmark programs. Only 10 projects have contributed records on historic architecture. It is possible that additional studies, particularly under CEQA, have been carried out but have not been submitted to the Information Centers.

Sensitivity Assessments

Distinct approaches to assessing sensitivity were applied to prehistoric archaeological sites, historic-era archaeological sites, and historic-era architectural resources. The details of the methods employed for assessing cultural resource sensitivity are presented in Byrd et al. (2009).

- **Prehistoric Surface Sites –** Prehistoric surface site densities are relatively low and highly patterned by landform, based on the results of archaeological survey. Middle Holocene landforms have the highest site density (20 per 1,000 acres), followed by early Holocene and latest Holocene-Modern landforms (four per 1,000 acres), while late Holocene and Pleistocene-and-earlier landforms have much lower densities (two to three sites per 1,000 acres). Landform age distribution also varies greatly throughout the Restoration Area; for example, middle Holocene landforms are concentrated in Reach 4. Based on survey results, site densities are highest in Reach 5, and lowest in the Bypass Reach. It is anticipated that full inventory would document between 500 and 800 surface sites.

- **Prehistoric Buried Sites –** The potential for buried archaeological deposits within the study area was determined based on the mapped distribution of different Quaternary-age landforms (those formed in the last 1.6 million years). Buried site potential was determined based on the age of the landform and the probability that any one spot on that landform was occupied at some time in the past. Over half of the Restoration Area appears to have a high to very high potential for buried sites. This is because large portions are covered by latest Holocene-Modern (36 percent) and late Holocene (15 percent) landforms. These results suggest that the low surface site densities in the Restoration Area may be largely due to alluviation that has buried much of the archaeological record (notably sites dating from the latest Pleistocene through the middle Holocene). Hence differential sensitivity for encountering surface and buried prehistoric sites is contextual within this large Restoration Area, but landform age appears to be the most appropriate tool for assessing localized sensitivity.

- **Historic-Era Sites –** Owing to the minimal number of recorded sites, the historic-era sensitivity analysis included known sites and potential archaeological sites based on documentary research. Of 1,024 potential archaeological resources, 214 are assessed as potentially sensitive historical archaeological properties. These include 92 that predate 1915, 119 agricultural properties dating from 1915 to 1950, two 1930s labor camps, and a Japanese Assembly Center. The remaining 810 potential site locations, all dating after 1915, were considered unlikely to contain significant information. Overall, agricultural properties (64 percent) dominate the potentially sensitive sites, followed by residences (22 percent), and towns and settlements (10 percent). Most of these are concentrated in Reach 1 (65 percent). Reaches 2 through 4 contain from 9 percent to 12 percent of these potential resources, Reach 5 has less than 3 percent, and the Bypass Reach has none.

- **Historic Architecture –** The number of “identified resources” outweighs the “known resources” by a ratio of approximately 22 to 1, with identified resources numbering 1,242 and previously recorded resources totaling 56. In large part, this great discrepancy is explained by the limited number of historic property survey reports undertaken within the 169,398-acre Restoration Area. The 1,242 localities with potential historic architecture are dominated by buildings and structures, followed by transportation infrastructure and water-related engineering features (comprising 93 percent). Homestead patents make up 5 percent, with the remaining 2 percent including mining, recreation, private land grants in the pre-statehood era; and miscellaneous elements, such as cemeteries, land colonies, and historic settlements. The sensitivity assessment used a qualitative ranking by assigning a numerical value to each potential resource based upon three main variables: (1) estimated construction (2) assumed presence or absence at the end of the historic period and (3) known historic association. Reach 1 has the highest sensitivity, Reaches 2, 3, 4, and 5 have appreciably less potential by a ratio of about 7 to 1, and the Bypass Reach has far less potential at a ratio of 70 to 1.

Potential Resources Eligible for Inclusion in the National Register

Five previously recorded resources have been determined eligible for the National Register of Historic Places. All are architectural resources: Mendota Dam (P-10-03200); Merced River Bridge (P-24-00724); Madera Canal (P-20-02308), Friant-Kern Canal, and Friant Dam. While the latter three resources contribute to the overall proposed Central Valley Project multiple property listing currently being undertaken by Reclamation, the Friant-Kern Canal and Friant Dam have also been found individually eligible for listing in the National Register. No individual archaeological sites are currently listed on the National Register, although one site, CA-MER-415 has been determined eligible.

A programmatic approach for evaluating cultural resources within the Restoration Area was presented. Salient research domains useful for assessing the significance and eligibility for nomination were identified separately for prehistoric and historic archaeological sites. For surface prehistoric sites, residential sites have the highest likelihood for being evaluated as eligible for inclusion in the National Register. Most of these sites are Late Holocene in age, and most of the archaeological record dating between 4,000 and 12,000 years ago lies buried by later alluvium. In contrast to surface sites, a more varied range of site types in buried contexts are more likely to be evaluated as eligible for the National Register since they would fill important data gaps in understanding the region’s prehistory.

Agriculture sites (64 percent) and residences and towns (32 percent) dominate the potentially eligible historic-era archaeological sites. Most of the former date to between 1915 and 1950, while potentially eligible residences and towns all predate 1915. Although these property types were given greater weight, all potential types of archaeological properties were discussed with respect to their ability to address significant research questions and the appropriate data sets to do so.

8.1.6 San Joaquin River from Merced River to the Delta

The only potentially significant effect to cultural resources in this geographic area would be from ground-disturbing activities associated with new pumping and conveyance facilities proposed as part of Alternatives C1 and C2. Since siting of these facilities has not occurred, it would be too speculative at this time to estimate what cultural resources may occur in the affected area of this large geographic area. Consequently, information would be collected and presented as part of future project-level analyses of the pump station and conveyance facilities.

8.2 Regulatory Setting

Under Federal and State law, effects to significant cultural resources (e.g., archaeological remains, historic-period structures, and traditional cultural properties) must be considered as part of the environmental analysis of a proposed project. Criteria for defining significant cultural resources are included in 36 CFR Part 63 (Determinations of

Eligibility for Inclusion in the National Register of Historic Places); the NHPA of 1966, as amended (NHPA; 16 USC 470 et seq.); and CEQA (CEQA, revised 2005). In addition, 36 CFR 800 outlines the compliance process for Section 106 of the NHPA.

8.2.1 Federal

Under the NHPA, the lead Federal agency must consider effects to eligible or unevaluated resources ("historic properties") from the proposed undertaking, in consultation with the State Historic Preservation Officer (SHPO). This includes identification (usually through archival research, field inventories, public interpretation, and/or test evaluations) of cultural properties eligible for the National Register, assessment of adverse effects to eligible properties, and development of mitigation measures to offset those effects. The revised regulations emphasize consultation with appropriate Native American communities, in the case of prehistoric or ethnographic properties, or traditional cultural properties, and the preparation of Memoranda of Agreement (MOA) among all involved agencies and parties.

8.2.2 State of California

Under CEQA, the lead agency must consider potential effects to important or unique cultural resources. While the language is somewhat different between NHPA and CEQA, the definitions of eligible properties and of adverse impacts are essentially the same. Evaluations under CEQA consider a resource's potential eligibility for inclusion in the California Register of Historical Resources.

8.3 Environmental Consequences and Mitigation Measures

This section describes the direct and indirect effects that the program alternatives would have on cultural resources. The program alternatives evaluated in this chapter are described in detail in Chapter 2.0, "Description of Alternatives," and summarized in Table 8-2. The impacts and mitigation measures are summarized in Table 8-3.

Table 8-2.
Actions Included Under Action Alternatives

Level of NEPA/CEQA Compliance	Actions[1]		Action Alternative					
			A1	A2	B1	B2	C1	C2
Project-Level	Reoperate Friant Dam and downstream flow control structures to route Interim and Restoration flows		✓	✓	✓	✓	✓	✓
	Recapture Interim and Restoration flows in the Restoration Area		✓	✓	✓	✓	✓	✓
	Recapture Interim and Restoration flows at existing CVP and SWP facilities in the Delta		✓	✓	✓	✓	✓	✓
Program-Level	Common Restoration actions[2]		✓	✓	✓	✓	✓	✓
	Actions in Reach 4B1 to provide at least:	475 cfs capacity	✓	✓	✓	✓	✓	✓
		4,500 cfs capacity with integrated floodplain habitat		✓		✓		✓
	Recapture Interim and Restoration flows on the San Joaquin River downstream from the Merced River at:	Existing facilities on the San Joaquin River			✓	✓	✓	✓
		New pumping infrastructure on the San Joaquin River					✓	✓
	Recirculation of recaptured Interim and Restoration flows		✓	✓	✓	✓	✓	✓

Note:

[1] All alternatives also include the Physical Monitoring and Management Plan and the Conservation Strategy, which include both project- and program-level actions intended to guide implementation of the Settlement.

[2] Common Restoration actions are physical actions to achieve the Restoration Goal that are common to all action alternatives and are addressed at a program level of detail.

Key:
CEQA = California Environmental Quality Act
cfs = cubic feet per second
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
NEPA = National Environmental Policy Act
PEIS/R = Program Environmental Impact Statement/Report
SWP = State Water Project

Table 8-3.
Summary of Environmental Consequences and Mitigation Measures – Cultural Resources

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Cultural Resources: Program-Level				
CUL-1: Disturbance or Destruction of Cultural Resources Within the Restoration Area	No-Action	No Impact	--	No Impact
	A1	PS	CUL-1: Comply with Section 106 of the NHPA or Equivalent	LTS
	A2	PS		LTS
	B1	PS		LTS
	B2	PS		LTS
	C1	PS		LTS
	C2	PS		LTS
Cultural Resources: Project-Level				
CUL-2: Disturbance or Destruction of Cultural Resources Around Millerton Lake	No-Action	LTS	--	LTS
	A1	PS	CUL-2: Comply with Section 106 of the NHPA and Develop and Implement a Programmatic Agreement	LTS
	A2	PS		LTS
	B1	PS		LTS
	B2	PS		LTS
	C1	PS		LTS
	C2	PS		LTS
CUL-3: Disturbance or Destruction of Cultural Resources in the Restoration Area	No-Action	LTS	--	LTS
	A1	PS	CUL-2: Comply with Section 106 of the NHPA and Develop and Implement a Programmatic Agreement	LTS
	A2	PS		LTS
	B1	PS		LTS
	B2	PS		LTS
	C1	PS		LTS
	C2	PS		LTS
CUL-4: Disturbance or Destruction of Cultural Resources Along the San Joaquin River Downstream from the Merced River	No-Action	LTS	--	LTS
	A1	PS	CUL-2: Comply with Section 106 of the NHPA and Develop and Implement a Programmatic Agreement	LTS
	A2	PS		LTS
	B1	PS		LTS
	B2	PS		LTS
	C1	PS		LTS
	C2	PS		LTS

Key:
-- = not applicable
LTS = less than significant
NHPH – National Historic Preservation Act
PS = potentially significant

8.3.1 Impact Assessment Methodology

The standard Section 106 process of the NHPA follows a series of steps that are described in the 36 CFR Part 800 regulations that implement the NHPA. These steps are as follows:

- Initiate Section 106 Process, 36 CFR Part 800.3
- Identify Historic Properties, 36 CFR Part 800.4
- Assess Adverse Effects, 36 CFR Part 800.5
- Resolve Adverse Effects, 36 CFR Part 800

In the event that historic properties within the area of potential effects (APE) for an undertaking would be subject to adverse effects, the Section 106 process is most often completed with the signing of an agreement document specifying measures that will be taken to avoid, minimize, or mitigate those effects. For the SJRRP, the APE (located within the Restoration Area) encompasses a 2-mile-wide corridor centered on the river, along with a 1-mile-wide corridor centered on the Eastside Bypass and Mariposa Bypass canals. This area was selected because it encompasses the focus of potential subsequent studies with potential to affect cultural resources. As part of compliance with 36 CFR Part 800 regulations, Reclamation conducted a records search for the APE to assess which portions of the APE have been previously inventoried, and to identify all previously recorded cultural resources. Although only a small portion of the APE has been inventoried, a considerable number of cultural resources have been previously documented. This sensitivity study gathered existing data and information used to estimate the impact of the program alternatives on historic properties or sites of cultural significance. Other geographic areas outside the APE are qualitatively assessed below for potential historic properties or sites of cultural significance.

Methods for assessing impacts to archaeological and historic-era structural resources and traditional cultural properties and areas of Native American concern are described in this section. Methods used for the cultural resources study included archival records searches, agency consultation, and meetings with Native American tribes. Sensitivity analyses were also conducted for prehistoric and historic-era resources to address data gaps using methods tailored to each data set. Native American issues and resource locations were discussed during meetings with Native American groups and individuals.

8.3.2 Archaeological and Historic-Era Structural Resources

Overall, the frequency and distribution of recorded cultural resources within the APE gives only a limited and incomplete picture of the actual number of resources; for two main reasons: (1) only 12 percent of the APE has been surveyed, and only 31 percent could be classified as systematic survey (40-meter or smaller spacing interval), and (2) survey coverage is highly varied within the APE. Reach 5 has been the most extensively inventoried (25 percent); all other reaches have been surveyed 11 percent or less, with Reach 3 having been surveyed only 2 percent. Given the small area surveyed, creating site density values for the surveyed area and then extrapolating these values to estimate site densities for larger areas can be considered only as coarse-grained estimates.

Highly divergent approaches to assessing sensitivity tailored to each data set were applied to prehistoric archaeological sites, historic-era archaeological sites, and historic-era architectural resources. Previous inventory and archival research (both documents and maps) were used to identify localities with potential historic architecture. The sensitivity assessment used a qualitative ranking by assigning a numerical value to each potential resource based on three main variables: (1) estimated construction, (2) assumed presence or absence at the end of the historic period, and (3) known historic association.

For prehistoric sites, straightforward site-density values based on known site quantities in the surveyed area and by landform age were calculated to predict the total number of cultural resources present within each reach. Sensitivity analyses were also conducted for buried sites (both prehistoric and historic) based on landform mapping, age classification, and other factors. Owing to the minimal number of recorded sites, historic-era archaeological site sensitivity analysis included known sites and potential archaeological sites. The latter were derived from an extensive GIS-based documentary research study developed for historic architectural resources.

8.3.3 Traditional Cultural Properties and Areas of Native American Concern

Native American ethnographic background research and tribal contact work for the SJRRP has been conducted sufficient to characterize Native American issues and concerns within the general Restoration Area. Work included background research at the Yosemite National Park archives (Frank Latta notes), the National Archives and Records Administration in San Bruno (tribal records), and research at the University of California Bancroft Library. Original field notes and published ethnographies were culled to identify places of importance to Tribes. Work also included identifying tribal groups that may have an interest in the area, contacting some of those people, and contacting the Native American Heritage Commission.

Reclamation contacted the identified tribes, by letter and follow-up telephone call in February 2008, to invite them to an informational meeting about the SJRRP. The letter stated that the meeting was intended to focus on issues of importance to the Native American community in the SJRRP process, to discuss the various legal acts that are relevant to Native American concerns, and to answer questions about the SJRRP. A similar letter was sent in late October 2008, which also provided maps of the study area, a description of the project, and an introduction to the SJRRP ethnographer.

The Native American Heritage Commission (NAHC), which in California oversees a sacred lands file and a list of Native Americans interested in projects near their homelands, was consulted. Formal request was made to determine if sites have been plotted on the Sacred Lands File or if other sensitive areas had been documented. It was further explained that the study area crosses over 14 quadrangles, and includes sections in 22 townships, and that the river channel location has changed dramatically over time, and it was asked if a sacred place had been plotted on a former San Joaquin River channel, which was information to be included, as well. The NAHC provided information in August 2008 to say that it had no listing of sacred lands in the Restoration Area, as described, but it provided a list of Native American people who might have information relevant to the SJRRP.

Initial contact was made with members of the California Indian Basketweavers Association at its annual meeting at Santa Rosa Rancheria, where discussions took place with several weavers about the SJRRP. Some preliminary meetings were arranged at that time. Interviews were held with the cultural resources representatives of several tribes, including the Dumna, Picayune Rancheria of Chukchansi Yokuts, Santa Rosa Rancheria (Tachi Yokuts), Wachumni, Dunlap Band of Mono Indians, and the North Fork Rancheria Environmental Committee. Groups identified, but not met with, include the Southern Sierra Miwok, various groups of Choinumne, Cold Springs Rancheria of Mono Indians, various Chowchilla groups, the North Fork Mono Tribe, Table Mountain Rancheria, North Valley Yokuts Tribe, and the Sierra Nevada Native American Coalition. Representatives of the Nupchenches and the Pitchachi, who occupied the majority of the western and southern banks of the San Joaquin River, were not identified during this effort. No fieldwork was conducted.

8.3.4 Significance Criteria

Criteria for determining significance of effects on cultural resources include Federal and State criteria, as described below.

Federal Criteria

Under Federal regulation 36 CFR Section 800.5(a)(1), the following is stated:

> *An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Consideration shall be given to all qualifying characteristics of a historic property, including those that may have been identified subsequent to the original evaluation of the property's eligibility for the National Register. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance or be cumulative.*

Examples of adverse effects 36 CFR Section 800.5(a)(2) include the following:

- Physical destruction, damage, or alteration, including moving the property from its historic location
- Isolation from, or alteration of, the setting
- Introduction of intrusive elements
- Neglect leading to deterioration or destruction
- Transfer, sale, or lease from Federal ownership

In addition to archaeological and architectural resources, Federal guidelines define eligible traditional cultural properties as those that have “association with cultural practices or beliefs of a living community that (a) are rooted in that community’s history, and (b) are important in maintaining the continuing cultural identity of the community” (Parker and King 1998, National Register Bulletin 38, Guidelines for Evaluation and Documenting Traditional Cultural Properties). Examples of traditional cultural properties include the following:

- A location associated with the traditional beliefs of a Native American group about its origins, its cultural history, or the nature of the world.
- A rural community whose organization, buildings and structures, or patterns of land use reflect the cultural traditions valued by its long-term residents.
- An urban neighborhood that is the traditional home of a particular cultural group, and that reflects its beliefs and practices.
- A location where Native American religious practitioners have historically gone, and are known or thought to go today, to perform ceremonial activities in accordance with traditional cultural rules of practice.
- A location where a community has traditionally carried out economic, artistic, or other cultural practices important in maintaining its historic identity.

Native American burials are also protected by Federal law. The Native American Graves Protection and Repatriation Act (Public Law 101-601; 25 USC 3001-3013) protects Native American burial sites and controls the removal of human remains, funerary objects, sacred objects, and items of cultural patrimony on Federal and tribal lands.

State Criteria

The thresholds of significance for impacts are based on the environmental checklist in Appendix G of the State CEQA Guidelines, as amended. These thresholds also encompass the factors taken into account under NEPA to determine the significance of an action in terms of its context and the intensity of its impacts. California regulations require that effects to cultural resources must be considered only for resources meeting the criteria for eligibility to the California Register of Historical Resources, outlined in Section 5024.1 of the California Public Resources Code. Demolition, replacement, substantial alteration, or relocation of an eligible resource are all actions that could change those elements of the resource which make it eligible. Under the State CEQA Guidelines, impacts on cultural resources may be considered significant if a project alternative would do any of the following:

- Cause a substantial adverse change in the significance of a historical resource, as defined in State CEQA Guidelines Section 15064.5
- Cause a substantial adverse change in the significance of an archaeological resource pursuant to State CEQA Guidelines Section 15064.5

- Disturb any human remains, including those interred outside formal cemeteries

California law also protects Native American burials, skeletal remains and associated grave goods regardless of their antiquity, and provides for the sensitive treatment and disposition of those remains (California Health and Safety Code Section 7050.5, California Public Resources Code Sections 5097.94 et seq.).

According to the above criteria, the project would be considered to have a significant impact on cultural resources if it would result in any of the following:

- Substantial adverse change in the significance of an historical resource
- Substantial adverse change in the significance of a unique archaeological resource
- Disturbance or destruction of unique paleontological resource or site or unique geologic feature
- Disturbance of any human remains, including those interred outside formal cemeteries
- Elimination of important examples of the major periods of California history or prehistory. Statements of impact significance are relative to both existing conditions (2005) and future conditions (2030), unless stated otherwise. Only those elements of a resource that contribute to its eligibility need to be considered; effects to noncontributing elements are less than significant.

8.3.5 Program-Level Impacts and Mitigation Measures

This section provides a program-level evaluation of the potential direct and indirect effects of the program alternatives on cultural resources. These program alternatives could affect cultural resources during construction activities that involve ground disturbance. No actions involving construction-related ground disturbance are proposed upstream from Friant Dam, in the Delta, or in CVP/SWP water service areas. Therefore, no program-level effects on cultural resources within the 30-year planning horizon are expected in these areas. For that reason, those geographic areas are not discussed further in this section. Only the Restoration Area and the area along the San Joaquin River downstream from the Merced River, where potential actions include construction activities, are evaluated below.

No-Action Alternative

Under the No-Action Alternative, there would be no construction activities associated with the reasonably foreseeable actions. Therefore, there would be no new types of construction-related impacts to cultural resources (archaeological sites, historic-era structural resources, and traditional cultural properties/areas of concern). No cultural resources impacts are anticipated in the Delta, or in CVP/SWP water service areas; therefore, no investigations took place in these areas. Potential flow-related effects are described in a separate section.

Alternatives A1 through C2

Program-level impacts to cultural resources under Alternatives A1 through C2 would be associated with construction activities in the Restoration Area. Impacts under Alternatives A2, B2, and C2 in Reach 4B1 would be similar to but likely greater than impacts under Alternatives A1, B1, and C1 as Alternatives A2, B2, and C2 include more intensive construction activities in this reach. Alternatives C1 and C2 also include the potential for impacts associated with construction activities related to new pumping and conveyance facilities along the San Joaquin River downstream from the Merced River, as described below.

Additional impacts associated with the release of Interim and Restoration flows are project-level impacts and are therefore described in a separate section. No program-level impacts to cultural resources would occur under Alternatives A1 through B2 outside the Restoration Area. No program-level impacts to cultural resources would occur under Alternatives C1and C2 outside the area along the San Joaquin River between Friant Dam and the Delta.

Impact CUL-1 (Alternatives A1 through C2): ***Disturbance or Destruction of Cultural Resources Within Restoration Area – Program-Level.*** Documented and currently undocumented cultural resources (archaeological sites, historic-era structural resources, and traditional cultural properties/areas of concern) are situated along the San Joaquin River from Friant Dam to the Delta. It is not possible to know the number of resources present, how many would be determined eligible, and how many of the eligible resources would be adversely impacted from these alternatives since only a small fraction of the area has been inventoried. However, since these alternatives include efforts to conduct a variety of large-scale restoration activities (including both channel and structural improvements), all of which include construction or ground-disturbing activities, potential exists for significant adverse impacts to occur to historic properties under these alternatives. This impact would be **potentially significant**.

Based on both historic ethnographic information, and on information supplied by Native American individuals, several places in the Restoration Area have importance to the various Yokuts tribes in particular. Native American individuals who supplied information for the SJRRP were, generally, unwilling to provide comprehensive site information, including precise locations of traditional cultural properties or areas of concern within the Restoration Area at this point in the SJRRP investigation, stating a preference for giving information for specific project-level actions only. Consequently, the full extent of potential impacts to potential traditional cultural properties and areas of Native American concern is currently unknown. Currently less than 10 percent of Reach 4 has been inventoried for cultural resources and 19 resources have been documented. It is estimated that approximately 200 cultural resources would be documented within this reach after full inventory efforts (Table 8-1). Alternatives A2, B2, and C2 include greater potential for disturbance or destruction of cultural resources within Reach 4B1 than Alternatives A1, B1, and C1.

Alternatives C1 and C2 also include the potential for disturbance or destruction of cultural resources along the San Joaquin River downstream from the Merced River. Only a small fraction of this area has been inventoried for cultural resources, consequently, it is not possible currently to say how many of these resources are present, how many would be determined eligible, and how many of the eligible resources would sustain adverse impacts from Alternatives C1 and C2. Once possible locations for new pumping infrastructure are identified then cultural resources investigations would be needed to identify whether resources are present in this reach. However, it is likely that significant adverse impacts could occur to historic properties under these alternatives.

The large-scale nature of many restoration activities and the number of potential cultural resources in the Restoration Area under the action alternatives, or along the San Joaquin River between the Merced River and the Delta under Alternatives A1 and C2, are likely to result in significant effects to some currently unidentified cultural resources. This impact would be potentially significant.

Mitigation Measure CUL-1 (Alternatives A1 through C2): ***Comply with Section 106 of the NHPA or Equivalent – Program-Level.*** The Federal project proponent, if any, will comply with Section 106 of the NHPA during subsequent site-specific studies, including complying with the Programmatic Agreement (PA) developed as part of Mitigation Measure CUL-2. The State project proponent, if any, must comply with Sections 5024 and 5024.5 of the PRC. Sections 5024 and 5024.5 of the PRC require State agencies to confer with the SHPO before implementing any project with the potential to affect historical resources listed in or potentially eligible for inclusion in the National Register of Historic Places (NRHP) or registered as or eligible for registration as a state historical landmark. In addition, the State project proponent may choose to join the PA as a signatory agency.

Site-specific environmental reviews will be conducted before all ground-disturbing activities. The following mitigation measures, consisting of inventory, evaluation, and treatment processes, will be conducted by the project proponent as part of the environmental reviews to ensure compliance with Section 106 of the NHPA or Sections 5024 and 5024.5 of the PRC, as applicable. Coordination will continue with the relevant Native American tribes in the area, as necessary to complete these compliance processes. The mitigation measures that will reduce the impacts of the program-level actions are:

- **Conduct Class III cultural resources surveys of portions of the project area that have not been surveyed.** Before any ground disturbance takes place in the project area (including areas of ancillary activities, such as staging areas and access routes), Class II cultural resource surveys covering the APE will be conducted to locate and record cultural resources. Where appropriate, subsurface discovery efforts also will be undertaken to identify buried archaeological sites.
- **Plan activities to avoid known cultural resources.** Before carrying out ground-disturbing activities, areas that have been delineated as containing cultural resources will be demarcated, and all ground-disturbing or related activities will be planned to avoid these areas.

- **Evaluate significance of resources that cannot be avoided**. If cultural resources cannot be avoided through careful planning of the activities associated with a project, additional research or test excavation (as appropriate) will be undertaken to determine whether the resources meet NRHP and/or CEQA significance criteria.

- **Develop treatment process to mitigate effects of project upon significant resources.** Impacts on significant resources that cannot be avoided will be mitigated in a manner that is deemed appropriate for the particular resource. Mitigation for significant resources may include, but are not be limited to, data recovery, public interpretation, performance of a Historic American Building Survey or Historic American Engineering Record, or preservation by other means.

These impacts would be less than significant after mitigation. Therefore, these impacts would be **less than significant**.

8.3.6 Project-Level Impacts and Mitigation Measures

Project-level impacts to cultural resources would be associated with the effects of Interim and Restoration flows, and would occur in the vicinity of Millerton Lake, in the Restoration Area, and along the San Joaquin River downstream from the Merced River.

No-Action Alternative

Project-level impacts under the No-Action Alternative are described below.

Impact CUL-2 (No-Action Alternative): ***Disturbance or Destruction of Cultural Resources Around Millerton Lake – Project-Level.*** Under the No-Action Alternative, Friant Dam operations would continue similar to current operations. Therefore, there would be no new types of impacts to cultural resources (archaeological sites, historic-era structural resources, and traditional cultural properties/areas of concern). Archaeological sites within the existing Millerton Lake fluctuation zone would continue to be impacted by fluctuations in the reservoir during ongoing operations under the No-Action Alternative. These impacts would be **less than significant**.

Impact CUL-3 (No-Action Alternative): ***Disturbance or Destruction of Cultural Resources in the Restoration Area – Project-Level.*** Under the No-Action Alternative, operations would continue similar to current operations. Therefore, there would be no new types of impacts to cultural resources (archaeological sites, historic-era structural resources, and traditional cultural properties/areas of concern). Archaeological sites within and adjacent to the existing San Joaquin River and bypass channels would continue to be impacted by Friant Dam releases and downstream diversions during ongoing operations under the No-Action Alternative. The scale of these events would continue to vary greatly interannually, with the most damage to resources occurring during occasional years with major flood events. This impact would be **less than significant**.

Impact CUL-4 (No-Action Alternative): ***Disturbance or Destruction of Cultural Resources Along the San Joaquin River Downstream from the Merced River – Project-Level.*** Under the No-Action Alternative, operations would continue similar to current operations. Therefore, there would be no new types of impacts to cultural resources (archaeological sites, historic-era structural resources, and traditional cultural properties/areas of concern). Archaeological sites within and adjacent to the existing San Joaquin River would continue to be impacted by releases from reservoirs on the Merced, Stanislaus, and Tuolumne rivers and downstream diversions during ongoing operations under the No-Action Alternative. The scale of these events would continue to vary greatly interannually, with the most damage to resources occurring during occasional years with major flood events. This impact would be **less than significant**.

Alternatives A1 Through C2

Project-level impacts under Alternatives A1 through C2 would be associated with release of flows tied to reoperating Friant Dam, and would occur within the vicinity of Millerton Lake, in the Restoration Area, and in the San Joaquin River downstream from the Merced River. No new types of impacts to cultural resources (archaeological sites, historic-era structural resources, and traditional cultural properties/areas of concern) would occur outside these geographic areas under Alternatives A1 through C2.

Impact CUL-2 (Alternatives A1 through C2): ***Disturbance or Destruction of Cultural Resources Around Millerton Lake – Project-Level.*** A number of archaeological sites and historic Native American places are situated within the existing Millerton Lake fluctuation zone. Release of Interim and Restoration flows from Friant Dam would alter the timing and magnitude of fluctuations in reservoir elevations in Millerton Lake. Based on geological/soils studies, variation in reservoir levels could result in localized erosion of soils and loss of soil horizons down to bedrock along the reservoir shore in the zone of water elevation variation. This impact would be **potentially significant.**

In general, changes the timing and magnitude of fluctuations in reservoir elevations could potentially increase exposure of cultural resources to cycles of inundation and drawdown, potentially eroding the value and character of historic resources. If the reoperation of Friant Dam results in a shift in the zone of fluctuation, cultural resources located within the zone also could be potentially affected through increased exposure to erosion, hydrologic sorting caused by wave action, and breakdown of organic matter through repeated wetting and drying. Any changes in timing and magnitude of fluctuations in reservoir elevations caused by the project-level actions have the potential to impact important or unevaluated cultural resources in Millerton Lake. Previous studies of reservoir impacts to cultural sites have shown that the greatest impacts are from wave action, which erodes the deposit and moves artifacts; and from cycles of inundation and drawdown, which also cause erosion and movement, in addition to repeated wetting and drying of the deposit. As such, changes in the magnitude of impacts to archaeological sites could occur during reoperation of Friant Dam and this impact would be potentially significant.

Mitigation Measure CUL-2 (Alternatives A1 through C2): ***Comply with Section 106 of the NHPA and Develop and Implement a Programmatic Agreement or Equivalent – Project-Level.*** Reclamation will comply with the Federal NHPA Section 106 process to mitigate any significant, adverse impacts to cultural resources and historic properties to less than significant levels.

Reclamation will develop a PA with the SHPO through the Section 106 consultation process. As part of the PA, Reclamation will identify archaeological sites and historic Native American places with the potential for significant impacts to occur due to changes in reservoir operations. In the event that release of Interim or Restoration flows are likely to cause damage to a historic property, Reclamation will comply with the process identified in the PA for the evaluation and recovery of data at any such cultural resource. Undocumented cultural resources may also exist in the reservoir basin. If such a site is identified during implementation of the alternatives and release of Interim or Restoration flows is likely to cause damage to such a site, Reclamation will ensure the evaluation and recovery of data at these sites. With mitigation, this impact would be **less than significant**.

Impact CUL-3 (Alternatives A1 through C2): ***Disturbance or Destruction of Cultural Resources Within the Restoration Area – Project-Level.*** Documented and currently undocumented cultural resources (archaeological sites, historic-era structural resources, and traditional cultural properties/areas of concern) are situated along the San Joaquin River from Friant Dam to the Merced River. It is not possible currently to know the number of resources present, how many would be determined eligible, and how many of the eligible resources would sustain adverse impacts from these alternatives. This impact would be **potentially significant**.

As demonstrated in the stage-frequency curves presented in Chapter 11.0, “Flood Management,” the river channel in the Restoration Area has experienced high flows frequently throughout the period of record. While disturbance has and will continue to occur due to such flows, the release of Interim and Restoration flows could lead to a change in erosion patterns in portions of some reaches, as described in Chapter 10.0, “Geology and Soils.” This change in erosion patterns could lead to disturbance and damage to cultural resources preserved adjacent to the river channel and exposed within the channel banks. Consequently, there is the potential for significant adverse impacts to occur to cultural and historic properties under these alternatives. This impact would be potentially significant.

Mitigation Measure CUL-2 (Alternatives A1 through C2): ***Comply with Section 106 of the NHPA and Develop and Implement a Programmatic Agreement – Project-Level.*** This mitigation measure is identical to Mitigation Measure CUL-2, as previously described for Alternatives A1 through C2.This impact after mitigation would be **less than significant**.

Impact CUL-4 (Alternatives A1 through C2): ***Disturbance or Destruction of Cultural Resources Along the San Joaquin River Downstream from the Merced River – Project-Level.*** Alternatives A1 through C2 would increase Interim and Restoration flows in this reach, therefore any archaeological sites along the banks of the San Joaquin River could be negatively impacted by increased lateral bank erosion. It is possible that significant, adverse impacts would occur to historic properties under these alternatives. In addition, Native American traditional places may be located along the San Joaquin River downstream from the Merced River. This impact would potentially be significant.

Mitigation Measure CUL-2 (Alternatives A1 through C2): ***Comply with Section 106 of the NHPA and Develop and Implement a Programmatic Agreement – Project-Level***. This mitigation measure is identical to Mitigation Measure CUL-2, as previously described for Alternatives A1 through C2.This impact after mitigation would be **less than significant**.

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Chapter 9.0 Environmental Justice

This chapter describes the environmental and regulatory settings of environmental justice, as well as environmental consequences, as they pertain to implementation of the program alternatives.

9.1 Environmental Setting

This section describes the affected environment related to environmental justice, as defined by Federal EO 12898 (59 FR 7629) and CEQ Guidance (1997). Under EO 12898, demographic information is used to determine whether minority populations or low-income populations are present in the areas potentially affected by the range of program alternatives. If so, a determination must be made whether implementation of the program alternatives may cause disproportionately high and adverse human health or environmental impacts on those populations.

9.1.1 San Joaquin River from Friant Dam to Merced River

This area includes the counties of Fresno, Madera, and Merced (i.e., the “Three County Region” mentioned elsewhere in this document), and includes the Restoration Area, the region in which the primary Restoration actions along the San Joaquin River will occur. This area is described in terms of U.S. Census Bureau census tracts (CT) that border the San Joaquin River from Friant Dam to the Merced River (see Figure 9-1). Comparable data for the cities of Clovis, Fresno, Reedley, Chowchilla, Madera, Atwater, Los Banos, and Merced are also presented.

Minority Groups

The CEQ (CEQ 1997) defines the term “minority” as persons from any of the following U.S. Census categories for race: Black/African American, Asian, Native Hawaiian or Other Pacific Islander, and American Indian or Alaska Native. Additionally, for the purposes of this analysis, “minority” also includes all other nonwhite racial categories that were added in the most recent census, such as “some other race” and “two or more races.” The CEQ also mandates that persons identified through the U.S. Census as ethnically Hispanic, regardless of race, should be included in minority counts (CEQ 1997). Hispanic origin is considered to be an ethnic category separate from race, according to the U.S. Census.

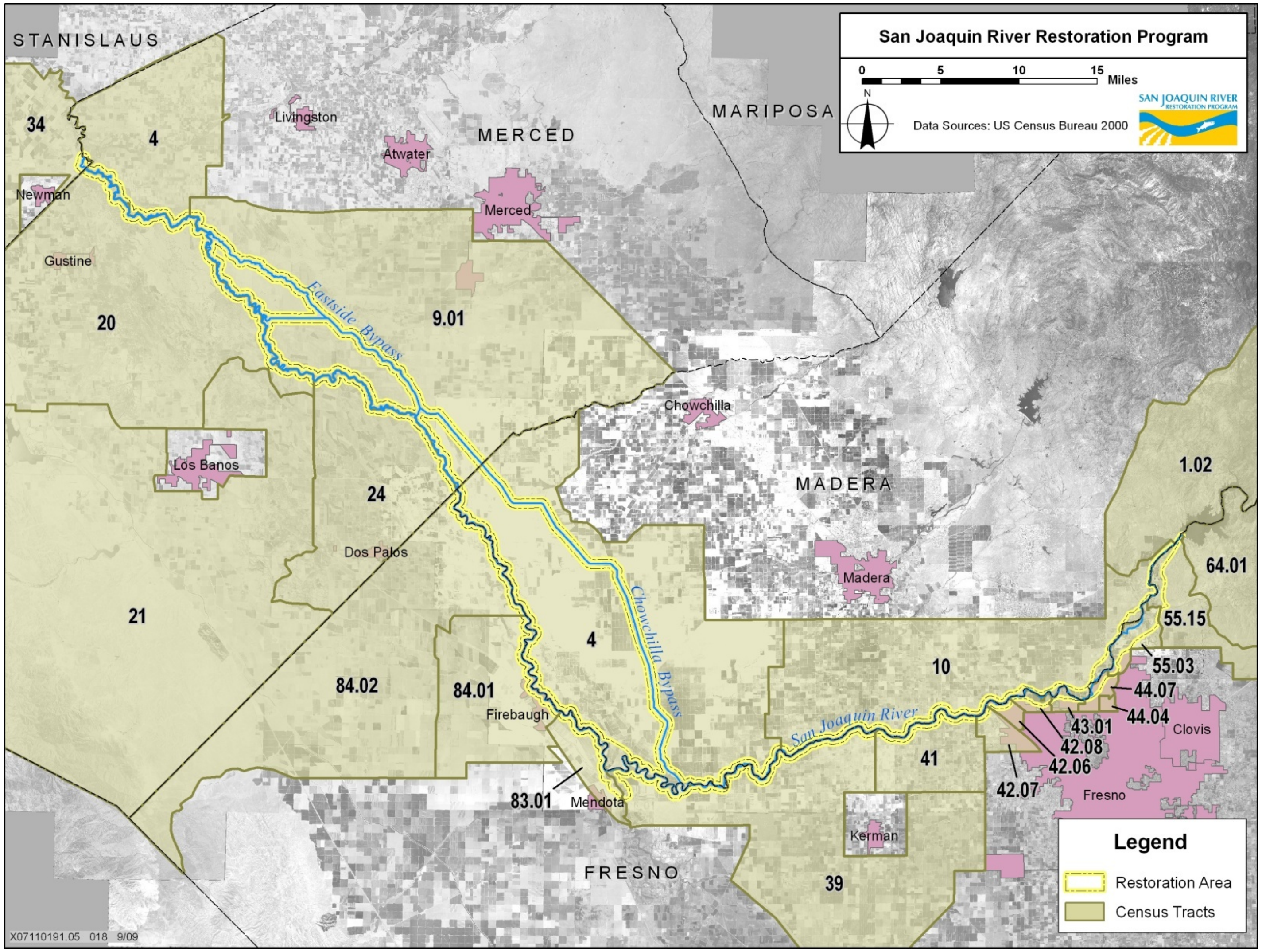

Figure 9-1.
Restoration Area Census Tracts 2000

The concept of a “minority” established by the CEQ is based on the nationwide population, in which residents racially self-identifying as “white alone” accounted for approximately 75.1 percent of the population in 2000 (with non-Hispanic white alone respondents 69.1 percent). Despite the State of California exhibiting a proportion of minority residents greater than 50 percent (as shown in Table 9-1 below), the Federal guidelines set forth by the CEQ regarding who a “minority” is applied to environmental justice analyses conducted within the State.

The Interagency Federal Working Group on Environmental Justice guidance states that a minority and/or low-income population may be present in an area if the proportion of the populations in the area of interest are “meaningfully greater” than that of the general population, or where the proportion exceeds 50 percent of the total population. For the purposes of this analysis, minority populations of individual CTs were compared against the general population of the surrounding counties, as well as with the State of California as a whole. For the purposes of this analysis, those CTs with minority populations exceeding 50 percent were considered areas containing environmental justice populations.

Table 9-1 presents the minority group composition of potentially affected CTs within the Restoration Area, including total numbers for this area as a whole. (This “total minority” count includes all residents except non-Hispanic whites, who are not considered minorities.) These data are from the 2000 decennial census, as the decennial census is the most recently completed dataset that can be used to show racial and ethnic heritage data at the CT level. As can be seen in the table, the State of California has a total minority group proportion exceeding 50 percent, as does each county included in this level of analysis. This area presented as a whole, which is composed of the CTs bordering the Restoration Area, has a total minority group proportion just under 50 percent (48.8 percent). The CTs within this study area exceeding 50 percent are generally located in the rural areas west of Fresno, which include the smaller communities of Firebaugh and Mendota, the agricultural areas south of Madera, and the CTs surrounding Los Banos in Merced County. Every county and city presented (excluding Clovis and Chowchilla) also exhibit total minority group proportions in excess of 50 percent, suggesting that the entire area can be considered to have high proportions of minorities, although clusters of especially high minority populations are evident in some CTs (CT 83.01 and CT 84.01, particularly). Those CTs that exhibit high proportions of minorities typically have Hispanic percentages higher than the State average, with some CTs having percentages twice as much as the State. Relatively high percentages of Asian residents can be found in CTs 44.04, 42.07, and 42.06, which are located on the northwest edge of Fresno in close proximity to the Restoration Area. It should be noted that a number of CTs and communities have high proportions of respondents identifying as “some other race,” which was a category provided in 2000 to provide people who did not feel included in the previously delineated racial categories to provide their own category. In many cases, the write-in entries for this category included “multiracial,” “mixed,” or an ethnic Hispanic/Latino grouping (e.g., “Mexican” or “Puerto Rican”). Throughout the country, many Hispanic residents chose “some other race” and it is likely that the high proportion of Hispanic residents in the Restoration Area responded as “some other race.”

Table 9-1.
Restoration Area Race, Hispanic Origin, and Proportion of Total Minority, 2000

Geographic Area	Total Population	Race							Hispanic Origin		Total Minority[b]
		White	Black/ African American	American Indian and Alaska Native	Asian	Native Hawaiian/ Pacific Islander	Some Other Race	Two or More Races	White Alone, Non-Hispanic	All Races, Hispanic[a]	
Total Area*	107,731 (100.0%)	70,265 (65.2%)	2,295 (2.1%)	1,802 (1.7%)	4,376 (4.1%)	118 (0.1%)	23,084 (21.4%)	5,791 (5.4%)	55,116 (51.2%)	41,589 (38.6%)	52,615 (48.8%)
Fresno County	**799,407 (100.0%)**	**434,045 (54.3%)**	**42,337 (5.3%)**	**12,790 (1.6%)**	**64,362 (8.1%)**	**1,000 (0.1%)**	**207,061 (25.9%)**	**37,812 (4.7%)**	**317,522 (39.7%)**	**351,636 (44.0%)**	**481,885 (60.3%)**
Clovis	68,468 (100.0%)	51,914 (75.8%)	1,302 (1.9%)	1,025 (1.5%)	4,441 (6.5%)	108 (0.2%)	6,502 (9.5%)	3,176 (4.6%)	46,186 (67.5%)	13,876 (20.3%)	22,282 (32.5%)
Fresno	**427,652 (100.0%)**	**214,556 (50.2%)**	**35,763 (8.4%)**	**6,763 (1.6%)**	**48,028 (11.2%)**	**583 (0.1%)**	**99,898 (23.4%)**	**22,061 (5.2%)**	**159,473 (37.3%)**	**170,520 (39.9%)**	**268,179 (62.7%)**
Reedley	**20,756 (100.0%)**	**10,743 (51.8%)**	**89 (0.4%)**	**251 (1.2%)**	**906 (4.4%)**	**15 (0.1%)**	**7,830 (37.7%)**	**922 (4.4%)**	**5,453 (26.3%)**	**14,028 (67.6%)**	**15,303 (73.7%)**
CT 39	**5,503 (100.0%)**	**2,829 (51.4%)**	**21 (0.4%)**	**90 (1.6%)**	**141 (2.6%)**	**5 (0.1%)**	**2,188 (39.8%)**	**229 (4.2%)**	**1,960 (35.6%)**	**3,246 (59.0%)**	**3,543 (64.4%)**
CT 41	**2,687 (100.0%)**	**1,267 (47.2%)**	**6 (0.2%)**	**42 (1.6%)**	**113 (4.2%)**	**6 (0.2%)**	**1,152 (42.9%)**	**101 (3.8%)**	**1,023 (38.1%)**	**1,463 (54.4%)**	**1,664 (61.9%)**
CT 42.06	4,582 (100.0%)	3,156 (68.9%)	191 (4.2%)	29 (0.6%)	511 (11.2%)	2 (0.0%)	511 (11.2%)	182 (4.0%)	2,526 (55.1%)	1,246 (27.2%)	2,056 (44.9%)
CT 42.07	**3,866 (100.0%)**	**1,953 (50.5%)**	**288 (7.4%)**	**88 (2.3%)**	**510 (13.2%)**	**7 (0.2%)**	**820 (21.2%)**	**200 (5.2%)**	**1,273 (32.9%)**	**1,664 (43.0%)**	**2,593 (67.1%)**
CT 42.08	4,899 (100.0%)	3,577 (73.0%)	253 (5.2%)	18 (0.4%)	485 (9.9%)	2 (0.0%)	357 (7.3%)	207 (4.2%)	3,123 (63.7%)	894 (18.2%)	1,776 (36.3%)
CT 43.01	3,619 (100.0%)	3,067 (84.7%)	37 (1.0%)	9 (0.2%)	337 (9.3%)	6 (0.2%)	65 (1.8%)	98 (2.7%)	2,948 (81.5%)	189 (5.2%)	671 (18.5%)

Table 9-1.
Restoration Area Race, Hispanic Origin, and Proportion of Total Minority, 2000 (contd.)

Geographic Area	Total Population	Race							Hispanic Origin		Total Minority[b]
		White	Black/ African American	American Indian and Alaska Native	Asian	Native Hawaiian/ Pacific Islander	Some Other Race	Two or More Races	White Alone, Non-Hispanic	All Races, Hispanic[a]	
CT 44.04	**3,610 (100.0%)**	**1,414 (39.2%)**	**167 (4.6%)**	**70 (1.9%)**	**612 (17.0%)**	**0 (0.0%)**	**1,135 (31.4%)**	**212 (5.9%)**	**905 (25.1%)**	**1,784 (49.4%)**	**2,705 (74.9%)**
CT 44.07	7,388 (100.0%)	5,258 (71.2%)	319 (4.3%)	85 (1.2%)	584 (7.9%)	8 (0.1%)	752 (10.2%)	382 (5.2%)	4,722 (63.9%)	1,426 (19.3%)	2,666 (36.1%)
CT 55.03	3,791 (100.0%)	3,274 (86.4%)	49 (1.3%)	15 (0.4%)	212 (5.6%)	2 (0.1%)	145 (3.8%)	94 (2.5%)	3,090 (81.5%)	344 (9.1%)	701 (18.5%)
CT 55.15	1,241 (100.0%)	1,081 (87.1%)	7 (0.6%)	14 (1.1%)	37 (3.0%)	1 (0.1%)	56 (4.5%)	45 (3.6%)	991 (79.9%)	164 (13.2%)	250 (20.1%)
CT 64.01	9,101 (100.0%)	8,015 (88.1%)	40 (0.4%)	416 (4.6%)	81 (0.9%)	20 (0.2%)	214 (2.4%)	315 (3.5%)	7,683 (84.4%)	708 (7.8%)	1,418 (15.6%)
CT 83.01	**3,936 (100.0%)**	**1,079 (27.4%)**	**30 (0.8%)**	**53 (1.3%)**	**25 (0.6%)**	**9 (0.2%)**	**2,421 (61.5%)**	**319 (8.1%)**	**105 (2.7%)**	**3,749 (95.2%)**	**3,831 (97.3%)**
CT 84.01	**7,142 (100.0%)**	**3,037 (42.5%)**	**89 (1.2%)**	**95 (1.3%)**	**59 (0.8%)**	**1 (0.0%)**	**3,521 (49.3%)**	**340 (4.8%)**	**700 (9.8%)**	**6,249 (87.5%)**	**6,442 (90.2%)**
CT 84.02	**2,192 (100.0%)**	**1,251 (57.1%)**	**11 (0.5%)**	**20 (0.9%)**	**12 (0.5%)**	**0 (0.0%)**	**775 (35.4%)**	**123 (5.6%)**	**726 (33.1%)**	**1,409 (64.3%)**	**1,466 (66.9%)**
Madera County	**123,109 (100.0%)**	**76,612 (62.2%)**	**5,072 (4.1%)**	**3,212 (2.6%)**	**1,566 (1.3%)**	**210 (0.2%)**	**29,979 (24.4%)**	**6,458 (5.2%)**	**57,391 (46.6%)**	**54,515 (44.3%)**	**65,718 (53.4%)**
Chowchilla	11,127 (100.0%)	7,061 (63.5%)	1,142 (10.3%)	289 (2.6%)	147 (1.3%)	29 (0.3%)	1,798 (16.2%)	661 (5.9%)	6,129 (55.1%)	3,138 (28.2%)	4,998 (44.9%)

Table 9-1.
Restoration Area Race, Hispanic Origin, and Proportion of Total Minority, 2000 (contd.)

Geographic Area	Total Population	Race							Hispanic Origin		Total Minority[b]
		White	Black/ African American	American Indian and Alaska Native	Asian	Native Hawaiian/ Pacific Islander	Some Other Race	Two or More Races	White Alone, Non-Hispanic	All Races, Hispanic[a]	
Madera	**43,207 (100.0%)**	**20,804 (48.1%)**	**1,665 (3.9%)**	**1,207 (2.8%)**	**618 (1.4%)**	**44 (0.1%)**	**16,425 (38.0%)**	**2,444 (5.7%)**	**10,859 (25.1%)**	**29,274 (67.8%)**	**32,348 (74.9%)**
CT 1.02	4,278 (100.0%)	3,435 (80.3%)	13 (0.3%)	331 (7.7%)	23 (0.5%)	17 (0.4%)	156 (3.6%)	303 (7.1%)	3,279 (76.6%)	358 (8.4%)	999 (23.4%)
CT 4	**1,559 (100.0%)**	**964 (61.8%)**	**9 (0.6%)**	**17 (1.1%)**	**34 (2.2%)**	**6 (0.4%)**	**453 (29.1%)**	**76 (4.9%)**	**604 (38.7%)**	**882 (56.6%)**	**955 (61.3%)**
CT 10	**6,325 (100.0%)**	**3,711 (58.7%)**	**40 (0.6%)**	**93 (1.5%)**	**141 (2.2%)**	**8 (0.1%)**	**1,872 (29.6%)**	**460 (7.3%)**	**2,545 (40.2%)**	**3,441 (54.4%)**	**3,780 (59.8%)**
Merced County	**210,554 (100.0%)**	**118,350 (56.2%)**	**8,064 (3.8%)**	**2,510 (1.2%)**	**14,321 (6.8%)**	**396 (0.2%)**	**55,013 (26.1%)**	**11,900 (5.7%)**	**85,585 (40.6%)**	**95,466 (45.3%)**	**124,969 (59.4%)**
Atwater	**23,113 (100.0%)**	**13,252 (57.3%)**	**1,153 (5.0%)**	**293 (1.3%)**	**1,254 (5.4%)**	**83 (0.4%)**	**5,659 (24.5%)**	**1,419 (6.1%)**	**10,245 (44.3%)**	**9,594 (41.5%)**	**12,868 (55.7%)**
Los Banos	**25,869 (100.0%)**	**15,161 (58.6%)**	**1,100 (4.3%)**	**350 (1.4%)**	**606 (2.3%)**	**85 (0.3%)**	**6,960 (26.9%)**	**1,607 (6.2%)**	**10,290 (39.8%)**	**13,048 (50.4%)**	**15,579 (60.2%)**
Merced	**63,893 (100.0%)**	**33,481 (52.4%)**	**4,044 (6.3%)**	**818 (1.3%)**	**7,267 (11.4%)**	**133 (0.2%)**	**14,813 (23.2%)**	**3,337 (5.2%)**	**24,121 (37.8%)**	**26,425 (41.4%)**	**39,772 (62.2%)**
CT 4	9,362 (100.0%)	7,395 (79.0%)	60 (0.6%)	44 (0.5%)	153 (1.6%)	2 (0.0%)	848 (9.1%)	860 (9.2%)	6,661 (71.1%)	1,698 (18.1%)	2,701 (28.9%)
CT 9.01	**3,453 (100.0%)**	**2,191 (63.5%)**	**94 (2.7%)**	**22 (0.6%)**	**154 (4.5%)**	**3 (0.1%)**	**812 (23.5%)**	**177 (5.1%)**	**1,616 (46.8%)**	**1,500 (43.4%)**	**1,837 (53.2%)**

Table 9-1.
Restoration Area Race, Hispanic Origin, and Proportion of Total Minority, 2000 (contd.)

Geographic Area	Total Population	Race							Hispanic Origin		Total Minority[b]
		White	Black/ African American	American Indian and Alaska Native	Asian	Native Hawaiian/ Pacific Islander	Some Other Race	Two or More Races	White Alone, Non-Hispanic	All Races, Hispanic[a]	
CT 20	7,107 (100.0%)	4,973 (70.0%)	45 (0.6%)	63 (0.9%)	87 (1.2%)	5 (0.1%)	1,470 (20.7%)	464 (6.5%)	4,055 (57.1%)	2,580 (36.3%)	3,052 (42.9%)
CT 21	**3,896 (100.0%)**	**2,248 (57.7%)**	**17 (0.4%)**	**52 (1.3%)**	**24 (0.6%)**	**7 (0.2%)**	**1,270 (32.6%)**	**278 (7.1%)**	**1,587 (40.7%)**	**2,098 (53.9%)**	**2,309 (59.3%)**
CT 24	**8,194 (100.0%)**	**5,090 (62.1%)**	**509 (6.2%)**	**136 (1.7%)**	**41 (0.5%)**	**1 (0.0%)**	**2,091 (25.5%)**	**326 (4.0%)**	**2,994 (36.5%)**	**4,497 (54.9%)**	**5,200 (63.5%)**
California	**33,871,648 (100.0%)**	**20,170,059 (59.5%)**	**2,263,882 (6.7%)**	**333,346 (1.0%)**	**3,697,513 (10.9%)**	**116,961 (0.3%)**	**5,682,241 (16.8%)**	**1,607,646 (4.7%)**	**15,816,790 (46.7%)**	**10,966,556 (32.4%)**	**18,054,858 (53.3%)**

Source: U.S. Census Bureau 2000a

Notes:

* Total Area consists of all included census tracts

Boldface denotes areas with meaningfully greater total minority proportion (over 50 percent)

[a] The term “Hispanic” is an ethnic category and can apply to members of any race, including respondents who self-identified as “white.” The total numbers of Hispanic residents for each geographic region are tabulated separately from the racial distribution by the U.S. Census Bureau. Hispanic information is taken from U.S. Census Bureau 2000a, while data regarding race are taken from U.S. Census Bureau 2000a, Table P7.

[b] *“Total minority” is the aggregation of all non-white racial groups with the addition of all Hispanics, regardless of race. Total minority information is taken from U.S. Census Bureau 2000a, with the total for “Not Hispanic or Latino: White alone” subtracted from the total population.*

Key:

% = percent

CT = Census Tract

Socioeconomic Indicators of Well-Being (Low-Income Groups)

Persons living with income below the poverty level are identified as "low-income," according to the annual statistical poverty thresholds established by the U.S. Census Bureau. The U.S. Census Bureau poverty thresholds indicated that the poverty level for a family of four in 2008 was $21,834. For this particular analysis, however, U.S. Census data from the 2000 census were used because they are the most comprehensive, most complete, and most customizable data set currently available for the study area. The U.S. Census Bureau poverty threshold applied in the 2000 census used 1999 earnings information, with $16,895 being established as the threshold for a family of four (two adults and two children). Although the use of more recent poverty thresholds may be preferable, 2008 demographic data are not available at the CT level of analysis, and the application of 2008 thresholds to post-2000 CT data (or other data) would likely result in incorrectly designated low-income areas because the Consumer Price Index has changed over time. Furthermore, publicly available U.S. Census data are not detailed enough to apply current poverty thresholds to, even if constant dollar calculations are applied. In practical terms, it is not likely that low-income population patterns in the area have shifted dramatically since 2000 since other demographic characteristics have not dramatically shifted over the past 9 years.

Table 9-2 presents the median household income, per capita income, and proportion of individuals living below the poverty threshold for the potentially affected CTs within this study area; nearby cities; the surrounding counties of Fresno, Madera, and Merced; and the State of California as a whole. Each county within the Restoration Area exhibits a proportion of people living in poverty higher than the State average; thus, values exceeding twice the State average of 14.2 percent. (A total of 28.4 percent were considered to be meaningfully greater for this analysis.) Using this benchmark, CTs 44.04 and 83.01 in Fresno County are considered to have a meaningfully greater proportion of people living below the poverty threshold, as is the City of Madera, which is north of this study area. CT 83.01, located near the small communities of Mendota and Firebaugh, also exhibits the lowest per capita income and median household income of any geographic region in the table, regardless of size. It should be noted that a number of CTs exhibit relatively high proportions of low-income residents, although the proportion does not exceed 28.4 percent. These include many rural CTs west of Fresno, south of Merced, and surrounding Los Banos. The cities of Merced, Madera, and Fresno also have relatively high proportions of residents living in poverty (all more than 26 percent), suggesting that there are clusters of low-income residents present in each of these urban centers along with low-income residents in the surrounding rural areas.

Table 9-2.
Restoration Area Population Below Poverty Level, 1999

Geographic Area	Median Household Income	Per Capita Income	Population Below Poverty Threshold
Total Area*	\$22,881 – \$98,404	\$6,785 – \$65,448	18,313 (17.1%)
Fresno County	\$34,725	\$15,495	179,085 (22.9%)
Clovis	\$42,283	\$18,690	7,160 (10.6%)
Fresno	\$32,236	\$15,010	109,703 (26.2%)
Reedley	\$34,682	\$12,096	4,832 (23.8%)
CT 39	\$26,541	\$11,238	1,529 (28.0%)
CT 41	\$36,167	\$14,677	473 (17.6%)
CT 42.06	\$58,039	\$20,708	194 (4.3%)
CT 42.07	\$30,900	\$13,145	899 (23.3%)
CT 42.08	\$65,290	\$32,490	109 (2.2%)
CT 43.01	\$98,404	\$65,448	43 (1.2%)
CT 44.04	**\$26,473**	**\$11,529**	**1,224** **(33.9%)**
CT 44.07	\$46,250	\$25,800	807 (11.0%)
CT 55.03	\$73,145	\$33,775	121 (3.2%)
CT 55.15	\$43,750	\$22,124	78 (6.4%)
CT 64.01	\$48,415	\$20,561	943 (10.6%)
CT 83.01	**\$22,881**	**\$6,785**	**1,425** **(36.8%)**
CT 84.01	\$30,817	\$9,038	1,849 (26.2%)
CT 84.02	\$27,147	\$9,274	600 (26.8%)

Table 9-2.
Restoration Area Population Below Poverty Level, 1999 (contd.)

Geographic Area	Median Household Income	Per Capita Income	Population Below Poverty Threshold
Madera County	$36,286	$14,682	24,514 (21.4%)
Chowchilla	$30,729	$11,927	1,450 (19.2%)
Madera	**$31,033**	**$11,674**	**13,921** **(32.5%)**
CT 1.02	$35,858	$19,071	555 (13.1%)
CT 4	$32,557	$12,718	236 (15.1%)
CT 10	$40,435	$17,945	992 (15.8%)
Merced County	$35,532	$14,257	45,059 (21.7%)
Atwater	$37,344	$15,162	4,261 (18.7%)
Los Banos	$43,690	$15,582	3,094 (12.1%)
Merced	$30,429	$13,115	17,489 (27.9%)
CT 4	$40,755	$15,607	1,129 (12.1%)
CT 9.01	$31,651	$14,007	702 (20.4%)
CT 20	$39,426	$16,622	1,291 (18.1%)
CT 21	$33,491	$16,505	884 (23.0%)
CT 24	$26,717	$12,727	2,230 (27.4%)
California	$47,493	$22,711	4,706,130 (14.2%)

Source: U.S. Census Bureau 2000a
Note:
* Total Area consists of all included census tracts
Boldface denotes areas with meaningfully greater low-income proportion (more than 28.4 percent)
Key:
% = percent

9.1.2 San Joaquin River from Merced River to the Delta and the Delta

This area comprises Contra Costa, Sacramento, Solano, San Joaquin, Stanislaus, and Yolo counties. The area potentially directly affected by the action alternatives is a small, rural subset of these five counties and the location of and effects from many actions cannot be determined at a fine scale. Thus, only large-scale data are presented. If significant adverse impacts may be localized in this area as a result of any project-level actions, a more detailed presentation and analysis of minority and low-income data will be included in project-level environmental documentation.

Minority Groups

Table 9-3 presents the racial and ethnic composition of potentially affected counties along the San Joaquin River from the Merced River to the Delta and in the Delta, which includes the counties of Contra Costa, Sacramento, San Joaquin, Solano, Stanislaus, and Yolo. Information for the State of California as a whole is presented for comparison purposes. These data, compiled from 2005 to 2007 by the U.S. Census Bureau, show that California has a proportion of total minorities of 57.0 percent, which is more than this study area as a whole (50.3 percent), and higher than four out of six included counties (Contra Costa, Sacramento, Stanislaus, and Yolo). Regardless, this area as a whole exhibits a proportion of minority residents greater than 50 percent, with the counties of San Joaquin and Solano exhibiting meaningfully high proportions of total minorities (59.8 and 55.4 percent, respectively). In contrast to the Restoration Area, the counties from Merced River to the Delta do not typically exhibit higher proportions of Hispanic residents than the analogous figure for the State. These counties exhibit higher proportions of African American residents, with Solano County exhibiting a 15.0 percentage, and this study area as a whole exhibiting at 9.5 percent (in contrast to California's 6.3 percent). This study area also has a higher proportion of Asian residents (13.4 percent), when compared to the State of California (12.2 percent).

Socioeconomic Indicators of Well-Being (Low-Income Groups)

Table 9-4 presents the median household income, per capita income, and proportion of individuals living below the poverty threshold for the potentially affected counties within this area. Information for the State of California as a whole is presented for comparison purposes. The data show that the counties in this study area generally have a similar proportion of those with low income when compared to the State of California as a whole, with Yolo County exhibiting the largest proportion at 16.5 percent. Per capita income and median household income for the counties are also similar to the State as a whole, with Contra Costa County exhibiting values that exceed the median household income and per capita income for any other county in this area, and the State as a whole. Contra Costa County also exhibits the lowest proportion of those living below the poverty threshold of any county in this study area (8.3 percent). At this scale, however, it is unknown where clusters of low-income residents may reside, although it is likely that residential areas with high proportions of low-income residents may be present in the urban centers and distributed throughout rural areas.

Table 9-3.
San Joaquin-Sacramento River Delta Race, Hispanic Origin, and Proportion of Total Minority, 2005–2007 Estimates

Geographic Area	Total Population	Race							Hispanic Origin		Total Minority[b]
		White	Black/ African American	American Indian and Alaska Native	Asian	Native Hawaiian/ Pacific Islander	Some Other Race	Two or More Races	White Alone, Non-Hispanic	All Races, Hispanic[a]	
Total Area	**4,155,520 (100.0%)**	**2,570,377 (61.9%)**	**359,912 (8.7%)**	**31,876 (0.8%)**	**516,194 (12.4%)**	**24,611 (0.6%)**	**478,944 (11.5%)**	**173,579 (4.2%)**	**2,063,660 (49.7%)**	**1,056,153 (25.4%)**	**2,091,860 (50.3%)**
Contra Costa	1,011,372 (100.0%)	609,869 (60.3%)	93,749 (9.3%)	4,091 (0.4%)	134,389 (13.3%)	3,970 (0.4%)	124,559 (12.3%)	40,745 (4.0%)	525,270 (51.9%)	220,862 (21.8%)	486,102 (48.1%)
Sacramento	1,373,773 (100.0%)	842,858 (61.4%)	138,501 (10.1%)	12,680 (0.9%)	184,209 (13.4%)	10,731 (0.8%)	126,769 (9.2%)	58,025 (4.2%)	728,397 (53.0%)	263,610 (19.2%)	645,376 (47.0%)
San Joaquin	**664,423 (100.0%)**	**404,925 (60.9%)**	**47,895 (7.2%)**	**5,609 (0.8%)**	**91,240 (13.7%)**	**3,144 (0.5%)**	**82,600 (12.4%)**	**29,010 (4.4%)**	**267,166 (40.2%)**	**237,416 (35.7%)**	**397,257 (59.8%)**
Solano	**408,388 (100.0%)**	**214,382 (52.5%)**	**61,226 (15.0%)**	**3,293 (0.8%)**	**57,284 (14.0%)**	**3,247 (0.8%)**	**48,463 (11.9%)**	**20,493 (5.0%)**	**182,076 (44.6%)**	**87,656 (21.5%)**	**226,312 (55.4%)**
Stanislaus	506,405 (100.0%)	368,492 (72.8%)	14,001 (2.8%)	4,603 (0.9%)	26,235 (5.2%)	2,468 (0.5%)	73,997 (14.6%)	16,582 (3.3%)	257,526 (50.9%)	193,369 (38.2%)	248,879 (49.1%)
Yolo	191,159 (100.0%)	129,851 (67.9%)	4,540 (2.4%)	1,600 (0.8%)	22,837 (11.9%)	1,051 (0.5%)	22,556 (11.8%)	8,724 (4.6%)	103,225 (54.0%)	53,240 (27.9%)	87,934 (46.0%)
California	**36,264,467 (100.0%)**	**21,892,718 (60.4%)**	**2,273,292 (6.3%)**	**263,496 (0.7%)**	**4,432,445 (12.2%)**	**128,245 (0.4%)**	**6,082,353 (16.8%)**	**1,191,918 (3.3%)**	**15,593,822 (43.0%)**	**12,954,535 (35.7%)**	**20,670,645 (57.0%)**

Source: U.S. Census Bureau 2008

Notes:

Boldface denotes areas with meaningfully greater total minority proportion (more than 50 percent)

[a] The term “Hispanic” is an ethnic category and can apply to members of any race, including respondents who self-identified as “white.” The total numbers of Hispanic residents for each geographic region are tabulated separately from the racial distribution by the U.S. Census Bureau. Hispanic information is taken from U.S. Census Bureau 2000a, while data regarding race are taken from U.S. Census Bureau 2000a, Table P7.

[b] “Total minority” is the aggregation of all non-white racial groups with the addition of all Hispanics, regardless of race. Total minority information is taken from U.S. Census Bureau 2000a, with the total for “Not Hispanic or Latino: White alone” subtracted from the total population.

Key:
% = percent

Table 9-4.
San Joaquin-Sacramento River Delta Population Below Poverty Level, 2005–2007 Estimates

Geographic Area	Median Household Income	Per Capita Income	Percent Population Below Poverty Threshold
Total Area	$52,872 – $75,483	$22,358 – $36,512	8.3% – 16.5%
Contra Costa	$75,483	$36,512	8.3%
Sacramento	$55,822	$26,405	12.5%
San Joaquin	$52,872	$22,358	14.4%
Solano	$65,533	$26,890	10.0%
Stanislaus	$50,375	$21,461	14.2%
Yolo	$54,307	$26,726	16.5%
California	$58,361	$28,049	13.0%

Source: U.S. Census Bureau 2008
Key:
% = percent

9.1.3 Central Valley Project/State Water Project Water Service Areas

This area represents the six-county region where Friant Division water is delivered for agricultural, municipal, and industrial uses. Minority and low-income data are presented for the counties of Fresno, Kern, Kings, Madera, Merced, and Tulare, as well as the cities of Clovis, Fresno, Reedley, Bakersfield, Delano, Wasco, Hanford, Lemoore, Madera, Atwater, Los Banos, Merced, Porterville, Tulare, and Visalia.

As this area may experience potential impacts to the agricultural industry, data describing minority participation in the agricultural industry, as well as income information, are presented in this section. The San Joaquin Valley is the one of the world’s most productive agricultural areas, with 8 million acres of land producing more than 250 crops. The action alternatives are anticipated to affect the amount of water available to the Friant Division water contractors for agricultural irrigation and municipal/industrial uses.

Minority Groups

Table 9-5 presents the racial and ethnic composition of potentially affected counties and municipalities in the CVP/SWP water service area. Information for the State of California as a whole is presented for comparison purposes. These data, compiled from 2005 to 2007 by the U.S. Census Bureau, show that most counties and cities within this study area exhibit a total minority proportion exceeding 50 percent, including some areas such as Delano, Wasco, and Madera that exhibit percentages exceeding 75 percent (91.6, 84.5, and 78.8 percent, respectively). Many of these cities and counties have Hispanic population proportions exceeding that of the State (35.7 percent), with the areas with the highest proportion of Hispanics being Wasco (73.4 percent), Delano (71.5 percent), and Madera (71.4 percent), suggesting that the high total minority percentages in the region are closely related to the proportion of Hispanic residents. While proportions of residents responding as being “two or more races” is generally consistent with the State for many of the cities and counties in this study area, the proportions of residents responding as “some other race” are higher in Fresno, Kern, Merced, and Tulare counties than California as a whole. With every geographic region exhibiting a total minority proportion more than 50 percent (with the exception of Clovis and Visalia), these data suggest that the region as a whole could be considered a large environmental justice population. Reedley data were unavailable from the U.S. Census detailing the number of Hispanic residents. Without this information, it is impossible to accurately quantify the number of minority residents in Reedley. It is likely, however, that Reedley would exhibit a total minority proportion more than 50 percent due to its high percentage of respondents of “some other race” (many of whom were known to respond as ethnically Hispanic in other geographic areas), and its location within Fresno County, which exhibits an overall total minority proportion of 63.6 percent. Similar race and ethnicity data from the 2000 decennial census for Reedley show a total minority percentage of 73.7 percent.

Table 9-6 presents the racial and ethnic composition of farm operators within the affected counties in the CVP/SWP water service area. The data show that the vast majority of farm operators in this study area are white, with the lowest percentage exhibited by Fresno County (86.3 percent). Proportions for the other five counties are all similar to that for the State of California as a whole (92.9 percent). Racial trends for this study area are generally similar to that of the State, with a slightly higher proportion of Native American farm operators in Madera County (2.3 percent) and Asian operators in Fresno County (10.8 percent). Hispanic farm operators are higher than the State average for this study area as a whole (12.7 percent), with Fresno County having the highest proportion in this study area (14.4 percent).

Table 9-7 presents the racial and ethnic composition of laborers and helpers within the affected counties in the CVP/SWP water service area. These data also include the racial and ethnic composition of the cities of Clovis, Fresno, Bakersfield, Merced, and Visalia. The category “laborers and helpers” excludes construction personnel, as they are captured under a different category by the U.S. Census Bureau; however, the category is not necessarily exclusive to farm laborers and the data may include other manual labor sectors as part of the total. Regardless, the race and ethnic composition of this sector suggests that laborers and helpers, as an employment sector, are generally of minority status, with Hispanics comprising the largest proportion of laborers in every geographic area except Clovis. The proportion of total minority laborers and helpers for the State of California (73.7 percent) is generally exceeded by the counties and cities in this study area, with this study area as a whole exhibiting a proportion of 84.8 percent. These data suggest that impacts to the agricultural industry could be considered to disproportionately accrue to environmental justice populations. According to CEQ Guidance (CEQ 1997), agencies may consider environmental justice communities either as a group of individuals living in geographic proximity to one other, or “a geographically dispersed/transient set of individuals (such as migrant workers or Native American[s]), where either type of group experiences common conditions of environmental exposure or effect.”

Table 9-5.
Friant Division Water Service Areas Race, Hispanic Origin, and Proportion of Total Minority, 2005-2007 Estimates

Geographic Area	Total Population	Race							Hispanic Origin		Total Minority[b]
		White	Black/ African American	American Indian and Alaska Native	Asian	Native Hawaiian/ Pacific Islander	Some Other Race	Two or More Races	White Alone, Non-Hispanic	All Races, Hispanic[a]	
Total Area*	**2,603,491 (100.0%)**	**1,692,235 (65.0%)**	**121,588 (4.7%)**	**27,320 (1.0%)**	**145,725 (5.6%)**	**3,462 (0.1%)**	**527,696 (20.3%)**	**85,465 (3.3%)**	**1,009,884 (38.8%)**	**1,266,938 (48.7%)**	**1,593,607 (61.2%)**
Fresno County	**886,074 (100.0%)**	**548,882 (61.9%)**	**45,072 (5.1%)**	**9,350 (1.1%)**	**77,225 (8.7%)**	**1,141 (0.1%)**	**173,834 (19.6%)**	**30,570 (3.5%)**	**322,503 (36.4%)**	**421,849 (47.6%)**	**563,571 (63.6%)**
Clovis	87,525 (100.0%)	63,368 (72.4%)	2,364 (2.7%)	840 (1.0%)	6,859 (7.8%)	353 (0.4%)	8,924 (10.2%)	4,817 (5.5%)	53,139 (60.7%)	22,035 (25.2%)	34,386 (39.3%)
Fresno	**471,722 (100.0%)**	**251,970 (53.4%)**	**38,285 (8.1%)**	**5,173 (1.1%)**	**55,238 (11.7%)**	**569 (0.1%)**	**103,717 (22.0%)**	**16,770 (3.6%)**	**160,398 (34.0%)**	**207,788 (44.0%)**	**311,324 (66.0%)**
Reedley	**23,624 (100.0%)**	**16,116 (68.2%)**	**122 (0.5%)**	**159 (0.7%)**	**921 (3.9%)**	**0 (0.0%)**	**5,806 (24.6%)**	**500 (2.1%)**	**** (**)**	**** (**)**	**** (**)**
Kern County	**771,347 (100.0%)**	**471,451 (61.1%)**	**44,326 (5.7%)**	**7,539 (1.0%)**	**29,568 (3.8%)**	**991 (0.1%)**	**189,834 (24.6%)**	**27,638 (3.6%)**	**330,119 (42.8%)**	**348,220 (45.1%)**	**441,228 (57.2%)**
Bakersfield	**312,478 (100.0%)**	**175,818 (56.3%)**	**25,533 (8.2%)**	**2,546 (0.8%)**	**17,051 (5.5%)**	**343 (0.1%)**	**78,299 (25.1%)**	**12,888 (4.1%)**	**134,529 (43.1%)**	**127,531 (40.8%)**	**177,949 (56.9%)**
Delano	**46,079 (100.0%)**	**23,960 (52.0%)**	**2,270 (4.9%)**	**264 (0.6%)**	**6,562 (14.2%)**	**116 (0.3%)**	**11,479 (24.9%)**	**1,428 (3.1%)**	**3,852 (8.4%)**	**32,937 (71.5%)**	**42,227 (91.6%)**
Wasco	**22,851 (100.0%)**	**13,791 (60.4%)**	**1,939 (8.5%)**	**91 (0.4%)**	**244 (1.1%)**	**112 (0.5%)**	**6,109 (26.7%)**	**565 (2.5%)**	**3,533 (15.5%)**	**16,770 (73.4%)**	**19,318 (84.5%)**
Kings County	**146,308 (100.0%)**	**100,013 (68.4%)**	**11,402 (7.8%)**	**2,009 (1.4%)**	**5,258 (3.6%)**	**188 (0.1%)**	**22,510 (15.4%)**	**4,928 (3.4%)**	**56,787 (38.8%)**	**69,413 (47.4%)**	**89,521 (61.2%)**
Hanford	**49,242 (100.0%)**	**36,053 (73.2%)**	**4,177 (8.5%)**	**373 (0.8%)**	**2,039 (4.1%)**	**0 (0.0%)**	**5,691 (11.6%)**	**909 (1.8%)**	**21,775 (44.2%)**	**20,768 (42.2%)**	**27,467 (55.8%)**

Table 9-5.
Friant Division Water Service Areas Race, Hispanic Origin, and Proportion of Total Minority, 2005-2007 Estimates (contd.)

Geographic Area	Total Population	Race							Hispanic Origin		Total Minority[b]
		White	Black/ African American	American Indian and Alaska Native	Asian	Native Hawaiian/ Pacific Islander	Some Other Race	Two or More Races	White Alone, Non-Hispanic	All Races, Hispanic[a]	
Lemoore	24,375 (100.0%)	16,565 (68.0%)	1,844 (7.6%)	140 (0.6%)	1,362 (5.6%)	139 (0.6%)	2,933 (12.0%)	1,392 (5.7%)	10,571 43.4	9,898 (40.6%)	13,804 (56.6%)
Madera County	143,656 (100.0%)	111,262 (77.5%)	5,569 (3.9%)	1,993 (1.4%)	2,932 (2.0%)	116 (0.1%)	16,676 (11.6%)	5,108 (3.6%)	60,043 41.8	70,836 (49.3%)	83,613 (58.2%)
Madera	52,215 (100.0%)	39,829 (76.3%)	1,976 (3.8%)	453 (0.9%)	1,263 (2.4%)	0 (0.0%)	7,147 (13.7%)	1,547 (3.0%)	11,081 21.2	37,302 (71.4%)	41,134 (78.8%)
Merced County	242,173 (100.0%)	153,401 (63.3%)	8,755 (3.6%)	2,282 (0.9%)	16,594 (6.9%)	644 (0.3%)	53,448 (22.1%)	7,049 (2.9%)	86,070 35.5	125,217 (51.7%)	156,103 (64.5%)
Atwater	30,414 (100.0%)	18,731 (61.6%)	1,569 (5.2%)	296 (1.0%)	1,747 (5.7%)	165 (0.5%)	7,050 (23.2%)	856 (2.8%)	11,496 37.8	14,475 (47.6%)	18,918 (62.2%)
Los Banos	33,726 (100.0%)	23,929 (71.0%)	1,162 (3.4%)	159 (0.5%)	1,170 (3.5%)	0 (0.0%)	5,882 (17.4%)	1,424 (4.2%)	10,108 21.2	20,594 (61.1%)	23,618 (70.0%)
Merced	70,460 (100.0%)	38,910 (55.2%)	4,457 (6.3%)	639 (0.9%)	7,423 (10.5%)	273 (0.4%)	15,858 (22.5%)	2,900 (4.1%)	23,760 33.7	33,106 (47.0%)	46,700 (66.3%)
Tulare County	413,933 (100.0%)	307,226 (74.2%)	6,464 (1.6%)	4,147 (1.0%)	14,148 (3.4%)	382 (0.1%)	71,394 (17.2%)	10,172 (2.5%)	154,362 37.3	231,403 (55.9%)	259,571 (62.7%)
Porterville	50,095 (100.0%)	31,705 (63.3%)	779 (1.6%)	681 (1.4%)	1,757 (3.5%)	22 (0.0%)	13,488 (26.9%)	1,663 (3.3%)	17,847 35.6	28,543 (57.0%)	32,248 (64.4%)

Table 9-5.
Friant Division Water Service Areas Race, Hispanic Origin, and Proportion of Total Minority, 2005-2007 Estimates (contd.)

Geographic Area	Total Population	Race							Hispanic Origin		Total Minority[b]
		White	Black/ African American	American Indian and Alaska Native	Asian	Native Hawaiian/ Pacific Islander	Some Other Race	Two or More Races	White Alone, Non-Hispanic	All Races, Hispanic[a]	
Tulare	**56,591 (100.0%)**	**40,543 (71.6%)**	**1,925 (3.4%)**	**352 (0.6%)**	**1,464 (2.6%)**	**83 (0.1%)**	**10,807 (19.1%)**	**1,417 (2.5%)**	**21,317 37.7**	**30,817 (54.5%)**	**35,274 (62.3%)**
Visalia	114,238 (100.0%)	91,645 (80.2%)	2,683 (2.3%)	1,005 (0.9%)	6,696 (5.9%)	94 (0.1%)	8,994 (7.9%)	3,121 (2.7%)	57,239 50.1	45,402 (39.7%)	56,999 (49.9%)
California	**36,264,467 (100.0%)**	**21,892,718 (60.4%)**	**2,273,292 (6.3%)**	**263,496 (0.7%)**	**4,432,445 (12.2%)**	**128,245 (0.4%)**	**6,082,353 (16.8%)**	**1,191,918 (3.3%)**	**15,593,822 (43.0%)**	**12,954,535 (35.7%)**	**20,670,645 (57.0%)**

Source: U.S. Census Bureau 2007

Notes:

* Total Area consists of all included counties

** Indicates that the U.S. Census ACS could not estimate value because the number of sample cases is too small.

Boldface denotes areas with meaningfully greater total minority proportion (more than 50 percent)

[a] The term "Hispanic" is an ethnic category and can apply to members of any race, including respondents who self-identified as "white." The total numbers of Hispanic residents for each geographic region are tabulated separately from the racial distribution by the U.S. Census Bureau. Hispanic information is taken from U.S. Census Bureau 2000a, while data regarding race are taken from U.S. Census Bureau 2000a, Table P7.

[b] *"Total minority" is the aggregation of all non-white racial groups with the addition of all Hispanics, regardless of race. Total minority information is taken from U.S. Census Bureau 2000a, with the total for "Not Hispanic or Latino: White alone" subtracted from the total population.*

Key:

% = percent

Table 9-6.
Friant Division Water Service Areas Race and Hispanic Origin of Farm Operators, 2002

Geographic Area	Total Farm Operators	White	Black/ African American	American Indian and Alaska Native	Asian	Native Hawaiian/ Pacific Islander	Two or More Races	All Races, Hispanic
Total Area*	29,878 (100.0%)	27,186 (91.0%)	117 (0.4%)	433 (1.4%)	1,856 (6.2%)	83 (0.3%)	203 (0.7%)	3,787 (12.7%)
Fresno County	9,211 (100.0%)	7,950 (86.3%)	38 (0.4%)	129 (1.4%)	995 (10.8%)	26 (0.3%)	73 (0.8%)	1,324 (14.4%)
Kern County	3,486 (100.0%)	3,270 (93.8%)	32 (0.9%)	57 (1.6%)	108 (3.1%)	7 (0.2%)	12 (0.3%)	283 (8.1%)
Kings County	1,816 (100.0%)	1,736 (95.6%)	6 (0.3%)	12 (0.7%)	41 (2.3%)	8 (0.4%)	13 (0.7%)	202 (11.1%)
Madera County	2,607 (100.0%)	2,374 (91.1%)	19 (0.7%)	60 (2.3%)	135 (5.2%)	7 (0.3%)	12 (0.5%)	214 (8.2%)
Merced County	4,358 (100.0%)	3,961 (90.9%)	8 (0.2%)	53 (1.2%)	288 (6.6%)	17 (0.4%)	31 (0.7%)	594 (13.6%)
Tulare County	8,400 (100.0%)	7,895 (94.0%)	14 (0.2%)	122 (1.5%)	289 (3.4%)	18 (0.2%)	62 (0.7%)	1,170 (13.9%)
California	120,901 (100.0%)	112,321 (92.9%)	388 (0.3%)	1,560 (1.3%)	5,379 (4.4%)	354 (0.3%)	899 (0.7%)	11,985 (9.9%)

Source: USDA 2002

Notes:

* Total Area consists of all included counties

“Total Minority” cannot be computed from the data provided by the USDA Agricultural Census, as a tabulation of “White Alone, Non-Hispanic” farm operators is not provided.

Key:

% = percent

Table 9-7.
Friant Division Water Service Areas Race, Hispanic Origin, and Proportion of Total Minority of Laborers and Helpers, 2000

Geographic Area*	Total Laborers and Helpers	Race						Hispanic Origin		Total Minority[b]
		White	Black/ African American	American Indian and Alaska Native	Asian	Native Hawaiian/ Pacific Islander	Two or More Races or Some Other Race	White Alone, Non-Hispanic	All Races, Hispanic[a]	
Total Area**	129,115 (100.0%)	19,640 (15.2%)	1,439 (1.1%)	704 (0.5%)	2,894 (2.2%)	58 (0.0%)	1,548 (1.2%)	19,640 (15.2%)	102,850 (79.7%)	109,475 (84.8%)
Fresno County	40,025 (100.0%)	5,425 (13.6%)	525 (1.3%)	210 (0.5%)	800 (2.0%)	4 (0.0%)	353 (0.9%)	5,425 (13.6%)	32,715 (81.7%)	34,600 (86.4%)
Clovis	1,465 (100.0%)	710 (48.5%)	4 (0.3%)	35 (2.4%)	55 (3.8%)	0 (0.0%)	30 (2.0%)	710 (48.5%)	630 (43.0%)	755 (51.5%)
Fresno	13,195 (100.0%)	2,200 (16.7%)	385 (2.9%)	115 (0.9%)	400 (3.0%)	4 (0.0%)	147 (1.1%)	2,200 (16.7%)	9,945 (75.4%)	10,995 (83.3%)
Kern County	33,065 (100.0%)	5,625 (17.0%)	520 (1.6%)	190 (0.6%)	1,180 (3.6%)	0 (0.0%)	408 (1.2%)	5,625 (17.0%)	25,145 (76.0%)	27,440 (83.0%)
Bakersfield	7,675 (100.0%)	1,800 (23.5%)	365 (4.8%)	55 (0.7%)	295 (3.8%)	0 (0.0%)	183 (2.4%)	1,800 (23.5%)	4,980 (64.9%)	5,875 (76.5%)
Kings County	6,680 (100.0%)	1,290 (19.3%)	45 (0.7%)	20 (0.3%)	44 (0.7%)	10 (0.1%)	119 (1.8%)	1,290 (19.3%)	5,150 (77.1%)	5,390 (80.7%)
Madera County	8,105 (100.0%)	1,270 (15.7%)	29 (0.4%)	85 (1.0%)	50 (0.6%)	19 (0.2%)	80 (1.0%)	1,270 (15.7%)	6,570 (81.1%)	6,835 (84.3%)
Merced County	11,980 (100.0%)	2,185 (18.2%)	190 (1.6%)	54 (0.5%)	310 (2.6%)	10 (0.1%)	289 (2.4%)	2,185 (18.2%)	8,950 (74.7%)	9,795 (81.8%)
Merced	2,660 (100.0%)	335 (12.6%)	70 (2.6%)	4 (0.2%)	80 (3.0%)	0 (0.0%)	55 (2.1%)	335 (12.6%)	2,105 (79.1%)	2,325 (87.4%)

Table 9-7.
Friant Division Water Service Areas Race, Hispanic Origin, and Proportion of Total Minority of Laborers and Helpers, 2000 (contd.)

Geographic Area*	Total Laborers and Helpers	Race						Hispanic Origin		Total Minority[b]
		White	Black/ African American	American Indian and Alaska Native	Asian	Native Hawaiian/ Pacific Islander	Two or More Races or Some Other Race	White Alone, Non-Hispanic	All Races, Hispanic[a]	
Tulare County	29,260 (100.0%)	3,845 (13.1%)	130 (0.4%)	145 (0.5%)	510 (1.7%)	15 (0.1%)	299 (1.0%)	3,845 (13.1%)	24,320 (83.1%)	25,415 (86.9%)
Visalia	3,220 (100.0%)	805 (25.0%)	20 (0.6%)	55 (1.7%)	90 (2.8%)	0 (0.0%)	75 (2.3%)	805 (25.0%)	2,170 (67.4%)	2,415 (75.0%)
California	875,550 (100.0%)	229,855 (26.3%)	36,945 (4.2%)	5,015 (0.6%)	34,350 (3.9%)	2,460 (0.3%)	16,350 (1.9%)	229,855 (26.3%)	550,575 (62.9%)	645,695 (73.7%)

Source: U.S. Census Bureau 2000b

Notes:

* Includes municipal areas with more than 50,000 residents (2000)

** Total Area consists of all included counties

[a] The term “Hispanic” is an ethnic category and can apply to members of any race, including respondents who self-identified as “white.” The total numbers of Hispanic residents for each geographic region are tabulated separately from the racial distribution by the U.S. Census Bureau. Hispanic information is taken from U.S. Census Bureau 2000a, while data regarding race are taken from U.S. Census Bureau 2000a, Table P7.

[b] “Total minority” is the aggregation of all non-white racial groups with the addition of all Hispanics, regardless of race, as tabulated by the EEO Data Tool.

Key:

% = percent

Socioeconomic Indicators of Well-Being (Low-Income Groups)

Table 9-8 presents the median household income, per capita income, and proportion of individuals living below the poverty threshold for the potentially affected counties and cities within this study area. Information for the State of California as a whole is presented for comparison purposes. The data show that each county within this study area has a proportion of low-income residents higher than that for the State (13.0 percent). In fact, only the cities of Clovis and Lemoore have proportions below the proportion in California, with 9.8 and 11.0 percent, respectively. Areas with meaningfully greater proportions, as identified by being twice as much as the State of California (26.0 percent), include the cities of Wasco and Merced, at 29.0 and 26.9 percent, respectively. Other municipalities have relatively high percentages as well, including Porterville (25.6 percent), Reedley (23.5 percent), Fresno (23.2 percent), Delano (23.1 percent), Madera (22.4 percent), and Tulare (20.4 percent). Delano also exhibits the lowest per capita income of any city in this study area ($11,546), with Wasco exhibiting the lowest median household income ($32,440).

Table 9-9 presents median annual wage information for farming occupations within the affected counties in the area of the Friant Division. While these data do not demonstrate as clearly as the U.S. Census data the proportion of residents living below the poverty threshold, the information presented in this table does suggest that median incomes in the farming industry are lower than the median income for all industries, with less skilled workers (graders and sorters, farmworkers) earning close to 50 percent of the median wage of all county industries combined, in some cases. These data suggest that impacts to the agricultural industry could be considered to disproportionately accrue to environmental justice populations.

Table 9-8. Friant Division Water Service Areas Population Below Poverty Level, 2005-2007 Estimates

Geographic Area	Median Household Income	Per Capita Income	Percent Population Below Poverty Threshold
Total Area*	$41,837 – $45,796	$16,951 – $19,803	17.8% – 22.7%
Fresno County	$44,979	$19,803	20.6%
Clovis	$60,610	$25,881	9.8%
Fresno	$41,546	$19,029	23.2%
Reedley	$42,198	$15,447	23.5%
Kern County	$44,620	$19,477	20.1%
Bakersfield	$50,918	$22,460	16.9%
Delano	$37,248	$11,546	23.1%
Wasco	$32,440	$12,309	29.0%
Kings County	$45,796	$16,951	19.4%
Hanford	$48,962	$20,465	15.7%
Lemoore	$53,779	$19,647	11.0%
Madera County	$44,534	$18,822	17.8%
Madera	$40,477	$16,083	22.4%
Merced County	$44,141	$18,132	19.7%
Atwater	$47,638	$18,859	19.5%
Los Banos	$49,673	$17,806	15.8%
Merced	$35,042	$17,088	26.9%
Tulare County	$41,837	$17,440	22.7%
Porterville	$35,633	$14,601	25.6%
Tulare	$44,330	$16,492	20.4%
Visalia	$50,316	$23,157	16.9%
California	$58,361	$28,049	13.0%

Note:
* Total area consists of all included counties.
Key:
% = percent

Table 9-9.
Friant Division Water Service Areas Agricultural Workers Median Annual Wages, 2008 (1st Quarter)

Geographic Area	Farming, Fishing, and Forestry Occupations – Overall	First-Line Supervisors	Agricultural Inspectors	Graders and Sorters	Equipment Operators	Farmworkers (Crop, Nursery, Greenhouse)	Farmworkers (Farm and Ranch Animals)	Agricultural Workers, All Other	Median Wage All Industries
Fresno County	$18,455	$24,018	$39,603	$19,043	$19,776	$17,680	$17,980	$28,776	$39,088
Kern County	$17,773	$28,456	na	$18,909	$21,716	$17,350	$20,767	na	$39,057
Kings County	$19,621	$38,715	$30,283	na	$30,283	$17,835	$21,355	$34,391	$38,290
Madera County	$18,351	$28,208	na	na	$20,746	$17,495	$18,847	na	$36,365
Merced County	$19,714	$36,445	na	$19,414	$21,696	$17,794	$20,591	na	$37,071
Tulare County	$19,260	$30,582	$40,233	$18,537	$25,649	$18,362	$25,133	$21,654	$34,502
California	$20,106	$35,753	$42,638	$18,981	$23,698	$18,382	$23,749	$30,943	$47,084

Source: California EDD 2008
Key:
na = not applicable

9.2 Regulatory Setting

This section describes the Federal, State, regional, and local regulatory setting related to environmental justice.

9.2.1 Federal

Federal laws and regulations pertaining to environmental justice in the study area are summarized briefly below.

Executive Order 12898

EO 12898 (59 FR 7629), entitled, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," was signed by President Clinton in 1994. The EO requires that Federal agencies identify and address, when appropriate, "…disproportionately high and adverse health or environmental effects of its projects, policies, and activities on minority populations and low-income populations.…" The EO also established an Interagency Working Group that would establish guidelines on criteria for identifying environmental justice populations and strategies to deal with environmental justice issues.

Council on Environmental Quality Guidance

The CEQ issued guidance in 1997 entitled, *Environmental Justice: Guidance under the National Environmental Policy Act* that established the role of EO 12898 as it relates to actions subject to NEPA. The guidance also established the criteria for identifying environmental justice populations and how to consider the involvement of environmental justice groups throughout phases of the NEPA process.

Environmental Compliance Memoranda No. ECM 95-3

The Department of the Interior Office of Environmental Policy and Compliance, in a letter responding to an earlier request by the Secretary of the Interior, confirms the requirement of EO 12898 for the Department of the Interior to consider impacts on minority and low-income populations and communities. The memorandum states, "[H]enceforth, all environmental documents should specifically analyze and evaluate the impacts of any proposed projects, actions or decisions on minority and low-income populations and communities, as well as the equity of the distribution of the benefits and risks of those decisions."

9.2.2 State of California

State laws and regulations pertaining to environmental justice are discussed below.

Senate Bill 115

SB 115 established the State of California as the first state to define environmental justice. SB 115 defines environmental justice as "the fair treatment of people of all races, cultures and income with respect to development, adoption and implementation of environmental laws, regulations and policies." SB 115 added this language to California Government Code Section 65040.12 and to Division 34 of the Public Resources Code relating to environmental quality. Finally, it also established the Governor's Office of

Planning and Research as the coordinating agency for State programs and requested that the California Environmental Protection Agency establish a model environmental justice policy for its boards, departments, and offices.

California Resources Agency Environmental Justice Policy

The California Resources Agency defines "environmental justice" in a manner consistent with the State of California as "the fair treatment of people of all races, cultures and income with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies." The agency states that its environmental justice policy is that the fair treatment of all people shall be considered during the planning, decision making, development, and implementation of its programs. The California Resources Agency intends for its policy "to ensure that the public, including minority and low-income populations, are informed of opportunities to participate in the development and implementation of all Resources Agency programs, policies and activities, and that they are not discriminated against, treated unfairly, or caused to experience disproportionately high and adverse human health or environmental effects from environmental decisions."

9.2.3 Regional and Local

There are no known regional or local plans or policies related to environmental justice.

9.3 Environmental Consequences and Mitigation Measures

This section describes the relative effects that the program alternatives would have on minority and low-income populations within the study area, with most of the analysis occurring within the Restoration Area counties because of the proximity of construction-related impacts to residents. This analysis is required under EO 12898, Environmental Justice (59 FR 7629). As described in the regulatory setting (Section 9.2), under EO 12898, demographic information is used to determine whether minority populations or low-income populations are present in the area potentially affected by the SJRRP. If so, a determination must be made regarding whether implementing the Settlement may cause disproportionately high and adverse human health or environmental impacts on those populations. It was determined that minority and low-income populations are present in the area potentially affected by implementation of the Settlement, and implementing the Settlement would cause disproportionately high and adverse human health or environmental impacts on those populations. Impacts that would be significant and unavoidable or potentially significant and unavoidable, after mitigation and, thus, that could cause disproportionately high and adverse effects, are presented in Table 9-10.

Chapter 29.0, "Consultation, Coordination, and Compliance," summarizes public participation activities and outreach initiatives associated with the SJRRP, including outreach initiatives that involved the surrounding minority communities and low-income stakeholders.

Table 9-10.
Impacts Potentially Causing Adverse Environmental Justice Effects

Alternative	Impact	Potential for Disproportionately High and Adverse Effects on Minority and Low-Income Populations
Environmental Justice: Program-Level		
No-Action	AIR-1: Construction-Related Emissions of Criteria Air Pollutants and Precursors	Yes
	AIR-2: Long-Term Operations-Related Emissions of Criteria Air Pollutants and Precursors	Yes
	AIR-3: Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants	Yes
	AIR-4: Exposure of Sensitive Receptors to Odor Emissions	No
	FSH-1: Changes in Water Temperatures in the San Joaquin River Between Friant Dam and the Merced River	Yes
	FSH-2: Changes in Pollutant Discharge in the San Joaquin River Between Friant Dam and the Merced River	Yes
	FSH-3: Changes in Sediment Discharge and Turbidity in the San Joaquin River Between Friant Dam and the Merced River	Yes
	VEG-3: Facilitate Increase in Distribution and Abundance of Invasive Plants in the Restoration Area	No
	VEG-10: Facilitate Increase in Distribution and Abundance of Invasive Plants Between the Merced River and the Delta	No
	LUP-1: Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts	Yes
	UTL-1: Potential Environmental Effects Associated with Needed Construction or Expansion of Water and Wastewater Treatment Facilities in the Restoration Area	Yes
	UTL-3: Potential for Insufficient Water Supply and Resources in the Restoration Area	Yes
	UTL-6: Potential for Insufficient Existing Water Supply and Resources Between the Merced River and the Delta	Yes

Table 9-10.
Impacts Potentially Causing Adverse Environmental Justice Effects (contd.)

Alternative	Impact	Potential for Disproportionately High and Adverse Effects on Minority and Low-Income Populations
Environmental Justice: Program-Level (contd.)		
A1-C2	AIR-1: Construction-Related Emissions of Criteria Air Pollutants and Precursors	Yes
	CLM-1: Construction-Related Emissions of GHGs in the Restoration Area	No
	LUP-1: Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts	Yes
	LUP-3: Conflict with Adopted Land Use Plans, Goals, Policies, and Ordinances of Affected Jurisdictions	Yes
	NOI-1: Exposure of Sensitive Receptors to Generation of Temporary and Short-Term Construction Noise	Yes
	NOI-2: Exposure of Sensitive Receptors to Increased Off-Site Traffic Noise Levels	Yes
	TRN-1: Reduced Traffic Circulation and Roadway Capacity	Yes
	VIS-2: Long-Term Changes in Scenic Vistas, Scenic Resources, and Existing Visual Character	No
Environmental Justice: Project-Level		
No-Action	AIR-5: Construction-Related Emissions of Criteria Air Pollutants and Precursors	Yes
	AIR-6: Operations-Related Emissions of Criteria Air Pollutants and Precursors	Yes
	AIR-7: Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants	Yes
	AIR-8: Exposure of Sensitive Receptors to Odor Emissions	No
	FSH-15: Changes in Water Temperatures and Dissolved Oxygen Concentrations in the San Joaquin River Upstream from Friant Dam	Yes
	FSH-22: Changes in Water Temperatures and Dissolved Oxygen Concentrations in the San Joaquin River Between Friant Dam and the Merced River	Yes
	FSH-23: Changes in Pollutant Discharge and Mobilization in the San Joaquin River Between Friant Dam and the Merced River	Yes
	FSH-24: Changes in Sediment Discharge and Turbidity in the San Joaquin River Between Friant Dam and the Merced River	Yes

Table 9-10.
Impacts Potentially Causing Adverse Environmental Justice Effects (contd.)

Alternative	Impact	Potential for Disproportionately High and Adverse Effects on Minority and Low-Income Populations
Environmental Justice: Project-Level (contd.)		
No-Action	FSH-31: Changes in Water Temperatures and Dissolved Oxygen Concentrations in the Delta	Yes
	FSH-38: Salinity Changes in the Delta	No
	FSH-39: Changes to Delta Inflow and Flow Patterns in the Delta	Yes
	VEG-18: Facilitate Increase in Distribution and Abundance of Invasive Plants in Sensitive Natural Communities in the Restoration Area	No
	GRW-4: Changes in Groundwater Levels in CVP/SWP Water Service Areas	Yes
	GRW-5: Changes in Groundwater Quality in CVP/SWP Water Service Areas	Yes
	SWS-5: Change in Recurrence of Delta Excess Conditions	No
	UTL-9: Potential Environmental Effects Associated with Needed Construction or Expansion of Water and Wastewater Treatment Facilities in the Restoration Area	Yes
	UTL-11: Potential for Insufficient Water Supply and Resources in the Restoration Area	Yes
A1-C2	CLM-4: Operational Emissions of GHGs in the Delta	No
	GRW-4: Changes in Groundwater Levels in CVP/SWP Water Service Areas	Yes
	GRW-5: Changes in Groundwater Quality in CVP/SWP Water Service Areas	Yes
	LUP-5: Substantial Diminishment of Agricultural Land Resource Quality and Importance Because of Altered Inundation and/or Soil Saturation	Yes
	LUP-8: Substantial Diminishment of Agricultural Land Resource Quality and Importance Because of Altered Water Deliveries	Yes
	UTL-11: Potential for Insufficient Existing Water Supply and Resources in the Restoration Area	Yes
	UTL-16: Potential for Insufficient Existing Water Supply and Resources from Recapture of Interim and Restoration Flows Between the Merced River and the Delta	No

Key:
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
GHG = greenhouse gas
SWP = State Water Project

9.3.1 Impact Assessment Methodology

The methodology for assessing environmental justice impacts starts with an examination of all potentially significant and unavoidable, or significant and unavoidable, impact conclusions after mitigation throughout this Draft PEIS/R, in addition to those cumulative effects discussed in Chapter 26.0, “Cumulative Effects.” If the impacts remain potentially significant and unavoidable, or significant and unavoidable, despite implementation of all mitigation measures, an evaluation was conducted regarding whether the resulting impacts after mitigation would result in disproportionately high and adverse effects on minority and/or low-income populations.

9.3.2 Disproportionately High and Adverse Criteria

The CEQ recommends that the following three factors be considered by the environmental justice analysis to determine whether disproportionately high and adverse impacts may accrue to minority or low-income populations:

- Whether there is or would be an impact on the natural or physical environment that significantly and adversely affects a minority population, low-income population, or Indian tribe. Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural or physical environment.
- Whether the environmental effects are significant and are, or may be, having an adverse impact on minority populations, low-income populations, or Indian tribes that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group.
- Whether the environmental effects occur or would occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards.

If an impact remains significant after all mitigation is implemented, then the impact is included in the environmental justice analysis, and the equity of the impact across the study area population is determined. Because of the large-scale nature of the program- and project-level actions, the environmental justice analysis presented in this Draft PEIS/R is evaluated at a broader, more regional scale. In instances where the location of the impact could be described, the demographic characteristics of the surrounding area were assessed to determine whether a minority or low-income population meaningfully greater than the proportion of minority and/or low-income residents in the general population was present. “Meaningfully greater” populations were interpreted to be either 50 percent of the total population of the geographic unit or simply “greater” than any other population group within the surrounding, larger geography (which provides for a more conservative analysis). In instances where the type of impact would be program-level and spread over a large area but would affect a minority or low-income community disproportionately, these impacts were assessed separately from demographic characteristics for any single geographical area.

Future environmental review documents developed for specific project-level evaluation of the program-level actions can tier from the Final PEIS/R for environmental justice effects, but some project-level analysis may be necessary at a localized scale as more specific project-level information becomes available. Potentially significant and unavoidable impacts and significant and unavoidable impacts are identified in other PEIS/R chapters, and environmental review documents for future project-level actions will likely include an environmental justice evaluation at the project-level for these resource areas:

- Air Quality
- Land Use Planning and Agricultural Resources
- Noise
- Transportation and Infrastructure

9.3.3 Program-Level Impacts

This section presents the program-level impacts that were determined to be significant and unavoidable or potentially significant and unavoidable, after mitigation, and evaluates whether those impacts may cause disproportionately high and adverse human health or environmental impacts on minority or low-income populations.

No-Action Alternative

Program-level impacts determined to be significant and unavoidable, or potentially significant and unavoidable, after mitigation, could occur under the No-Action Alternative in the Restoration Area, along the San Joaquin River from the Merced River to the Delta, and in the Delta.

Impact AIR-1 (No-Action Alternative): ***Construction-Related Emissions of Criteria Air Pollutants and Precursors – Program-Level.*** Under the No-Action Alternative, the existing regulatory framework would likely minimize adverse effects from emission of criteria air pollutants and precursors in localized areas. Local regulations that require dust abatement and criteria pollutant emissions reduction during construction are expected to reduce these impacts. However, there could be residual significant and unavoidable impacts, and regional effects could disproportionately affect low-income groups. If the SJVAB remains in nonattainment status for criteria air pollutants, then health impacts associated with poor air quality could affect low-income residents with less access to health care. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact AIR-2 (No-Action Alternative): ***Operations-Related Emissions of Criteria Air Pollutants and Precursors – Program-Level.*** Under the No-Action Alternative, the existing regulatory framework would likely minimize adverse air quality effects from long-term operation-related emissions in localized areas. Local regulations that require dust abatement and criteria pollutant emissions reduction during construction are expected to reduce these impacts. However, there could be residual significant and unavoidable impacts, and regional effects could disproportionately affect low-income groups. If the SJVAB remains in nonattainment status for criteria air pollutants, then health impacts associated with poor air quality could affect low-income residents with less access to health care. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact AIR-3 (No-Action Alternative): ***Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants – Program-Level.*** This analysis and conclusion is the same as Impact AIR-2 (No-Action Alternative). Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact AIR-4 (No-Action Alternative): ***Exposure of Sensitive Receptors to Odor Emissions – Program-Level.*** Under the No-Action Alternative, the existing regulatory framework would likely minimize adverse effects of odor emissions in localized areas. Although a significant and unavoidable impact, there would be no disproportionate impacts on minority and low-income populations. Disproportionately high and adverse effects on minority and low-income populations **would not occur**.

Impact FSH-1 (No-Action Alternative): ***Changes in Water Temperatures in the San Joaquin River Between Friant Dam and the Merced River – Program-Level.*** Under the No-Action Alternative, water temperatures in the downstream portions of Reach 1 and the wetted portions of Reach 2, particularly during summer and fall, could increase. Increased water temperatures in this reach could affect cold-water species (e.g., rainbow trout) and other representative species (e.g., hardhead, Kern Brook lamprey, black bass) found in wetted portions of Reaches 1 and 2. This potentially significant impact on game species (such as rainbow trout and black bass) could affect subsistence fishing in Reach 1, which would disproportionately affect low-income groups. Disproportionately high and adverse effects on low-income populations **could occur**.

Impact FSH-2 (No-Action Alternative): ***Changes in Pollutant Discharge in the San Joaquin River Between Friant Dam and the Merced River – Program-Level.*** Under the No-Action Alternative, potential increased discharges and nonpoint source runoff of agricultural pollutants because of the planned Grassland Bypass Project extension may impair reproduction or other essential behaviors of special-status and game fish species found in Reach 5 of the Restoration Area (e.g., Sacramento splittail, black bass, striped bass). This analysis and conclusion is similar to Impact FSH-1 (No-Action Alternative). Disproportionately high and adverse effects on low-income populations **could occur**.

Impact FSH-3 (No-Action Alternative): ***Changes in Sediment Discharge and Turbidity in the San Joaquin River Between Friant Dam and the Merced River – Program-Level.*** Under the No-Action Alternative, potential increased discharges and nonpoint source runoff of suspended sediments because of the planned Grassland Bypass Project extension may affect special-status and game fish species found in the San Joaquin River downstream from the Merced River confluence (e.g., Sacramento splittail, black bass, striped bass). This analysis and conclusion is similar to Impact FSH-1 (No-Action Alternative). Disproportionately high and adverse effects on low-income populations **could occur**.

Impact VEG-3 (No-Action Alternative): ***Facilitate Increase in Distribution and Abundance of Invasive Plants in the Restoration Area – Program-Level.*** Under the No-Action Alternative, existing populations of invasive plant species would continue to be introduced and spread along the San Joaquin River. The spread of invasive species could reduce recreational values and increase operations and maintenance costs. These impacts resulting from the continued increase in the distribution and abundance of nonnative invasive vegetation in the Restoration Area would not disproportionately affect low-income populations or minority groups because the adverse affects are distributed over a large geographic area and would equally affect all economic and racial/ethnic populations. Disproportionately high and adverse effects on minority and low-income populations **would not occur.**

Impact VEG-10 (No-Action Alternative): ***Facilitate Increase in Distribution and Abundance of Invasive Plants Between the Merced River and the Delta – Program-Level.*** Under the No-Action Alternative, existing populations of invasive plant species would continue to be introduced and spread in the Delta. The spread of invasive species could reduce recreational values and increase operations and maintenance costs. These impacts resulting from the continued increase in the distribution and abundance of nonnative invasive vegetation in the Delta would not disproportionately affect low-income populations or minority groups because the adverse effects would be distributed over a large geographic area and would equally affect all economic and racial/ethnic populations. Disproportionately high and adverse effects on minority and low-income populations **would not occur.**

Impact LUP-1 (No-Action Alternative): ***Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts – Program-Level.*** Under the No-Action Alternative, some land would be converted in a manner inconsistent with local policies that call for the agricultural productivity of Important Farmland to be preserved and Williamson Act contracts to be maintained to the extent possible. This significant and unavoidable impact is not expected to disproportionately affect specific geographic concentrations of low-income populations or minority groups because the effects would be distributed across broad geographical areas of the State. However, the agricultural workers affected by reduced acreage of farmland are disproportionately racial and/or ethnic minorities relative to California's demographics. The percentage of low-income agricultural workers who work in this area is also high. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact UTL-1 (No-Action Alternative): ***Potential Environmental Effects Associated with Needed Construction or Expansion of Water and Wastewater Treatment Facilities in the Restoration Area – Program-Level.*** Population increases in Fresno, Madera, and Merced counties projected under the No-Action Alternative would likely result in the need for increased water and wastewater treatment capacity. Therefore, this impact would be potentially significant. The Restoration Area, which includes the counties of Fresno, Madera, and Merced, exhibits proportions of minority residents in excess of 50 percent and communities exhibiting high proportions of low-income residents. Thus, disproportionately high and adverse impacts related to water supply would occur in residential areas within the counties with high proportions of minority and low-income residents. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact UTL-3 (No-Action Alternative): ***Potential for Insufficient Water Supply and Resources in the Restoration Area – Program-Level.*** Population increases in Fresno, Madera, and Merced counties projected under the No-Action Alternative would likely increase the demand for water supply in the Restoration Area. Because this region's groundwater resources are expected to remain in a state of overdraft, and surface water supplies have been fully allocated, existing water rights or contracts and resources would be unable to meet new water supply demand. This analysis and conclusion is similar to Impact UTL-1 (No-Action Alternative). Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact UTL-6 (No-Action Alternative): ***Potential for Insufficient Existing Water Supply and Resources Between the Merced River and the Delta – Program-Level.*** Population increases in Stanislaus County projected under the No-Action Alternative would likely increase the demand for water supply between the Merced River and the Delta. Because this region's groundwater resources are expected to remain in a state of overdraft, and surface water supplies have been fully allocated, existing water rights or contracts and resources would be unable to meet new water supply demand. This analysis and conclusion is similar to Impact UTL-1 (No-Action Alternative). Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Alternatives A1 Through C2

Program-level impacts determined to be significant and unavoidable, or potentially significant and unavoidable, after mitigation, could occur under Alternatives A1 through C2 in the Restoration Area along the San Joaquin River from the Merced River to the Delta, and in the Delta.

Impact AIR-1 (Alternatives A1 through C2): ***Construction-Related Emissions of Criteria Air Pollutants and Precursors – Program-Level.*** The construction phase of restoration activities associated with Alternatives A1 through C2 would result in a temporary but significant increase in air pollutants. Recommended mitigation measures would result in a project-level analysis of construction-related emissions during subsequent environmental review. Depending on the results of this subsequent analysis, it is possible that disproportionately high and adverse air quality impacts would occur on residential areas with a high proportion of minority or low-income residents. Therefore, a more focused environmental justice evaluation will likely be necessary in project-level environmental documents to evaluate the effects of project-level actions on air quality, and resulting effects on minority and low-income populations. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact CLM-1 (Alternatives A1 and B1): ***Construction-Related Emissions of GHGs – Program-Level.*** Construction activities performed under Alternatives A1 and B1 could generate substantial quantities of GHGs. Implementing feasible mitigation would help reduce GHG emissions by individual projects, and could result in a less-than-significant impact. However, without specific project-level information, the levels of GHG emissions after mitigation cannot be quantified at this time. Thus, without relying on speculation, it is assumed that construction-generated GHG emissions could be a considerable contribution to a significant cumulative impact. The global nature of this impact, however, has little relevance in environmental justice analysis. Disproportionately high and adverse effects on minority and low-income populations **would not occur**.

Impact LUP-1 (Alternatives A1 through C2): ***Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts – Program-Level.*** Proposed land use conversions associated with Alternatives A1 through C2 would be inconsistent with local policies that call for the agricultural productivity of Important Farmland to be preserved and Williamson Act contracts to be maintained to the extent possible. The conversion of Important Farmland and cancellation of Williamson Act contracts could occur in the Restoration Area. This significant and unavoidable impact is not expected to disproportionately affect specific geographic concentrations of low-income populations or minority groups because the effects would be distributed across broad geographical areas of the State. However, the agricultural workers affected by reduced acreage of farmland are disproportionately racial and/or ethnic minorities relative to California's demographics. The percentage of low-income agricultural workers who work in this area is also high. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact LUP-3 (Alternatives A1 through C2): ***Conflict with Adopted Land Use Plans, Goals, Policies, and Ordinances of Affected Jurisdictions – Program-Level.*** Proposed land use conversion associated with Alternatives A1 through C2 would conflict with adopted land use plans, goals, policies, and ordinances throughout the study area, including the Restoration Area. No mitigation measures are available. The affected population includes areas exhibiting a high proportion of minority or low-income residents, as well as areas with relatively few minority or low-income residents. Depending on the types of land use changes and their locations within the study area, disproportionately high and adverse impacts could occur on residential areas with a high proportion of minority or low-income residents. Therefore, a more focused environmental justice evaluation will likely be necessary in project-level environmental documents to evaluate the effects of project-level actions on land use planning and agricultural resources, and resulting effects on minority and low-income populations. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact NOI-1 (Alternatives A1 through C2): ***Exposure of Sensitive Receptors to Generation of Temporary and Short-Term Construction Noise – Program-Level.*** Proposed construction activities associated with Alternatives A1 through C2 would result in significant increases in noise pollution surrounding the construction sites. Despite mitigation measures that would reduce short-term noise levels caused by construction, this impact would likely remain significant. The impact would occur in the Restoration Area. Noise-generating activities would occur only during daylight hours with implementation of mitigation measures and commitments to adhere to local noise ordinances. The affected population includes areas exhibiting a high proportion of minority and low-income residents, as well as areas with relatively few minority or low-income residents. Depending on the type and location of construction activities, it is possible that disproportionately high and adverse noise impacts would occur on residential areas with a high proportion of minority or low-income residents. Therefore, a more focused environmental justice evaluation will likely be necessary in project-level environmental documents to evaluate the effects of project-level actions on the noise environment, and resulting effects on minority and low-income populations.

Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact NOI-2 (Alternatives A1 through C2): ***Exposure of Sensitive Receptors to Increased Off-Site Traffic Noise Levels – Program-Level.*** Proposed construction activities associated with Alternatives A1 through C2 would result in significantly increased off-site noise levels along roadway segments. Despite mitigation measures that would reduce short-term noise levels from construction-related traffic increases, this impact would be significant. The impact would occur in the Restoration Area. The affected population includes areas exhibiting a high proportion of minority and low-income residents, as well as areas with relatively few minority or low-income residents. Depending on the type and location of construction activities, it is possible that disproportionately high and adverse noise impacts would occur on residential areas with a high proportion of minority or low-income residents. Therefore, a more focused environmental justice evaluation will likely be necessary in project-level environmental documents to evaluate the effects of project-level actions on the noise environment, and resulting effects on minority and low-income populations. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact TRN-1 (Alternatives A1 through C2): ***Reduced Traffic Circulation and Roadway Capacity – Program-Level.*** Proposed changes associated with Alternatives A1 through C2 could reduce traffic circulation and roadway capacity to a level considered to be potentially significant. Mitigation measures identified may minimize impacts on traffic circulation and roadway capacity, but the impact is still considered to be potentially significant and unavoidable after mitigation. The affected population includes areas exhibiting a high proportion of minority and low-income residents, as well as areas with relatively few minority and low-income residents. Depending on the type and location of construction activities, it is possible that disproportionately high and adverse impacts would occur in areas with a high proportion of minority or low-income residents. Therefore, a more focused environmental justice evaluation will likely be necessary in project-level environmental documents to evaluate the effects of project-level actions on traffic circulation and roadway capacity and resulting effects on minority and low-income populations. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact VIS-2 (Alternatives A1 through C2): ***Long-Term Changes in Scenic Vistas, Scenic Resources, and Existing Visual Character – Program-Level.*** Restoration activities associated with Alternatives A1 through C2 would significantly affect the visual character of the Restoration Area. Despite mitigation measures involving the screening of new facilities, the impact would be significant. The affected population includes areas exhibiting a high proportion of minority and low-income residents, as well as areas with relatively few minority or low-income residents. Project impacts would not be concentrated in areas with meaningfully greater populations for which environmental justice impacts were analyzed, and the distribution of project impacts would not disproportionately accrue to minority or low-income residents compared with the general population along the restoration corridor. Disproportionately high and adverse effects on minority and low-income populations **would not occur**.

9.3.4 Project-Level Impacts

This section presents the project-level impacts that were determined to be significant and unavoidable or potentially significant and unavoidable, after mitigation, and evaluates whether those impacts may cause disproportionately high and adverse human health or environmental impacts on minority or low-income populations.

No-Action Alternative

Project-level impacts determined to be significant and unavoidable, or potentially significant and unavoidable, after mitigation, could occur under the No-Action Alternative in the Restoration Area, along the San Joaquin River from the Merced River to the Delta, in the Delta, and in the CVP/SWP water service areas.

Impact AIR-5 (No-Action Alternative): ***Construction-Related Emissions of Criteria Air Pollutants and Precursors – Project-Level.*** This analysis and conclusion is the same as Impact AIR-1 (No-Action Alternative) above. Regional effects could disproportionately affect minority and low-income populations. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact AIR-6 (No-Action Alternative): ***Operations-Related Emissions of Criteria Air Pollutants and Precursors – Project-Level.*** This analysis and conclusion is the same as Impact AIR-2 (No-Action Alternative). Regional effects could disproportionately affect minority and low-income populations. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact AIR-7 (No-Action Alternative): ***Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants – Project-Level.*** This analysis and conclusion is the same as Impact AIR-3 (No-Action Alternative). Regional effects could disproportionately affect minority and low-income populations. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact AIR-8 (No-Action Alternative): ***Exposure of Sensitive Receptors to Odor Emissions – Project-Level.*** This analysis and conclusion is the same as Impact AIR-4 (No-Action Alternative). Regional effects would likely not disproportionately affect minority and low-income populations. Disproportionately high and adverse effects on minority and low-income populations **would not occur**.

Impact FSH-15 (No-Action Alternative): ***Changes in Water Temperatures and Dissolved Oxygen Concentrations in the San Joaquin River Upstream from Friant Dam – Project-Level.*** This analysis and conclusion is the same as Impact FSH-1 (No-Action Alternative) above. Disproportionately high and adverse effects on low-income populations **could occur**.

Impact FSH-22 (No-Action Alternative): ***Changes in Water Temperatures and Dissolved Oxygen Concentrations in the San Joaquin River Between Friant Dam and the Merced River – Project-Level.*** This analysis and conclusion is the same as Impact FSH-2 (No-Action Alternative) above. Disproportionately high and adverse effects on low-income populations **could occur**.

Impact FSH-23 (No-Action Alternative): ***Changes in Pollutant Discharge and Mobilization in the San Joaquin River Between Friant Dam and the Merced River – Project-Level.*** This analysis and conclusion is the same as Impact FSH-3 (No-Action Alternative) above. Disproportionately high and adverse effects on low-income populations **could occur**.

Impact FSH-24 (No-Action Alternative): ***Changes in Sediment Discharge and Turbidity in the San Joaquin River Between Friant Dam and the Merced River – Project-Level.*** This impact is the same as Impact FSH-23 (No-Action Alternative), previously described for program-level impacts. Disproportionately high and adverse effects on low-income populations **could occur**.

Impact FSH-31 (No-Action Alternative): ***Changes in Water Temperatures and Dissolved Oxygen Concentrations in the Delta – Project-Level.*** Under the No-Action Alternative, water temperatures in the Delta could increase, which could adversely affect cold-water fish species, including Central Valley fall-run Chinook salmon, Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, Central Valley steelhead, and other special-status species that use the Delta. This potentially significant impact on game species (such as rainbow trout and black bass) could affect subsistence fishing in the Delta, which would disproportionately affect low-income groups. Disproportionately high and adverse effects on low-income populations **could occur**.

Impact FSH-38 (No-Action Alternative): ***Salinity Changes in the Delta – Project-Level.*** Average sea level is expected to rise about 1 foot by 2030, which would cause increased salinities in the Delta. Delta smelt and longfin smelt both spawn in the fresher water portions of the Delta, and delta smelt remain in areas with low salinities throughout their life cycle. Increased salinity would likely be stressful to delta smelt and longfin smelt, particularly during their egg and larval stages. These impacts would not disproportionately affect low-income populations or minority groups because the affected species (delta smelt and longfin smelt) are not game fish. Disproportionately high and adverse effects on minority and low-income populations **would not occur.**

Impact FSH-39 (No-Action Alternative): ***Changes to Delta Inflow and Flow Patterns in the Delta – Project-Level.*** Inflow from the major tributaries of the Delta is expected to increase during winter months and decrease during spring and early summer because of reduced snowpack associated with global climate change. The changes in seasonal inflows are likely to adversely 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. This potentially significant impact on game species (particularly salmon) could affect subsistence fishing in the Delta, which would disproportionately affect low-income groups. Disproportionately high and adverse effects on low-income populations **could occur**.

VEG-18 (No-Action Alternative): ***Facilitate Increase in Distribution and Abundance of Invasive Plants in Sensitive Natural Communities in the Restoration Area – Project-Level.*** Under the No-Action Alternative, existing populations of invasive plant species would continue to be introduced and spread along the San Joaquin River. The spread of invasive species can reduce recreational values and increase operations and maintenance costs. These impacts resulting from the continued increase in the distribution and abundance of nonnative invasive vegetation in the Restoration Area would not disproportionately affect minority and low-income populations because the adverse effects are distributed over a large geographic area and would equally affect all economic and ethnic populations. Disproportionately high and adverse effects on minority and low-income populations **would not occur**.

GRW-4 (No-Action Alternative): ***Change in Groundwater Levels in CVP/SWP Water Service Areas – Project-Level.*** The No-Action Alternative could result in changes in groundwater levels throughout CVP/SWP water service areas, which include the counties of Fresno, Kern, Kings, Madera, Merced, and Tulare. The six counties exhibit proportions of minority residents in excess of 50 percent, and communities exhibiting high proportions of low-income residents in this area include Orange Cove, Madera, and Lindsay. Thus, disproportionately high and adverse impacts related to groundwater could occur to residential areas within the counties with high proportions of minority and low-income residents. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

GRW-5 (No-Action Alternative): ***Change in Groundwater Quality in CVP/SWP Water Service Areas – Project-Level.*** The No-Action Alternative could result in changes in groundwater quality throughout CVP/SWP water service areas, which include the counties of Fresno, Kern, Kings, Madera, Merced, and Tulare. The six counties exhibit proportions of minority residents in excess of 50 percent, and communities exhibiting high proportions of low-income residents in this area include Orange Cove, Madera, and Lindsay. Thus, disproportionately high and adverse impacts related to groundwater could occur to residential areas within the counties with high proportions of minority and low-income residents. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact SWS-5 (No-Action Alternative): ***Change in Recurrence of Delta Excess Conditions – Project-Level.*** The No-Action Alternative could result in a change of recurrence of Delta excess conditions at a frequency potentially impacting CCWD's ability to fill Los Vaqueros Reservoir. This would adversely affect CCWD's ability to make water supply deliveries; however, Contra Costa County also exhibits the lowest proportion of those living below the poverty threshold of any county in this study area and these impacts would equally affect all economic and ethnic populations. Disproportionately high and adverse effects on minority and low-income populations **would not occur**.

Impact UTL-9 (No-Action Alternative): ***Potential Environmental Effects Associated with Needed Construction or Expansion of Water and Wastewater Treatment Facilities in the Restoration Area – Project -Level.*** Population increases in Fresno, Madera, and

Merced counties projected under the No-Action Alternative would likely result in the need for increased water and wastewater treatment capacity. The three counties exhibit proportions of minority residents in excess of 50 percent and communities exhibiting high proportions of low-income residents. Thus, disproportionately high and adverse impacts related to water supply would occur in residential areas within the counties with high proportions of minority and low-income residents. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact UTL-11 (No-Action Alternative): ***Potential for Insufficient Water Supply and Resources in the Restoration Area – Project -Level.*** Population increases in Fresno, Madera, and Merced counties projected under the No-Action Alternative would likely increase the demand for water supply in the Restoration Area. Because this region's groundwater resources are expected to remain in a state of overdraft, and surface water supplies have been fully allocated, existing water rights or contracts and resources would be unable to meet new water supply demand. The three counties exhibit proportions of minority residents in excess of 50 percent and communities exhibiting high proportions of low-income residents. Thus, disproportionately high and adverse impacts related to water supply would occur in residential areas within the counties with high proportions of minority and low-income residents. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Alternatives A1 Through C2

Significant project-level impacts determined to be significant and unavoidable after mitigation would occur under Alternatives A1 through C2 in the Restoration Area, along the San Joaquin River from the Merced River to the Delta, and in the Delta.

Impact CLM-4 (Alternatives A1 through C2): ***Operational Emissions of GHGs – Project Level.*** GHG emissions from flow releases related to Alternatives A1 through C2 were evaluated and found to be substantial. As a result of project-level actions, GHG emissions could be increased through traffic from increased recreational visitors, and increased by increased groundwater pumping and changes in CVP/SWP energy generation and consumption. These impacts, as well as potential effects of the project that could offset or decrease GHG emissions, are discussed in greater detail below. Overall, this is potentially a considerable contribution to a significant cumulative impact. However, without specific project-level information, the levels of GHG emissions after mitigation cannot be quantified at this time. Thus, without relying on speculation, it is assumed that construction-generated GHG emissions could be a considerable contribution to a significant cumulative impact. The global nature of this impact, however, has little relevance in environmental justice analysis. Disproportionately high and adverse effects on minority and low-income populations **would not occur**.

GRW-4 (Alternatives A1 through C2): ***Change in Groundwater Levels in CVP/SWP Water Service Areas – Project-Level.*** The proposed Interim and Restoration flows associated with Alternatives A1 through C2 could result in changes in groundwater levels throughout CVP/SWP water service areas, which include the counties of Fresno, Kern, Kings, Madera, Merced, and Tulare. The six counties exhibit proportions of minority residents in excess of 50 percent, and communities exhibiting high proportions of low-income residents in this area include Orange Cove, Madera, and Lindsay. It is likely that disproportionately high and adverse impacts related to groundwater could occur to residential areas within the counties with high proportions of minority and low-income residents. Disproportionately high and adverse effects on minority and low-income populations **could occur.**

GRW-5 (Alternatives A1 through C2): ***Change in Groundwater Quality in CVP/SWP Water Service Areas – Project-Level.*** The proposed Interim and Restoration flows associated with Alternatives A1 through C2 could result in changes in groundwater quality throughout CVP/SWP water service areas, which include the counties of Fresno, Kern, Kings, Madera, Merced, and Tulare. The six counties exhibit proportions of minority residents in excess of 50 percent, and communities exhibiting high proportions of low-income residents in this area include Orange Cove, Madera, and Lindsay. It is likely that disproportionately high and adverse impacts related to groundwater could occur to residential areas within the counties with high proportions of minority and low-income residents. Disproportionately high and adverse effects on minority and low-income populations **could occur.**

LUP-5 (Alternatives A1 through C2): ***Substantial Diminishment of Agricultural Land Resource Quality and Importance Because of Altered Inundation and/or Soil Saturation – Project-Level.*** Proposed Interim and Restoration flows associated with Alternatives A1 through C2 could cause substantial diminishment of agricultural land quality and importance along the San Joaquin River. Mitigation measures put in place to preserve agricultural activity would not lower the level of the impact to less than significant, and the impact is considered to be significant and unavoidable. This significant and unavoidable impact is not expected to disproportionately affect specific geographic distributions of minority and low-income populations because the effects would be distributed across broad geographical areas of the State. However, the agricultural workers affected by diminished quality of farmland are disproportionately racial and/or ethnic minorities relative to California’s demographics. The proportion of low-income agricultural workers who work in this area is also substantial. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

LUP-8 (Alternatives A1 through C2): ***Substantial Diminishment of Agricultural Land Resource Quality and Importance Because of Altered Water Deliveries – Project-Level.*** Potential reductions in water deliveries associated with Alternatives A1 through C2 could cause substantial diminishment of agricultural land quality and importance. Mitigation measures put in place to preserve agricultural activity would not lower the level of the impact to less than significant, and the impact is considered to be significant and unavoidable. This significant and unavoidable impact is not expected to disproportionately affect specific geographic distributions of low-income populations or minority groups because the effects would be distributed across broad geographical areas of the State. However, the agricultural workers affected by diminished quality of farmland are disproportionately racial and/or ethnic minorities relative to California’s demographics. The proportion of low-income agricultural workers who work in this area is also substantial. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

UTL-11 (Alternatives A1 through C2): ***Potential for Insufficient Existing Water Supply and Resources in the Restoration Area – Project-Level.*** Proposed changes resulting from Alternatives A1 through C2 could result in insufficient water supply entitlements in the Restoration Area, which includes the counties of Fresno, Madera, and Merced. There are no mitigation measures that could reduce the impact of these changes in water supply to less than significant. The three counties exhibit proportions of minority residents in excess of 50 percent and communities exhibiting high proportions of low-income residents. Thus, disproportionately high and adverse impacts related to water supply would occur in residential areas within the counties with high proportions of minority and low-income residents. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

UTL-16 (Alternatives A1 through C2): ***Potential for Insufficient Existing Water Supply and Resources from Recapture of Interim and Restoration Flows Between the Merced River and the Delta – Project-Level.*** Proposed changes resulting from Alternatives A1 through C2 could result in insufficient water supply and resources between the Merced River and the Delta, which includes Stanislaus County. There are no mitigation measures that could reduce the impact of these changes in water supply to less than significant. The county as a whole does not exhibit a proportion of minority or low-income residents meaningfully greater than the State, and no individual communities within Stanislaus County exhibit high proportions of minority or low-income residents. Consequently, the distribution of impacts within this county would not disproportionately accrue to minority or low-income residents compared with the general population of Stanislaus County. Disproportionately high and adverse effects on minority and low-income populations **would not occur**.

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Chapter 10.0 Geology and Soils

This chapter describes the environmental and regulatory settings of geology and soils, as well as environmental consequences and mitigation measures, as they pertain to implementation of the Settlement. The discussion of geology and soils existing conditions and the potential impacts of the program alternatives on geology and soils encompasses the San Joaquin River upstream from Friant Dam, the Restoration Area, the San Joaquin River downstream from the Restoration Area, and the Delta. Implementation of the Settlement is not anticipated to cause impacts to geology and soils in the CVP/SWP service areas. Therefore, these areas were eliminated from detailed environmental analysis.

10.1 Environmental Setting

Because of the regional-scale nature of earth resources, the geology and soils characteristics addressed in this section are described in a regional context, referring to geologic provinces, physiographic regions, or other large-scale areas, as appropriate.

10.1.1 Regional Setting

This section discusses regional-scale geology, seismicity and neotectonics, soils, mineral resources, erosion and sedimentation, and geomorphology.

Geology

The various geologic processes active in California over millions of years have created many geologically different areas, called provinces. The upper San Joaquin River lies in the Sierra Nevada Province, and the Restoration Area and lower San Joaquin River are in the Central Valley Province.

The upper San Joaquin River is located in the central portion of the Sierra Nevada Province at its boundary with the eastern edge of the Central Valley Province. The Sierra Nevada Province encompasses the Sierra Nevada Mountains, and comprises primarily intrusive rocks, including granite and granodiorite, with some metamorphosed granite and granite gneiss. The province is a tilted fault block nearly 400 miles long, with a high, steep multiple-scarp east face and a gently sloping west face that dips beneath the Central Valley Province (CGS 2002a). The central Sierra Nevada has a complex history of uplift and erosion. The greatest uplift tilted the entire Sierra Nevada block to the west. The high elevation of the Sierra Nevada Mountains leads to the accumulation of snow, including the Pleistocene glaciation responsible for shaping much of the range. Snowmelt in the Sierra Nevada Mountains feeds the San Joaquin River and its major tributaries, including those upstream from Friant Dam as well as the Merced, Tuolumne, Stanislaus, and Mokelumne rivers and other tributaries downstream from the Merced River confluence. These large rivers and their smaller tributaries cut through the granitic rocks present in the upper San Joaquin River watershed, and through intrusive formations and sedimentary and metamorphosed rocks. The metamorphic bedrock in these watersheds contains gold-bearing veins in the northwest-trending Mother Lode that are not present in the more southerly watershed of the upper San Joaquin River. To the south, the Kings River originates in the Sierra Nevada Province and cuts through bedrock similar to the bedrock in the headwaters of the San Joaquin River (CGS 2002b).

At the western border, alluvium and sedimentary rocks overtop the Sierra Nevada Province. Occasional remnants of lava flows and layered tuff are present in the area at the highest elevations. Metamorphic rocks in the Friant Dam area dip steeply downstream to the west, and strike northwesterly. The contact of these metamorphic rocks with the Sierra Nevada batholith lies just east of Friant Dam under Millerton Lake. Friant Dam is founded on metamorphic rocks consisting of quartz biotite schist intruded by aplite and pegmatite dikes, and by inclusions of dioritic rocks. Erosion has resulted in thin colluvial cover (Reclamation 2002). Intrusive Sierra Nevada batholith rocks underlie most of Millerton Lake and areas immediately upstream from Friant Dam. Surface weathering has produced some decomposed granite and soils.

The Central Valley Province encompasses the Central Valley, an alluvial plain about 50 miles wide and 400 miles long in the central part of California, stretching from just south of Bakersfield to Redding. The San Joaquin Valley makes up approximately half of the Central Valley Province and is drained by the San Joaquin River. The San Joaquin River and its tributaries flow out of the Sierra Nevada Province into the Central Valley, depositing sediments on the alluvial fans, riverbeds, floodplains, and historical wetlands of the Central Valley Province. The Central Valley Province is characterized by alluvial deposits and continental and marine sediments deposited almost continually since the Jurassic Period (CGS 2002b).

Alternating marine and continental deposits of Tertiary age underlie much of the Central Valley Province, including the San Joaquin Valley (Page 1986). The more recent Quaternary Period was characterized by continental sedimentary deposition. Tertiary and Quaternary continental rocks and deposits in the San Joaquin Valley contain lenses of clay and silt comprising lacustrine, marsh, and floodplain deposits. These deposits are of varying thickness, in some instances, thousands of feet thick (Page 1986). These continental deposits, including the Merhten, Kern River, Laguna, San Joaquin, Tulare, Tehama, Turlock, Riverbank, and Modesto formations, make up the major aquifer of the San Joaquin Valley (Ferriz 2001, Page 1986). The aquifer system is further discussed in Chapter 12.0, “Hydrology – Groundwater.” The San Joaquin Valley is a structural trough into which sediments have been deposited as much as 6 miles deep. The most recent surficial alluvial deposits are mined for aggregate, as discussed below (CGS 2002a). Tectonic activity during the Tertiary Period strongly influenced the evolution of the Central Valley, alternately trapping water in the San Joaquin Valley or entire Central Valley to form inland seas that deposited marine sediments, and opening to allow drainage to the ocean, as under current conditions.

Seismicity and Neotectonics

Both the Sierra and Central Valley geologic provinces continue to be subject to minor tectonic activity. Current activity is defined as occurring within the past 1.6 million years, called the Quaternary Period, and continuing through the present day.

Sierra Nevada Microplate Motion. Both the Sierra Nevada and Central Valley provinces are part of the Sierra Nevada microplate, which is one component of a broad tectonically active belt that accommodates motion between the North American plate to the east and the Pacific plate to the west. On its eastern side, the Sierra Nevada microplate is bounded by the Sierra Nevada frontal fault system. This system, marked by the steep eastern escarpment of the Sierra Nevada Mountains, is characterized by normal and right-lateral strike-slip faults that mark the beginning of the Basin and Range Province. On the west, the microplate is bounded by the fold and thrust belt of the Coast Range Province (Wakabayashi and Sawyer 2001).

Relative to the North American plate to the east, the right-lateral movement of the Sierra Nevada microplate is 10 to 14 mm/year (0.4 to 0.6 inches per year (in/year)). Its relative right-lateral motion compared to the Pacific Plate to the west is much higher, at 38 to 40 mm/year (1.5 to 1.6 in/year). Internal deformation of the Sierra Nevada microplate is minimal compared to the deformation occurring along its boundaries. However, vertical deformation along the frontal fault system has caused westward or southwestward tilting of the Sierra Nevada mountain block (Bartow 1991; Wakabayashi and Sawyer 2001). Westward tilting has been concurrent with 5,610 to 6,330 feet of uplift by the Sierra Nevada crest over the past 5 million years, equivalent to uplift of 0.34 to 0.39 mm/year (0.013 to 0.015 in/year) (Wakabayashi and Sawyer 2001). This uplift triggered rapid stream incision and deep canyon erosion by the rivers draining the range, including the San Joaquin River and its glacial-meltwater-fed tributaries (Wakabayashi and Sawyer 2001).

Locally, normal faults are found in the Sierra Nevada foothills, probably because the west, or valley, side of the Sierra block is subsiding faster than uplift of the east side (Bartow 1991). One such tensional feature, and west-northwest-trending fault, is thought to be present in the Merced-Chowchilla area based on an offset of a post-Eocene unconformity. This fault may be related to a superficial feature called the Kings Canyon lineament, which crosses the valley north of Chowchilla, parallels the south fork of the Kings River, and continues nearly to Death Valley in the southeast (Bartow 1991). It is unclear whether this fault has been active recently.

San Joaquin Valley Deformation and Subsidence. Regional deposition and deformation patterns of sediments in the San Joaquin Valley have been strongly controlled by recent tectonic activity (Bartow 1991). Quaternary deposits in the San Joaquin Valley are deformed into a broad, asymmetrical trough with its axis 12 to 19 miles west of the current course of the San Joaquin River (Lettis and Unruh 1991). Valley subsidence is continuing at a rate thought to be a minimum of 0.2 to 0.4 mm/year (0.008 to 0.016 in/year) (Lettis and Unruh 1991). Subsidence is probably due in part to the uplift and tilting of the Sierran block to the west and the Coast Ranges to the east, although the rate of valley subsidence is higher than that of Sierran uplift. It is hypothesized that valley subsidence may also be due to sediment loading and compressional downwarping or thrust loading from the Coast Ranges (Lettis and Unruh 1991). Valley subsidence is also known to be occurring because of (1) aquifer compaction caused by pumping-related reduction of groundwater levels, as discussed in Chapter 12.0, and (2) compaction and disappearance of soils with high organic content due to development (Reclamation 1997), as discussed in the soils section below.

Active and inactive faults are recognized on both the north and south sides of the San Joaquin Valley. On the north, the basin is bounded by the Stockton fault. This fault forms the northern boundary of the Stockton arch, and is a south-dipping reverse fault that runs roughly west-northwest across the valley (Bartow 1991). Faulting at the southern boundary of the San Joaquin Valley is concentrated around the Bakersfield arch, a broad southwest plunging subsurface ridge (Bartow 1991). Few faults fall north of the Bakersfield arch, which offset Quaternary sediments, suggesting a lack of recent tectonic activity (Bartow 1991). The Pond and Greeley fault systems are two major buried structures recognized to have normal offsets of as much as 1,640 to 2,020 feet, but offsets decrease upward so that no deposits younger than late Miocene have shifted. Similarly, neither the Clovis fault, about 5 miles from the City of Clovis, nor the Foothills fault system, comprising the Bear Mountain and Melones fault zones about 70 to 80 miles north of Fresno, are considered to have been active in the Quaternary period. Additionally, a series of northwest-trending lineaments is exposed at the surface around the Kern River, but they have not been shown to be connected with subsurface faults (Bartow 1991). However, the Nunez reverse fault, located 7 miles northwest of Coalinga, was first mapped after it ruptured during the 1983 Coalinga earthquake and its aftershocks (Lin and Stein 2006). Details of the timing and total offset along the fault remain unknown.

The eastern-most fault subsystem separating the Central Valley from the Coast Ranges is the Great Valley blind thrust, part of the San Andreas fault system. This reverse fault separates Great Valley sequence deposits on the east from Franciscan rocks on the west. The fault subsystem comprises at least 14 segments along an extent of over 300 miles, although precise locations of its surface traces are not well documented (USGS 1996). The Great Valley thrust system is thought to accommodate a nominal 0.5 to 1.5 mm/year (0.02 to 0.06 in/year) of motion (CGS 2002c, USGS 1996).

Groundshaking and Liquefaction Hazards. Although a fault rupture can cause significant damage along its narrow surface trace, earthquake damage is mainly caused by strong, sustained groundshaking (WG02 2003). Seismic groundshaking can also cause soils and unconsolidated sediments to compact and settle. If compacted soils or sediments are saturated, pore water is forced upward to the ground surface, forming sand boils or mud spouts. This soil deformation, called liquefaction, may cause minor to major damage to infrastructure. Earthquake groundshaking hazard potential is low in most of the San Joaquin Valley and Sierra Nevada foothills (CSSC 2003). Although the San Joaquin Valley is not considered to be a high-risk liquefaction area because of its generally low earthquake and groundshaking hazard risk, it can be assumed that some liquefaction risk exists throughout the valley in areas where unconsolidated sediments and a high water table coincide, such as near rivers and in wetland areas (Merced County 2007a).

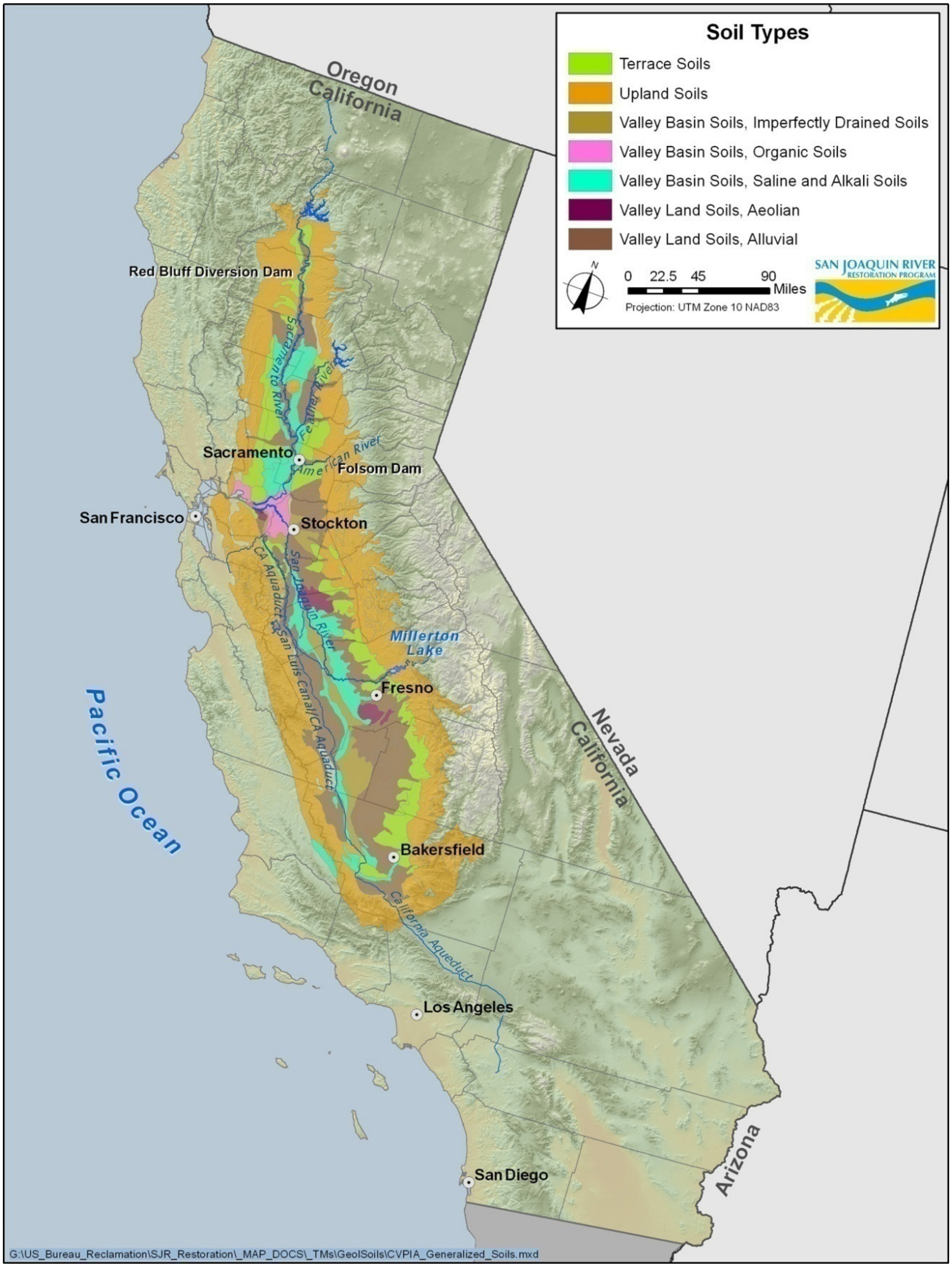
Soils

The development of individual soils is based largely on parent material, climate, associated biology, topography, and age. These factors combine to create the more than 2,000 unique soils in the State. Because these factors are similar within physiographic regions, soils in the vicinity of the San Joaquin River are described here according to four distinct physiographic regions, including valley land, valley basin, terrace land, and upland, as summarized in Table 10-1. Valley basin land and valley land soils occupy most of the San Joaquin Valley floor, as shown in Figure 10-1. Valley land soils consist of deep alluvial and aeolian soils that make up some of the best agricultural land in the State. Valley basin land soils consist of organic soils, imperfectly drained soils, and saline and alkali soils in the valley trough and on the basin rims. Areas above the San Joaquin Valley floor consist of terrace land and upland soils, on higher elevations and steeper slopes. Overall, these soils are not as productive as the valley land and valley basin land soils. Without irrigation, these soils are primarily used for grazing and timberland; with irrigation, additional crops can be grown. These soil types and their geographic extents are described in detail below, followed by a brief description of soil salts in the San Joaquin Valley, an important feature of some soils.

Table 10-1.
Summary of Soils in San Joaquin River Basin

Physiographic Region	Location	Texture
Valley Basin Land		
Organic Soils	Sacramento-San Joaquin Delta	Peat, organic
Imperfectly Drained Soils	Sacramento-San Joaquin Valley trough	Clays
Saline/Alkaline Soils	West side of the San Joaquin Valley	Clay loam – clay
Valley Land		
Alluvial Soils	Alluvial fans and low terraces in the Sacramento and San Joaquin valleys	Sandy loam – loam
Aeolian Soils	Portions of Stanislaus, Merced, and Fresno counties	Sands – loamy sand
Terrace Land		
Brown, Neutral Soils	West side Sacramento Valley and southeast San Joaquin Valley	Loam – clay
Red-Iron Hardpan Soils	East side Sacramento and San Joaquin valleys	Sandy loam – loam hardpan
Upland		
Shallow Depth to Bedrock	Foothills surrounding Central Valley	Loam – clay loams
Moderate Depth to Bedrock	East side Merced and Stanislaus counties	Sandy loam – clay loam
Deep Depth to bedrock	Higher elevations of the Sierra Nevada, Klamath Mountains, and Coast Range	Loam – clay loams

Source: University of California 1980



Source: University of California 1980

Figure 10-1.
Physiographic Region Soil Types in the Central Valley and Delta

Valley Basin Land. Valley basin land soils occupy the lowest parts of the San Joaquin Valley and the Delta. These soils fall into three categories: organic soils, imperfectly drained soils, and saline/alkali soils.

- **Organic Soils –** Organic soils are so named because of high organic matter content, which is 12 percent or more by weight and typically greater than 50 percent in the upper layers. These soils are typically dark and acidic because of their high organic matter content, and are usually referred to as peat. They often form in areas that are frequently saturated with water (poorly drained), and are therefore common in the Delta, at the downstream end of the San Joaquin River.

- **Imperfectly Drained Soils –** This category of soils generally contains dark clays and has a high water table or is subject to overflow. These soils are found in the trough of the San Joaquin Valley, and consist in part of several thick lake bed deposits.

- **Saline/Alkali Soils –** These soils are characterized by excess salts (saline), excess sodium (sodic), or both (saline-sodic). In many of the older soil surveys, salinity and sodicity were jointly referred to as alkaline. A distinction was sometimes made because the saline soil many times formed a white crust on the surface and was called “white alkali,” and the soils with excess sodium appeared to be “black,” thus, black alkali. Both are fairly common throughout the San Joaquin Valley. In uncultivated areas, saline soils are used for saltgrass pasture and native range. Some of these soils support seasonal salt marshes. In areas of intermediate to low rainfall, the soils have excess sodium as well as salt. Many of these soils are irrigated with moderately saline Delta surface water, imported via the DMC and California Aqueduct, or with slight to moderately saline groundwater. In addition, salts are added through application of fertilizers or other additives needed for cropping. This saline addition to saline soils forms a crust on top of the soils, changes the chemical characteristics of the soils in the root zone, and reduces the capability of the soils to transfer applied moisture to the roots. To minimize salinity problems, irrigators apply water to the soil before planting seed or plants to leach salts from the root zone. Leaching is complicated by poor drainage, low permeability, and high sodium content. Leaching increases salinity in the groundwater aquifers, which further exacerbates the salinity problem because the saline groundwater is used for irrigation. Because of the rise in groundwater salinity, the area with soil salinity problems has grown. This most recently occurred during the 1987 to 1994 drought, when surface water availability was limited and groundwater use escalated. Leaching also increases the salinity in flows from subsurface drains, which affects water quality in surface waters that receive return flows, or the quality of water and sediments in evaporation ponds. The increase in groundwater salinity and its effects on the capability of land to be used for irrigated crops are further discussed in Chapter 12.0, “Hydrology – Groundwater.”

Valley Land. Valley land soils are generally found on flat to gently sloping surfaces, such as on alluvial fans. These well-drained soils include some of the best all-purpose agricultural soils in the State. Both alluvial- and aeolian-deposited soils are present in the San Joaquin Valley.

- **Alluvial Soils –** Alluvial-deposited valley land soils include calcic brown, noncalcic brown, and gray desert alluvial soils. Figure 10-1 shows the distribution of all San Joaquin Valley alluvial soils. Calcic brown and noncalcic brown alluvial soils are found in the San Joaquin Valley on deep alluvial fans and floodplains occurring in areas of intermediate rainfall (10 to 20 inches annually). These two soils tend to be brown to light brown with a loam texture that forms soft clods. Calcic brown soil is calcareous; noncalcic soil is usually neutral or slightly acid. These soils are highly valued for irrigated crops such as alfalfa, apricots, carrots, corn, lettuce, peaches, potatoes, sugar beets, and walnuts. Where the climate is suitable, avocados, citrus fruits, cotton, and grapes can be grown on these soils. These soils are found in the northern and central San Joaquin Valley. Gray desert alluvial soil is found on alluvial fan and floodplains of low rainfall (4 to 7 inches annually). This soil appears in the western San Joaquin Valley as light-colored calcareous soil low in organic matter. These soils are too dry to produce crops without irrigation. When irrigated, these soils are valued for alfalfa, cotton, and flax.

- **Aeolian Soils –** Aeolian-deposited and wind-modified soils found in the east side of the San Joaquin Valley are noncalcic brown sand soils. These soils are prone to wind erosion, have low water-holding capacity, and are somewhat deficient in plant nutrients.

Terrace Land. Terrace land soils are found along the edges of the San Joaquin Valley at elevations 5 to 100 feet above the valley floor. Several groups of terrace soils surround the floor of the Central Valley. Two of the more widespread groups are discussed in the following paragraphs. Terrace land soils are grouped together and shown in Figure 10-1.

- **Brown Neutral Soils –** The first group consists of moderately dense, brownish soils of neutral reaction. These soils are found in areas receiving 10 to 20 inches of rain per year. In the southeast San Joaquin Valley, these soils tend to have a clay texture. This soil group is commonly used for irrigated pasture; however, citrus orchards are grown on some of these soils. Following ripping, these soils are suitable for orchard and vineyard development.

- **Red Iron Pan Soils –** A second type of terrace soil has a red-iron hardpan layer and is found along the east side of the San Joaquin Valley. These soils consist of reddish surface soil with a dense silica-iron cemented hardpan, which is generally 1 foot thick. Some of these hardpan soils have considerable amounts of lime. These soils occur in areas receiving 7 to 25 inches of rain per year. Dry farming practices have fair results with hay, grains, and pastures, although following ripping, these soils are well suited for orchards and vineyards.

Upland Soils. Upland soils are found on hilly to mountainous topography and are formed in place through decomposition and disintegration of the underlying parent material. The more widespread upland soil groups include shallow depth, moderate depth, and deep depth to bedrock. Two upland soil groups, shallow depth and moderate depth, are more common because of their geographic location and elevation. Upland soils are found around the perimeter of the San Joaquin Valley, as shown in Figure 10-1. Soils on the west side have mostly developed on sedimentary rocks while those on the east side typically developed on igneous rocks.

- **Shallow Depth to Bedrock –** This group of upland soils is found in the Sierra Nevada and Coast Range foothills that surround the San Joaquin Valley. The soils have a loam-to-clay-loam texture with low organic matter, and some areas have calcareous subsoils. These soils usually have a shallow depth to weathered bedrock, less than 2 feet. These soils are found in areas of low to moderate rainfall that support grasslands used primarily for grazing. Tilled areas are subject to considerable erosion.

- **Moderate Depth to Bedrock –** This group of upland soils is found on hilly to steep upland areas having medium rainfall and that can support grasslands. These soils have a sandy-loam-to-clay-loam texture and moderate depth to weathered bedrock, about 2 feet. This slightly acidic soil group is dark and is found in the Stanislaus County and Merced County foothills east of the valley floor.

- **Deep Depth to Bedrock –** This group of upland soils is found at the higher elevations in the Sierra Nevada and Coast Range on hilly to steep topography. These soils are characterized by moderate to strongly acidic reaction, especially in the subsoils, which can extend 3 to 6 feet before reaching bedrock. Bedrock consists of meta-sedimentary and granitic rocks. Soils forming on granitic rocks consist of decomposed granitic sands. These soils receive 35 to 80 inches of precipitation per year and support extensive forests.

Salts

The accumulation of salts in the soils of the San Joaquin Valley is due to a combination of the regional geology, high water table, intensive irrigation practices, and the importation of water from the Delta that is high in salinity and application to lands in the region. The Corcoran Clay and other clay layers contribute to a naturally high water table in the valley, concentrating salts in the root zone by evaporation through the soil. Farmers actively leach these salts from the soil into drainage water with irrigation and subsurface drainage practices. Drainage water with high concentrations of salts may be reused for irrigation (with or without treatment), accumulate in groundwater, or be discharged to evaporation ponds or tributaries to the San Joaquin River. Salinization caused by concentrations of naturally-occurring soil salts is exacerbated by the use of more saline Delta water, imported via the DMC and California Aqueduct, as a major source of irrigation water.

Additionally, naturally occurring trace elements in soils may be mobilized and concentrated along with salts. Soils throughout the San Joaquin Valley typically contain some selenium, and soils on the west side of the valley are particularly selenium-rich. These soils have developed on alluvial deposits comprising eroded material from the Coast Range, where selenium is found in marine deposits. Selenium can pose a hazard to fish and wildlife when it becomes highly concentrated in surface waters.

To address the ongoing problem of salinization of soils and water in the San Joaquin Valley, which is causing loss of agricultural production and damage to local water infrastructure, including pipes, pumps, water heaters, SWRCB, the Central Valley RWQCB, and the multifaceted stakeholder group named the Central Valley Salinity Coalition have teamed to lead efforts to identify and manage salt sources and processes causing salt loading in the San Joaquin Valley. Through the program CV-SALTS, this diverse group is devising a collaborative basin planning effort aimed at developing and implementing a comprehensive salinity and nitrate management strategy. Reclamation has also agreed to participate in salinity control efforts in the lower San Joaquin River watershed, as described in its Management Agency Agreement with the Central Valley RWQCB.

TMDLs, which define a maximum acceptable level of loading of a particular constituent in surface water, exist, or are currently being developed, for salts in the San Joaquin River and several tributaries. More information on salt-related TMDLs, as well as a more detailed description of water quality conditions in the study area, is presented in Chapter 14.0, "Hydrology – Surface Water Quality."

Mineral Resources

In 2006, California ranked third in the nation in nonfuel mineral production. In that year, California yielded $4.6 billion in nonfuel minerals, totaling 7 percent of the Nation's entire production (Kohler 2006). The value and quantity produced of the most economically important products in the State are summarized in Table 10-2. Of these products, construction sand and gravel are the most widely mined resources in the vicinity of the San Joaquin River. Historically, gold was also extracted from the riverbed.

Sand, Gravel, and Other Rock Products. In 2006, California was the Nation's largest producer of construction sand and gravel ($1.5 billion) and portland cement ($1.25 billion) (Kohler 2006). California also produced significant quantities of crushed stone ($481 million), industrial sand and gravel ($62.2 million), masonry cement ($87.8 million), and dimension stone ($11.2 million) (Table 10-2). Together, the market value of these products totals $3.4 billion, almost 75 percent of the total value of State nonfuel mineral production. The San Joaquin River below Friant Dam is a significant source of sand and gravel in the State, and mining occurs at multiple locations on the floodplain and river terraces (Reclamation 1997, Mussetter 2002a).

**Table 10-2.
California Nonfuel Mineral Production in 2006**

Product	Quantity (short tons)	Value ($ millions)
Construction sand and gravel	178,605,000	1,500
Portland cement	12,899,200	1,250
Boron minerals	674,700	731.8
Crushed stone	58,728,000	481.7
Other[1]	NA	395.6
Masonry cement	771,700	87.8
Industrial sand and gravel	2,260,100	62.2
Clays	1,334,000	46.1
Gold	1.11	19.6
Dimension stone	47,400	11.2
Gemstones	NA	1.1
Total	NA	4,587

Source: Kohler 2006a
Note:
[1] Other includes diatomite, feldspar, gypsum, iron ore, lime, magnesium compounds, perlite, pumice and pumicite, salt, soda ash, silver, talc, sodium sulfate, and zeolites.
Key:
NA = Not available

Gold. Historically, gold was mined from quartz veins in the Mother Lode of the northern Sierra Nevada as well as from placer deposits in loosely consolidated alluvial sediments throughout the Sierra Nevada foothills. The San Joaquin River above Friant Dam was subject to some degree of placer mining from 1848 to 1880, followed by dredge mining from 1880 to the 1960s (Mussetter 2002a). These activities significantly reworked the riverine environments, redistributing sediments and altering channel forms. However, the San Joaquin River was less affected by dredge mining than the more northerly Sierra Nevada drainages, where gold was more plentiful (McBain and Trush 2002). Gold extraction does not currently occur on any part of the San Joaquin River.

Erosion and Sedimentation

The sediment load of the San Joaquin River and its tributaries originates from the erosion of soil and rock units of the Sierra Nevada Province, as discussed above. In upstream reaches of the San Joaquin River, the sediment load generally comprises large boulders, cobbles of diameters greater than or equal to 4 inches, fine sand, and less commonly, intermediate-size gravels (SCE 2003). Direct erosion and mass wasting into the watercourses is the primary reason that angular to subangular, medium- to coarse-grained sands and large boulders make up most of the substrate of granitic watersheds, like that of the San Joaquin River above Millerton Lake (SCE 2003). The sediment load of the San Joaquin River becomes finer with distance downstream, as described in further detail in Section 10.1.2.

Soil Erosion Potential. Natural physical and chemical forces constantly work to break down soils. This process, called erosion, has two effects. First, erosion removes soils, undermining structures like bridges and forming unstable slopes. Second, erosion deposits these soils in low-lying areas, causing sedimentation of streams and reservoirs. Erosion also results in landslides that may damage roads, buildings, and other infrastructure. Soil characteristics that affect the erosion rate are soil surface texture and structure, particle size, permeability, infiltration rate, and the presence of organic or other cementing materials. Other key factors determining erosion potential are the extent of vegetation, type of vegetative cover, human or other disturbance, topography, and rainfall.

Along the San Joaquin River above Friant Dam, soils on steep, unvegetated slopes are particularly vulnerable to erosion, especially on slopes greater than 30 percent (Fresno County 2000a). Since natural and cut slopes in decomposed granite soils erode readily, soil is particularly vulnerable to erosion in the Sierra Nevada and foothills (FERC 2002). Many of these soils are located within the boundaries of National Forest and National Park land, which prevents their extensive development. In the San Joaquin Valley, the bluffs of the San Joaquin River in Reach 1 are steep and exhibit severe erosion potential (Fresno County 2000a).

Human activities can also effectively accelerate natural erosion processes. The greatest cause of localized sedimentation problems is construction and development, which usually involves vegetation removal, compaction of porous soils, and drainage of large areas. In particular, road building and timber harvesting have the greatest potential to increase erosion that results in watercourse sedimentation (SCE 2003). Improper agricultural management practices can also accelerate erosion. Overgrazing and land clearing, particularly on steep slopes, but also on flat areas, make surfaces vulnerable to topsoil loss. Elevation measurements made from 1922 to 1981 indicate that even normal agricultural practices, regardless of crop type, may cause up to 1 to 3 inches of soil loss per year (Rojstaczer et al. 1991).

Infrastructure Effects on Sediment Transport. The most significant effect of dams and storage reservoirs on a watershed is on sediment supply because they serve as impediments to sediment transport downstream. Because of the slowing of river velocity in the reservoir that forms behind a dam, river carrying capacity decreases and the sediment load drops out of the water column and onto the channel bottom. Although the water and some of its fine sediment may be released on the downstream side of the dam, the majority of the sediment load, particularly the coarse materials, remains on the upstream side. This sediment accumulation may be so marked that over time it can significantly decrease the storage volume of the reservoir itself. Removal of these accumulated sediments can also be problematic. In the past, sluicing to remove sediments from the relatively small Kerckhoff Reservoir (storage volume of 4,000 acre-feet) on the San Joaquin River immediately upstream from Friant Dam resulted in extremely high levels of sediment downstream, although flood flows in intervening years may have flushed these sediments from the river into Millerton Lake (SCE 2003).

Major dams with potential to limit sediment supply to the mainstem San Joaquin River and its major tributaries, along with their corresponding reservoirs and volumes, are listed in Table 10-3.

Table 10-3.
Major Dams and Reservoirs with Storage Capacity Greater than 50,000 Acre-Feet in San Joaquin River Basin

River	Reservoir/Dam[1]	Volume (TAF)	Year Completed	Operating Agency
Calaveras	New Hogan	317	1965	USACE
Chowchilla	Eastman/Buchanan	150	1975	USACE
Fresno	Hensley/Hidden	90	1974	USACE
Kaweah	Kaweah/Terminus	183	1962	USACE
Kern	Isabella	570	1953	USACE
Kings	Pine Flat	1,000	1954	USACE
Merced	McClure/New Exchequer	1,032	1967	Merced ID
Mokelumne	Camanche	341	1964	EBMUD
San Joaquin	Millerton/Friant	520	1942	Reclamation
Stanislaus	New Melones	2,400	1979	Reclamation
Tule	Success	82	1961	USACE
Tuolumne	New Don Pedro	2,031	1971	Turlock and Modesto IDs

Note:
[1] The dam name is only listed when it differs from the reservoir name.

Key:
EBMUD = East Bay Municipal Utility District
ID = Irrigation District
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
TAF = thousand acre-feet
USACE = U.S. Army Corps of Engineers

Under unaltered conditions, geomorphic fluvial processes, including sediment transport, occur on a relatively consistent basis along the length of a river, and flow energy in the river channel is dissipated gradually. Bridges and culverts constrict the natural channel and disrupt these processes, which also alter channel form. This may occur at either high or low flows, depending on the size of the structure.

Effects of channel constrictions caused by bridge and culvert crossings include the following:

- Sediment deposition upstream from the constriction (backwater effects).
- Scour at the constriction due to an elevated water surface and increased water velocity.
- Sediment deposition downstream from the constriction due to flow expansion, leading to the formation of splay bars.
- Reduced flood conveyance capacity due to filling in of floodplain space when building bridge and culvert abutments.

Bridge and culvert crossings in the Restoration Area and their effects are listed in the Restoration Area reach-by-reach descriptions in Section 10.1.2.

The function and operation of the water supply and flood control infrastructure present in the study area also affect fluvial processes of the San Joaquin River. Such infrastructure includes diversion structures, bypasses and bypass diversions, other hydraulic control structures, offstream flood control dams, levees, and canals. These structures divert base flows and/or flood flows and thereby significantly alter fluvial processes. The processes most affected are sediment transport, local incision and deposition, and channel migration (Table 10-4).

Table 10-4.
Generalized Effects on Geomorphic Processes of Major Flood Control and Water Supply Infrastructure

Infrastructure	Effects
Diversion structures	Backwater effects cause disruption of local incision and deposition patterns; riprap protection prevents channel migration and avulsion; reroute sediment load
Bypasses	Reroute sediment load within the Restoration Area
Bypass diversion structures	Backwater effects cause disruption of local incision and deposition patterns; reroute sediment load within the Restoration Area
Other hydraulic control structures	Backwater effects cause disruption of local incision and deposition patterns; reroute sediment load within the Restoration Area
Offstream flood control dams	Reroute sediment load within the study area
Levees	Dissect the historic floodplain, stop channel migration and avulsion, increase river velocity and, thus, also increase incision, bed armoring, and channel simplification
Canals	Embankments dissect the historic floodplain, stop channel migration and avulsion, increase river velocity and, thus, also increase incision, bed armoring, and channel simplification; reroute sediment load

Sediment load is carried by flows, and all infrastructure that reroutes flows alters sediment transport within the watershed. Flood control bypasses in particular divert most of the sediment load of the San Joaquin River from Reach 2 directly to the bypass system. This results in a long-term effect on river sedimentation patterns. Small diversion structures, like Mendota Dam, also affect sediment transport by modifying the delivery of sediment downstream. Diversion and other hydraulic control structures may constrict the river channel, which alters local incision and deposition patterns, as described above. Levees and canal embankments dissect the historic floodplain, which prevents channel migration and avulsion. This prevents oxbow formation and also increases river velocity, which encourages channel incision, bed armoring, and channel simplification.

Specific flood control and water supply infrastructure in the study area and its effects on sediment transport are listed in Appendix M, “Soil Classes and Geomorphology in the Restoration Area.” The most significant of these structures in Reaches 1 through 5 are discussed further in Section 10.1.2.

Geomorphology

Upstream from the Restoration Area, Millerton Lake is set in the lower foothills of the Sierra Nevada, is fairly open, and mostly surrounded by low hills. The San Joaquin River upstream from Temperance Flat lies in a steep and narrow canyon with a bedrock channel that has an overall average gradient of about 1 percent, many long narrow pools, and an occasional steep cascade. Several small, ephemeral streams enter the San Joaquin River in this reach. Most of the river margins are steep and rocky and flood flows frequently scour the channel.

Major tributaries to the San Joaquin River, including the Merced, Tuolumne, Stanislaus, and Mokelumne rivers, flow west out of the Sierra Nevada to join the San Joaquin River. South of the San Joaquin River, the Kings River flows west out of the Sierra Nevada. Similar to the San Joaquin River, these rivers lie in steep, narrow canyons in the Sierra Nevada and foothills, then flow west into the Central Valley over broad, open alluvial fans and floodplains.

The San Joaquin Valley floor is divided into several geomorphic land types, including dissected uplands, low alluvial fans and plains, river floodplains and channels, and overflow lands and lake bottoms. The dissected uplands consist of consolidated and unconsolidated continental deposits of Tertiary and Quaternary age that have been slightly folded and faulted.

The alluvial fans and plains consist of unconsolidated continental deposits that extend from the edges of the valleys toward the valley floor. The alluvial plains cover most of the valley floor and make up some of the intensely developed agricultural lands in the Central Valley. Alluvial fans along the Sierra Nevada consist of high percentages of clean, well-sorted gravel and sand. Fans from Coast Range streams are less extensive. West side fans tend to be poorly sorted and contain high percentages of fine sand, silt, and clay. Interfan areas between major alluvial fans of the east side are drained by smaller intermittent streams similar to those on the west side. Thus, these interfan areas tend to be poorly sorted and have lower permeabilities than main fan areas. In general, alluvial sediments of the western and southern parts of the Central Valley tend to have lower permeability than east side deposits.

River floodplains and channels lie along the major rivers and to a lesser extent the smaller streams that drain into the valley from the Sierra Nevada. Some floodplains are well-defined where rivers incise their alluvial fans. These deposits tend to be coarse and sandy in the channels and finer and silty in the floodplains. Lake bottoms of overflow lands include historical beds of Tulare Lake, Buena Vista Lake, and Kern Lake as well as other less defined areas in the valley trough.

10.1.2 San Joaquin River from Friant Dam to Merced River

The following subsections describe the geology and soils of the Restoration Area in more detail. Geology, seismicity and neotectonics, soils, mining, erosion and sedimentation, and geomorphology are discussed as they apply to each reach of the Restoration Area and the bypasses. Acreages of the 65 soil classes present within the Restoration Area, including all river reaches and the Chowchilla, Eastside, and Mariposa bypasses, are listed in Appendix M, “Soil Classes and Geomorphology in the Restoration Area.”

Reach 1

At Friant Dam, the San Joaquin River leaves its narrow canyon in the Sierra Nevada. Upon exiting the mountains, the river is confined by bluffs 50 to 100 feet high as a result of the river incising the Pleistocene alluvial fan. Within the bottomland between the bluffs, the river has also cut through more recently formed (Holocene) old alluvial fans, the remnants of which make up terraces 15 to 30 feet high bounding the river. These confining features extend as far as Gravelly Ford.

Reach 1A has the steepest slope in the Restoration Area, 0.00067, as computed from the Mussetter HEC-RAS model (2002a). The reach has a coarse sediment substrate consisting of gravels and cobbles. Recent Reclamation sediment sampling (described further in Appendix N, “Geomorphology, Sediment Transport, and Vegetation Assessment”) in this reach has focused on the riffle sections. Median bed material diameter at riffles sections varies between about 85 mm in the upper part of Reach 1A to about 40 mm in the lower part of Reach 1A.

Reach 1B has an average slope of approximately 0.0004, which is approximately 40 percent less than the average slope in Reach 1A. Riffles are composed of slightly smaller gravels than Reach 1A and contain significant amounts of sand. Material in the riffles gradually becomes finer, and the fraction of sand in the bed gradually increases in the downstream direction.

The current channel form in Reach 1 has been simplified from its historic state into a single narrow channel. Large parts of the channel have been altered because of aggregate mining and, in places, in- and off-channel mining pits have captured streamflow. Since the construction of Friant Dam, the lower watershed has been cut off from the upper watershed, its major source of sediment. Remaining sediment sources to the lower watershed include (1) lateral erosion of terraces, (2) vertical incision of the riverbed itself, and (3) two small tributaries entering the reach directly, Cottonwood and Little Dry creeks. However, reduction in the original high-flow regime with the emplacement of Friant Dam has reduced the ability of the river to recruit coarse terrace and bed sediment. Furthermore, substantial aggregate mining in Little Dry Creek, and more extensively in the San Joaquin River itself, has decreased coarse sediment replenishment.

Reach 1A is the most substantially mined part of Reach 1. From Friant Dam to Skaggs (Highway 145) Bridge, at least nine large pits ranging in size from 2.8 to 67.3 acres have been captured by the river (McBain and Trush 2002). More than 60 separate pits have been identified within this reach. Table 10-5 shows the total area of mining pits, and area and percentage capture by the river between Friant Dam and Skaggs Bridge. An estimated 1,562,000 cubic yards of aggregate were removed from the active channel of Reach 1A of the San Joaquin River between 1939 and 1989, and another 3,103,000 cubic yards were removed from Reach 1A floodplain and terraces. During the same time, an estimated 107,000 cubic yards of aggregate were removed from the active river channel in Reach 1B, and 72,000 cubic yards were extracted from Reach 1B floodplain and terraces (Cain 1997, cited in McBain and Trush 2002).

Table 10-5.
Aggregate Mining Areas in Reach 1 Between Friant Dam and Skaggs Bridge

Reach	Total Area of Mining Pits (acres)	Area of Pits Captured by River (acres)	Percentage of Pits Captured
Reach 1A from Friant Dam to State Route 41	494.5	7.5	1.5
Reach 1A from State Route 41 to State Route 99	784.4	155.4	19.8
Reach 1B from State Route 99 to Skaggs Bridge (Highway 145)	76.2	26.8	35.1
Totals	**1,355.1**	**189.7**	**14.0**

Source: McBain and Trush 2002

Along with aggregate mining, Reach 1 has been affected by cutoff of the coarse sediment supply thought to have been delivered from the upper watershed before emplacement of Friant Dam. Given an estimated sediment transport rate of 26,000 to 48,600 cubic yards/year, the river would have transported approximately 1,865,000 cubic yards of material into Reach 1 in the 50-year period from 1939 through 1989 in the absence of Friant Dam. Local channel degradation throughout Reach 1 can most likely be attributed both to aggregate mining, in combination with the cutoff of sediment supply from the upper watershed (Cain 1997, cited in McBain and Trush 2002).

Aside from the captured aggregate mining pits, there are very few side channels or backwater complexes except in one or two locations where permanent channels have established themselves around major in-channel islands or gravel pits. In-channel islands are rarely natural features, and instead have formed because of the hydraulics of breached gravel pit levees. The islands, and the river channel itself, are armored with riparian vegetation because of a lack of channel bed scour. In other places, large swaths of riparian vegetation have been removed by active and abandoned mining operations.

Friant Dam and other upstream dams has not only separated the lower watershed from its source of coarse sediment, but have also cut off the watershed's main source of fine sediment. Fine sands and silts do not generally deposit in the active channel, but do deposit on the floodplain, and are necessary for riparian vegetation regeneration. Without such fine sediment, riparian regeneration is impaired.

Elimination of the high-flow regime under post-Friant conditions has reduced the river's ability to carry away the coarse sediments that do enter the river. These coarse sediments are too heavy to be carried away by most dam release flows and, thus, have a long residence time in Reach 1. This results in an armored riverbed, in which (1) coarse materials are preferentially distributed at the riverbed surface rather than equally throughout the bed vertical profile, and (2) spaces between and underneath coarse materials become tightly packed with fine sediments (Mount 1995). Based on historical accounts and aerial photography, armoring in Reach 1 has also resulted from net erosion of mid-sized sandy sediments that previously overlaid streambed gravel and cobbles under pre-Friant conditions (see Attachment 2 to Appendix N, “Geomorphology, Sediment Transport, and Vegetation Assessment”). Armoring, which impedes sediment mobility and instream cleaning of gravels for salmonid habitat, was confirmed by a recent sediment sampling campaign (see Attachment 1 to Appendix N, “Geomorphology, Sediment Transport, and Vegetation Assessment”).

Reach 1 is dominated by sandy loam and sand, with minor amounts of loam, clay loam, and clay. Table 10-6 contains the calculated areas in acres for each generalized soil texture in the reaches and bypasses. Additional National Resource Conservation Service (NRCS) data (Soil Survey Staff 2008) are provided in Appendix M, “Soil Classes and Geomorphology in the Restoration Area.” These data indicate that Reach 1 soils have a moderate erosion potential. The exception is the bluffs of the San Joaquin River, which have steep slopes and are subject to a high erosion potential. Soils in Reach 1 generally contain less than 0.09 ppm selenium in the top 12 inches of soil. In the vicinity of Fresno, selenium is more highly concentrated in the soils (0.10 to 0.13 ppm).

Table 10-6.
Acreages of Soil Textures in Reaches and Bypasses

Reach	Subreach	Acreage of Soil Texture					Total Acreage
		Clay/Clay Loam	Loam	Sand	Sandy Loam	Variable[1]	
1	1A	103	96	1,541	6,193	2,732	10,663
	1B	<1	24	902	3,629	610	5,165
	Reach 1 Total	103	119	2,443	9,822	3,341	15,828
2	2A	<1	525	540	2,684	780	4,530
	2B	517	1,274	129	2,065	658	4,644
	Reach 2 Total	517	1,799	669	4,750	1,438	9,173
3	3	885	1,279	209	5,096	588	8,056
4	4A	624	713	254	2,602	402	4,595
	4B1	3,211	1,192	539	870	701	6,513
	4B2	1,338	509	82	418	983	3,331
	Reach 4 Total	5,173	2,415	875	3,890	2,086	14,439
5	5	2,583	317	341	756	1,464	5,460
Bypasses	(all subreaches)	4,896	7,937	672	3,980	2,137	19,623
Total All Reaches		19,950	18,198	9,198	46,755	17,920	112,020

Source: Soil Survey Staff 2008

Note:

[1] The category “variable” includes soils of undifferentiated texture and areas that were not mapped by the National Resource Conservation Service (i.e., areas covered by water during the mapping period).

Reach 2

Along the downstream end of Reach 1B, river terraces gradually merge with the floodplain, and by Gravelly Ford, bluffs and terraces no longer confine the river. The river gradient decreases throughout Reach 2, based on modeled water surface profiles (Mussetter 2002a). The average slope of Reach 2A is 0.0004, which is the same as the slope of Reach 1B. At the boundary of Reaches 1B and 2A, a rapid transition occurs from a gravel bed with a median bed material size of approximately 20 mm to a sand bed with a median bed material size of approximately 0.7 mm in less than a mile.

Reach 2b extends from just downstream from the Chowchilla Bifurcation Structure downstream to Mendota Pool. The slope decreases to 0.00022 or about 1 foot per mile, which is almost a factor of 2 less than in Reach 2a. The median bed material diameter is approximately 0.65 mm (Mussetter 2002a). Currently, water operations allow a maximum flow of approximately 1,300 cfs in this reach with all excess flow diverted into the Chowchilla Bypass.

The lack of confining features and the reduced gradient in Reach 2 both cause the channel to change to sand-bedded, meandering morphology. Meanders are moderate in Reach 2A and become more sinuous in Reach 2B as the river runs up against the prograding alluvial fans of the Coast Range drainages. The presence of the large-scale sloughs that typify the lower river reaches begins at the boundary of Reaches 2A and 2B. This is also the point of diversion of the Chowchilla Bypass Bifurcation Structure, which diverts most of the flows that enter Reach 2 into the Chowchilla Bypass system. Lone Willow Slough is a historical side channel that begins near the Chowchilla Bypass Bifurcation Structure and terminates in Reach 3. Today, this channel carries agricultural return flows and runoff.

Because of lack of through flows, most sediment is routed through the Chowchilla Bypass and very little sediment currently moves through Reach 2B. Instead, most sediment is routed with flows into the bypass, or accumulates in the sand traps immediately downstream from the bypass. Historically, when flows through Reach 2 were more consistent, sediment supply and transport capacity decreased gradually from Reach 1B through Reach 2 as sediment was deposited on the floodplains and multiple side channels evolved across the floodplain. With the combination of agricultural development, reduction of the high-flow regime under Friant Dam conditions, construction of project levees, and incorporation of sloughs into flood control structures such as the Chowchilla Bypass system, the river channel became simplified. High-flow scour channels were eliminated, the main channel footprint was reduced, and side channels were cut off from the main river.

Lack of vegetation and the sandy substrate cause the riverbed to be easily eroded when flows do pass through the reach. Bed mobility probably occurs at most baseflows, and bed scour is likely throughout the reach at flows of a few thousand cfs. As a result of this erosion, channel avulsion and migration can still occur between the project levees. Local landowners perform some sand mining in the levees, leaving pits 10 to 15 feet deep. However, the pits appear to fill after a single flood control release from Friant Dam.

Reaches 2A and 2B are dominated by sandy loam and sand, with sand becoming less common and loam more common with distance downstream. Additionally, loam, clay loam, and clay dominate the area of Fresno Slough and the Mendota Pool. Table 10-6 contains the calculated areas in acres for each generalized soil texture in Reaches 2A and

2B. NRCS data (Soil Survey Staff 2008) indicate that most Reach 2 soils have moderate erosion potential.

Reach 2 soils have high selenium content. Soils in Reach 2A and the upper portion of Reach 2B contain 0.10 to 0.13 ppm of selenium in the top 12 inches of soil. The lower portion of Reach 2B contains 0.14 to 0.36 ppm selenium in the top 12 inches of soil (SJVDP 1990). Soils in reaches 2B and 3 have the highest selenium concentrations in the Restoration Area.

Reach 3

Reach 3 is characterized by a meandering, sand-bedded channel, with a meander pattern that is less consistent than the meanders of Reach 2B. The slope decreases in Reach 3 relative to Reach 2 to 0.00021 (Mussetter 2002b). Bed material in Reach 3 is primarily coarse sand that is slightly larger in diameter than sediment in Reach 2B or in Reach 4A. The current flow capacity in Reach 3 is significantly greater than Reach 2B. Flow capacity in this reach varies between approximately 6,300 cfs near Mendota Dam to approximately 7,200 cfs near Sack Dam (Mussetter 2002b).

Alluvial fans of Coast Range tributaries, which join the river from the west, are the main geologic control on the river morphology in this reach. Additionally, the river's natural floodplain levees and floodplains were originally the major channel confining features. However, man-made structures, including canal embankments and project and nonproject levees, confine the river on both banks and prevent most overbank flows, channel migration, and avulsion. Confining canals are slightly set back from the channel between Mendota and Firebaugh, but downstream from Firebaugh, the channel is tightly bounded by canals that follow the meander of the river. These canals not only restrict the river channel but they also cut off the river from its historic floodplain. Additionally, agricultural lands in the narrow strip between the river and canals are protected in some places by dikes that prevent inundation from flows of up to 4,500 cfs.

The rate of channel migration since construction of Friant Dam has been low (McBain and Trush 2002). This is likely the result of decreased peak flow and a continued base flow that encourage dense riparian vegetation. Furthermore, historic high-flow cutoff channels and meanders have also been separated from the river channel by canals and levees. Many of these presently convey agricultural return flows and, during rain events, precipitation. Examples of these in Reach 3 include Lone Willow Slough, which originates near the Chowchilla Bypass Bifurcation Structure and terminates just over a mile upstream from the Arroyo Canal diversion, and Button Willow Slough, a tributary to Lone Willow Slough.

Construction and operation of the Chowchilla Bypass system has effectively separated Reach 3 from most upstream sediment supply. During infrequent flooding of the Kings River, flows are diverted into the James Bypass and Fresno Slough, bringing sediment into Mendota Pool at the downstream end of Reach 2. Much of the sediment that is transported through Reach 2 is temporarily caught behind Mendota Dam at the head of Reach 3. However, periodic pulling of boards on the dam and occasional draining of the Mendota Pool for inspection allow high flows to eventually carry this sediment into

Reach 3. The Chowchilla Bypass Bifurcation Structure itself causes significant backwater effects, resulting in sediment build-up in the river channel just downstream from the structure.

Reach 3 is dominated by sandy loam, with minor amounts of loam, clay loam, clay, and sand. Table 10-6 contains the calculated areas in acres for each generalized soil texture in Reach 3. NRCS data (Soil Survey Staff 2008) indicate that overall, Reach 3 soils have moderate erosion potential. Soils in this reach have the highest selenium content in the Restoration Area, along with Reach 2B, with concentrations in the top 12 inches of soil between 0.14 to 0.36 ppm (SJVDP 1990).

Reach 4

Similar to Reach 3, Reach 4 begins as a meandering, sand-bedded channel with a slope similar to that of Reach 3 (Mussetter 2002b). The average channel slope is 0.00021, and the median bed material size is 0.55 mm. Flow capacity was estimated to be 7,400 cfs (Mussetter 2002b). However, in the upstream part of Reach 4, river morphology changes from the moderately confined configuration of Reaches 2 and 3 to the extensive flood basin geometry that characterizes Reaches 4 and 5.

Beginning in Reach 4, the channel is confined by smaller riparian levees rather than by the bank-full channel and floodplains. The width between the levees varies between 200 and 700 feet. Many large anabranching sloughs originate in Reach 4; these sloughs probably conveyed summer and winter base flows in the past. Today, these channels carry agricultural return flows and runoff. These sloughs include Sand Slough, which originates near the Sand Slough Control Structure and terminates near the end of the Mariposa Bypass, and the Pick Anderson Bypass, which originates and terminates in Reach 4B1 and has been heavily channelized to convey agricultural flows. Numerous other side channels exist in the vicinity of Reaches 4 and 5 that do not carry any significant return flows or runoff. Channel migration and avulsion were probably historically slower and less frequent than in Reaches 2 and 3 because of the low sediment supply and dissipation of stream energy as floodwaters spilled out into the flood basin. In the present day, agricultural reclamation of almost the entire flood basin has left an approximately 300-foot-wide floodway (excluding the Eastside Bypass).

The river sediment load is typically low by the time flows arrive at Reach 4. The lack of extensive floodplains and a lower frequency of exposed sand bars within the channel indicate that Reach 4 was previously capable of transporting most sediment that was supplied to the reach. Since the construction of, and diversion of the majority of river flows into, the Chowchilla Bypass in Reach 2, sediment supplied to Reach 4 has decreased and potentially resulted in a sediment-deprived condition.

At the boundary between Reaches 4A and 4B1, the Sand Slough Control Structure diverts all flows into the Eastside Bypass. With flows, the entire sediment load of the river is conveyed into the bypass, entirely cutting off the sediment supply from the main river channel to Reach 4B1. In the Eastside Bypass just downstream from the Sand Slough Control Structure, a sediment basin accommodates very small loads.

Reach 4B1 extends from the Sand Slough Control Structure to the return of the Mariposa Bypass. This reach has had very little flowing water since the construction of the Sand Slough Control Structure. Currently, the capacity of the river is severely limited by vegetation in the channel and adjacent land use. Levees are not present in the reach to contain flood flows. Mussetter (2002b) estimated the flow capacity of Reach 4B1 to be 400 cfs. The slope is 0.00017, which is the lowest slope of all project reaches.

Reach 4B2 extends from Mariposa Bypass at the upstream end to the return of the Eastside Bypass into the San Joaquin River at the downstream end. This reach is bordered on the south side by the San Luis National Wildlife Refuge. Levees bound the river, but the width between the levees is generally more than 1,000 feet. Mussetter (2002b) estimated the channel capacity in this reach to be greater than 10,000 cfs. The river slope is approximately 0.00019, and the median bed material size is 0.56 mm.

The return flow from Mariposa Bypass during flood flows maintains a well-defined channel in Reach 4B2. The river has a much wider floodplain area and is generally well connected to it. Overbank flow occurs at relatively low discharges in the range of 3,000 to 4,000 cfs. The channel is heavily vegetated and the meander rate is low.

Downstream from the Sand Slough Control Structure, the Mariposa Bypass directs flow and sediment from Reach 4A and the bypass system into Reach 4B. Downstream from the Mariposa Bypass, Reach 4B receives further sediment influx from flow in the Chowchilla and Eastside bypasses and agricultural return flows.

The upstream half of Reach 4A is dominated by sandy loam, but farther downstream, the river channel is characterized by more loam, clay loam, and clay. Reach 4B comprises mainly clay loam, clay, and some loam, with minor amounts of sandier soils. Lack of flows through this reach has likely prevented channel scour from removing these fine sediments. Table 10-6 contains the calculated areas in acres for each generalized soil texture in Reaches 4A and 4B. NRCS data (Soil Survey Staff 2008) indicate that overall, Reach 4 soils have a moderate erosion potential. Soils in this reach have a selenium content of approximately 0.10 to 0.13 ppm in the top 12 inches of soil, decreasing to less than 0.09 ppm in Reach 4B2 (SJVDP 1990).

Reach 5

The extensive flood basin morphology of Reach 4 continues into Reach 5, with little change in stream gradient. Mussetter (2002b) estimated the capacity of this reach to be over 20,000 cfs. The slope is 0.0002, and the median bed material size is 0.52 mm.

Historically, natural riparian levees provided moderate control of flows, although project and nonproject levees confine the river today. Anabranching channels that historically conveyed summer and winter base flows continue to be common in this reach. Salt Slough and Mud Slough, tributaries that originate in the farmlands south of Reach 4, join the river in Reach 5. At the downstream end of Reach 5, the alluvial fan of the Merced River provides base level control of the river channel. Downstream from Reach 5, river geometry returns to a floodplain rather than flood basin morphology because of sediment supply from the Merced River.

Reach 5 is the least disturbed reach of the river in the study area. Public lands such as Fremont Ford State Park and San Luis NWR encompass much of Reach 5, and agricultural development in these areas has been limited relative to upstream reaches. These lands are currently managed for waterfowl habitat, which differs from the historical flow regime of the river. Even so, much of the natural channel geometry remains intact, including remnant abandoned channels, scroll bars, and riparian vegetation.

Similar to Reach 4, historical sediment supply to Reach 5 from the main river channel was low. The sediment load has been reduced even further by emplacement of the flood control and water supply structures mentioned in the upstream reaches. However, agricultural return flows and erosion of the bypass system (via the Eastside Bypass) have augmented the natural sediment supply to Reach 5. Mud and Salt sloughs deliver sediment to the river in this reach as well.

Reach 5 is dominated by clay loam and clay, with minor amounts of coarser soils. Table 10-6 contains the calculated areas in acres for each generalized soil texture in Reach 5. NRCS data (Soil Survey Staff 2008) indicate that overall, Reach 5 soils have moderate erosion potential. Soil selenium concentrations in Reach 5 are similar to those in Reach 4B2, with less than 0.09 ppm in the top 12 inches of soil (SJVDP 1990).

Chowchilla Bypass, Eastside Bypass, and Mariposa Bypass

The bypass system is constructed in the San Joaquin River floodplain and is composed of man-made channels and converted sloughs. A low-flow channel exists in much of the bypass system; however, it is best defined in the Mariposa Bypass, where the high groundwater table maintains more frequent base flows. A sediment detention basin is located in the Chowchilla Bypass downstream from the bifurcation structure, and is commonly excavated following high-flow events. Sand scoured from Eastside Bypass Reach 1 is deposited in Eastside Bypass Reach 3. This aggradation has affected the conveyance capacity of the bypass system (USACE 1993).

Soil in the bypass system is dominated by loam, clay loam, and clay, with some sandy loam and minor amounts of sand. Table 10-6 contains the calculated areas in acres for each generalized soil texture in the bypass system. NRCS data (Soil Survey Staff 2008) indicate that overall, soils in the bypass system have a moderate erosion potential.

A sediment detention basin is located in the Chowchilla Bypass downstream from the bifurcation structure. The 250,000-cubic-yard basin captures incoming sediment, particularly sand, to prevent it from filling the bypass channels farther downstream. As part of its operations and maintenance, LSJLD contracts with private companies to excavate this sand to maintain basin capacity. LSJLD generates revenue from sand removal activities. Sand scoured from Eastside Bypass Reach 1 is deposited in Eastside Bypass Reach 3.

10.2 Regulatory Setting

This section presents applicable Federal, State, and local laws and regulations associated with geology and soils in the study area.

10.2.1 Federal

Federal regulations associated with geology and soils in the study area include the CWA and NPDES program, as well as the Federal Flood Insurance Program, which regulates construction of levees and other flood-related activities.

Clean Water Act Section 402

(See Chapter 14) CWA Section 402 is directly relevant to excavation and grading activities that may occur during restoration and other activities which may affect geology and soils in the study area.

Federal Flood Insurance Program Regulations

(See Chapter 11) Criteria in 44 CFR 65.10 apply to Mapping of Areas Protected by Levee Systems and to standards for levee design and performance.

10.2.2 State of California

Several codes and acts are in place in the State that may pertain to activities affecting geology and soils in the study area.

Alquist-Priolo Earthquake Fault Zoning Act

California's Alquist-Priolo Earthquake Fault Zoning Act (Public Resources Code Section 2621 et seq.), originally enacted in 1972 as the Alquist-Priolo Special Studies Zones Act, and renamed in 1994, is intended to reduce the risk to life and property from surface fault rupture during earthquakes. The Alquist-Priolo Act prohibits the location of most types of structures intended for human occupancy across the traces of active faults, and strictly regulates construction in the corridors along active faults (earthquake fault zones).

California Building Standards Code

California's minimum standards for the design and construction of buildings, associated facilities, and equipment are given in the CCR. Many of the applicable standards are found in CCR Title 24, also known as the California Building Standards Code (CBSC). Other standards applicable to buildings are given in CCR Titles 8, 19, 21, and 25. Design and construction must satisfy CCR requirements.

Surface Mining and Reclamation Act

In 1975, the State Surface Mining and Reclamation Act (SMARA, Public Resources Code Section 2710 – 2796.5) mandated that the State Geologist make an inventory, by county, of mineral resources of statewide and regional significance.

10.2.3 Local

Local policies and plans in the Restoration Area may relate to implementation of program alternatives potentially affecting geology and soils.

County General Plans

As required by state law, counties in the Restoration Area have developed their own general plans. At a minimum, these documents must address the topics of land use, transportation, housing, conservation, open space, noise, and safety. These documents serve as statements of county goals, policies, standards, and implementation programs for the physical development of a county. These documents include the Fresno County General Plan Policy Document (2000b), the Madera County General Plan Policy Document (1995), and the Merced County General Plan (2007).

San Joaquin River Parkway Master Plan

The Parkway Plan is a regional resource management plan for the San Joaquin River area between Friant Dam and SR 99 (SJRC 1992). The SJRC, a regionally governed agency created by the State, is charged with implementing the Parkway Plan. The plan's main tenets include protection of natural resources, public education, and promotion of low-impact recreation use of the river corridor.

10.3 Environmental Consequences and Mitigation Measures

The purpose of this section is to provide information about the environmental consequences of the program alternatives on geology and soils. This section describes the methods and assumptions, criteria for determining significant impacts, and impacts and mitigation measures associated with the effects on geology and soils of each of the program alternatives. Implementing the action alternatives could affect geology and soils of the San Joaquin River system upstream from Friant Dam, from Friant Dam to the Delta, and in the Delta. The program alternatives evaluated in this chapter are described in detail in Chapter 2.0, "Description of Alternatives," and summarized in Table 10-7. The potential impacts to geology and soils and associated mitigation measures are summarized in Table 10-8. As mentioned previously, the Settlement is not anticipated to cause impacts to geology and soils in the CVP/SWP service areas. Therefore, these areas were eliminated from detailed environmental analysis.

Table 10-7.
Actions Included Under Action Alternatives

Level of NEPA/CEQA Compliance	Actions[1]		Action Alternative					
			A1	A2	B1	B2	C1	C2
Project-Level	Reoperate Friant Dam and downstream flow control structures to route Interim and Restoration flows		✓	✓	✓	✓	✓	✓
	Recapture Interim and Restoration flows in the Restoration Area		✓	✓	✓	✓	✓	✓
	Recapture Interim and Restoration flows at existing CVP and SWP facilities in the Delta		✓	✓	✓	✓	✓	✓
Program-Level	Common Restoration actions[2]		✓	✓	✓	✓	✓	✓
	Actions in Reach 4B1 to provide at least:	475 cfs capacity	✓	✓	✓	✓	✓	✓
		4,500 cfs capacity with integrated floodplain habitat		✓		✓		✓
	Recapture Interim and Restoration flows on the San Joaquin River downstream from the Merced River at:	Existing facilities on the San Joaquin River			✓	✓	✓	✓
		New pumping infrastructure on the San Joaquin River					✓	✓
	Recirculation of recaptured Interim and Restoration flows		✓	✓	✓	✓	✓	✓

Note:

[1] All alternatives also include the Physical Monitoring and Management Plan and the Conservation Strategy, which include both project- and program-level actions intended to guide implementation of the Settlement.

[2] Common Restoration actions are physical actions to achieve the Restoration Goal that are common to all action alternatives and are addressed at a program level of detail.

Key:
CEQA = California Environmental Quality Act
cfs = cubic feet per second
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
NEPA = National Environmental Policy Act
PEIS/R = Program Environmental Impact Statement/Report
SWP = State Water Project

Table 10-8.
Summary of Environmental Consequences and Mitigation Measures – Geology and Soils

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Geology and Soils: Program-Level				
GEO-1: Potential Localized Soil Erosion, Sedimentation, and Inadvertent Permanent Soil Loss	No-Action	LTS	--	LTS
	A1	PS	GEO-1: Prepare and Implement a Stormwater Pollution Prevention Plan that Minimizes the Potential Contamination of Surface Waters, and Complies with Applicable Federal Regulations Concerning Construction Activities	LTS
	A2	PS		LTS
	B1	PS		LTS
	B2	PS		LTS
	C1	PS		LTS
	C2	PS		LTS
GEO-2: Potential Loss of Availability of a Known Mineral Resource of Value	No-Action	LTS	--	LTS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
Geology and Soils: Project-Level				
GEO-3: Potential Localized Soil Erosion, Sedimentation, and Inadvertent Permanent Soil Loss	No-Action	LTS	--	LTS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
GEO-4: Potential Increase in Channel Erosion, Sediment Transport, and Meander Migration from San Joaquin River Flows	No-Action	LTS	--	LTS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
GEO-5: Potential Loss of Availability of a Known Mineral Resource of Value	No-Action	LTS	--	LTS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS

Key:
-- = not applicable
LTS = less than significant
PS = potentially significant
SU = significant and unavoidable

10.3.1 Impact Assessment Methodology

The analysis presented in this section is qualitative and based on the general information on geology, soils, mineral resources, seismicity and neotectonics, and geomorphology documented for the region, as previously described. Impacts associated with soils, mineral resources, neotectonics, and geomorphology that could result from project construction and operational activities were evaluated qualitatively based on expected construction practices, materials, locations, and duration of project construction and related activities, as well as the effects of modified reservoir levels and San Joaquin River flows. The geological and soils environmental consequences of the action alternatives were derived from a comparison with the No-Action Alternative and existing conditions. Mitigation is identified for all potentially significant impacts to this resource area. The proposed mitigation reduces geological and soils impacts to less-than-significant levels.

A one-dimensional sediment transport and morphology model was developed to predict the rate of sediment erosion and deposition in the channel of the San Joaquin River from Friant Dam to the Merced River; model methods and assumptions are described in Appendix N, “Geomorphology, Sediment Transport, and Vegetation Assessment.” This model represents the spatial distribution of sediment erosion and deposition, and was developed to quantify present erosion rates and predict future erosion rates. Model inputs included flow rates, sediment loads, channel roughness, initial channel geometry, and initial bed material. In addition, several computational parameters were required, including the active layer thickness and sediment transport formula. Model outputs included bed elevation changes, sediment erosion and deposition volumes, and mean bed sediment size (D50) for several cross sections per reach. Outputs were also averaged by reach to determine potential reach-scale impacts.

Further studies performed to support environmental impact analysis included a sediment mobilization and transport study for Reaches 1 and 2 (see Appendix N, “Geomorphology, Sediment Transport, and Vegetation Assessment”). Study inputs included flow rate and fraction of material by weight in each size class present in the channel bed. Study outputs included local and reach-averaged sediment mobilization and annual loads of sand, small gravel, and large gravel. A geomorphic assessment using aerial photographs was also performed for Reach 1. Using georeferenced aerial photographs from 1938 and 2007, changes in channel planform during this time period were observed to identify geomorphic characteristics that would most likely develop under an altered flow regime (see Appendix N, “Geomorphology, Sediment Transport, and Vegetation Assessment”). Assessment results included measurements of active channel width, channel sinuosity calculations, and predicted changes in channel morphology under Interim and Restoration flows.

10.3.2 Significance Criteria

Impacts to geology and soils from the program alternatives were determined to be significant if they would do any of the following:

- Decrease the channel capacity of the San Joaquin River.
- Destabilize existing infrastructure, such as levees, bridges, or other structures.

- Result in a change in river channel substrate that would change its ability to support vegetation.
- Result in substantial soil erosion or loss of topsoil.
- Result in the loss of availability of a known mineral resource of value.

The current and predicted rates and volumes of sediment erosion and deposition calculated by the sediment transport model were used as indicators of potential changes that could result in the first three types of impacts listed above. Soil erosion was evaluated qualitatively based on general soils information presented in Section 10.1.1 and on known construction practices, as described in the previous subsection.

The following additional significance criteria are based on the environmental checklist in Appendix G of the State CEQA Guidelines, as amended. Impacts of an alternative on geology and soils would be significant if project implementation would expose people or structures to potential substantial adverse effects, including the risk of loss, or injury, or death, through the following:

- Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault.
- Strong seismic ground shaking
- Seismic-related ground failure, including liquefaction
- Landslides
- Substantial soil erosion or loss of topsoil
- Location of project on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
- Location of project on expansive soil creating substantial risks to life or property
- Soils incapable of adequately supporting the use of septic tanks, or alternative wastewater disposal systems where sewers are not available for disposal of wastewater.

As described in Section 10.2, the lack of faults and/or recent seismic activity within the Restoration Area where most construction would occur under the Action Alternatives, and the lack of features that would contribute to landslides within most of the study area, reduces the potential for most of the impact mechanisms listed above. The potential for subsidence to occur is primarily in the Friant Division water service areas, as described in Chapter 12.0, “Hydrology – Groundwater,” and is not further described in this chapter. The potential for the action alternatives to result in substantial soil erosion is described in Sections 10.3.3 and 10.3.4. Action alternatives would not include the use of septic tanks or alternative wastewater disposal systems. Significance statements are relative to both existing conditions (2006) and future conditions (2030), unless stated otherwise.

10.3.3 Program-Level Impacts and Mitigation Measures on Geology and Soils

This section determines the significance of impacts related to program-level actions defined in Chapter 2.0 of the PEIS/R, and based on the impact indicators described in Section 10.3.2.

No-Action Alternative

Under the No-Action Alternative, the Settlement would not be implemented and no Settlement-related construction activities would take place. Several potential changes from the existing condition could occur under the No-Action Alternative. The USACE policy on levee vegetation, as described in Chapter 2.0 of the PEIS/R, has the potential to impact geology and soils in the study area under the No-Action alternative. Flood system improvements are currently underway or will be initiated under this policy, which calls for the removal of vegetation from levees as necessary to maintain levee integrity and fire-fighting access (California Levees Roundtable 2009).

Impact GEO-1 (No-Action Alternative): ***Potential Localized Soil Erosion, Sedimentation, and Inadvertent Permanent Soil Loss – Program-Level.*** Under the No-Action Alternative, the USACE policy on levee vegetation would remain in place. Removing vegetation from the river channel and bypasses could result in localized erosion in areas where vegetation is removed (California Levees Roundtable 2009). However, this vegetation removal would be within the range of historical vegetation removal and, therefore, the potential erosion would likely be within the range of historical erosion rates and patterns. Therefore, this impact would be **less than significant**.

Impact GEO-2 (No-Action Alternative): ***Potential Loss of Availability of a Known Mineral Resource of Value – Program-Level.*** Under the No-Action Alternative, no program-related construction activities would take place. No existing gravel or sand mining locations would be altered, and excavation in the Chowchilla Bypass sediment detention basin would not be impeded. This impact would be **less than significant**.

Alternatives A1 and B1

Program-level impacts under Alternatives A1 and B1 would include impacts due to construction and maintenance activities in the Restoration Area.

Impact GEO-1 (Alternatives A1 and B1): ***Potential Localized Soil Erosion, Sedimentation, and Inadvertent Permanent Soil Loss – Program-Level.*** Program-level construction and maintenance activities could result in localized soil erosion, sedimentation, and inadvertent permanent soil loss. This impact would be **potentially significant**.

Program-level construction and maintenance would have the potential to expose bare soil to precipitation and result in entrainment of soils in surface runoff. Activities involving soil disturbance, channel alteration, dredging, excavation, cutting/filling, and grading activities could result in an increased volume of, or an accelerated rate of soil erosion and sedimentation, to local surface waters. Furthermore, clearing vegetation along existing or proposed channels may destabilize soils and result in inadvertent permanent soil loss. Alternatives A1 and B1 would involve substantial construction activities in or near the San Joaquin River channel over a number of years. For these reasons, mitigation measures would be implemented to reduce impacts on the environment.

Mitigation Measure GEO-1 (Alternatives A1 and B1): ***Prepare and Implement a Stormwater Pollution Prevention Plan that Minimizes the Potential Contamination of Surface Waters, and Complies with Applicable Federal Regulations Concerning Construction Activities – Program-Level.*** This mitigation measure is identical to Mitigation Measure SWQ-1A, as described in Chapter 14.0, "Hydrology – Surface Water Quality."

This impact would be **less than significant** after mitigation.

Impact GEO-2 (Alternatives A1 and B1): ***Potential Loss of Availability of a Known Mineral Resource of Value – Program-Level.*** Program-level construction and maintenance activities could result in short-term alteration of existing gravel or sand mining locations, but would not result in long-term interruption of mining activities. This impact would be **less than significant**.

Mining activities including gravel mining in Reach 1, and informal sand mining in areas of sediment accumulation in the Chowchilla and Eastside bypass and in Reach 2A would not be substantially affected by program-level actions. In Reach 1, only inactive mining sites are under consideration for permanent modification by program-levels actions. Program-level construction and maintenance activities would occur periodically in downstream reaches, potentially affecting sand removal in Reach 2A or the Eastside Bypass; however, these activities could continue during periods when active construction and maintenance activities would not occur. In addition, no Conditional Use Permits for mining activities in Reach 2A or in Eastside Bypass Reach 2 are on record with the appropriate counties or Department of Fish and Game. No actions would occur in the Chowchilla Bypass; therefore, excavation in this area would not be affected by Alternatives A1 and B1. This impact would be less than significant.

Alternatives A2 and B2

Program-level impacts of Alternatives A2 and B2 would include impacts due to construction and maintenance activities in the Restoration Area. Program-level actions in Alternatives A2 and B2 would include many of the same actions included in Alternatives A1 and B1; therefore, impacts under Alternatives A2 and B2 would be similar to those described under Alternatives A1 and B1.

Impact GEO-1 (Alternatives A2 and B2): ***Potential Localized Soil Erosion, Sedimentation, and Inadvertent Permanent Soil Loss – Program- Level.*** Program-level construction and maintenance activities could result in localized soil erosion, sedimentation, and inadvertent permanent soil loss. This impact would be **potentially significant**.

This impact would be similar to Impact GEO-1 for Alternatives A1 and B1, with the possibility of additional localized soil erosion, sedimentation, and inadvertent permanent soil loss in Reach 4B due to construction activities associated with increasing Reach 4B1 channel capacity to at least 4,500 cfs, and modifying the San Joaquin River headgates and Sand Slough Control Structure.

Mitigation Measure GEO-1 (Alternatives A2 and B2): ***Prepare and Implement a Stormwater Pollution Prevention Plan that Minimizes the Potential Contamination of Surface Waters, and Complies with Applicable Federal Regulations Concerning Construction Activities – Program-Level.*** This mitigation measure is identical to Mitigation Measure SWQ-1A, as described in Chapter 14.0, "Hydrology – Surface Water quality."

This impact after mitigation would be **less than significant**.

Impact GEO-2 (Alternatives A2 and B2): ***Potential Loss of Availability of a Known Mineral Resource of Value – Program-Level.*** This impact would be the same as Impact GEO-2 for Alternative A1, as described for program-level impacts. This impact would be **less than significant**.

Alternative C1

Program-level impacts under Alternative C1 would include impacts due to construction and maintenance activities in the Restoration Area, as described for Alternative A1. Additional impacts under Alternative C1 would occur in the San Joaquin River below the Merced River confluence because of construction of new infrastructure to increase pumping capacity on the San Joaquin River in this area.

Impact GEO-1 (Alternative C1): ***Potential Localized Soil Erosion, Sedimentation, and Inadvertent Permanent Soil Loss – Program-Level.*** This impact would be similar to Impact GEO-1 for Alternative A1. In addition to impacts within the Restoration Area described in Impact GEO-1 for Alternative A1, program-level construction and maintenance of the new infrastructure to increase pumping capacity could result in localized soil erosion, sedimentation, and inadvertent permanent soil loss along the San Joaquin River below the Merced River confluence. Therefore, this impact would be **potentially significant**.

Mitigation Measure GEO-1 (Alternative C1): ***Prepare and Implement a Stormwater Pollution Prevention Plan that Minimizes the Potential Contamination of Surface Waters, and Complies with Applicable Federal Regulations Concerning Construction Activities – Program-Level.*** This mitigation measure is identical to Mitigation Measure SWQ-1A, as described in Chapter 14.0, "Hydrology – Surface Water quality."

This impact would be **less than significant** after mitigation.

Impact GEO-2 (Alternative C1): ***Potential Loss of Availability of a Known Mineral Resource of Value – Program-Level.*** This impact would be the same as Impact GEO-2 for Alternative A1, as described for program-level impacts. This impact would be **less than significant**.

Alternative C2

Program-level impacts in the Restoration Area under Alternative C2 would include impacts due to construction and maintenance activities, as described for Alternatives C1 and C2. Additional impacts would occur in the San Joaquin River downstream from the Merced River confluence, as described for Alternative C1.

Impact GEO-1 (Alternative C2): ***Potential Localized Soil Erosion, Sedimentation, and Inadvertent Permanent Soil Loss – Program-Level.*** This impact would be similar to Impact GEO-1 for Alternatives A2 and B2. In addition to the impacts within the Restoration Area described in Impact GEO-1 for Alternatives A2 and B2, program-level construction and maintenance of the new infrastructure to increase pumping capacity could result in localized soil erosion, sedimentation, and inadvertent permanent soil loss along the San Joaquin River below the Merced River confluence, as described in Impact GEO-1 for Alternative C1. Therefore, this impact would be **potentially significant**.

Mitigation Measure GEO-1 (Alternative C2): ***Prepare and Implement a Stormwater Pollution Prevention Plan that Minimizes the Potential Contamination of Surface Waters, and Complies with Applicable Federal Regulations Concerning Construction Activities – Program-Level.*** This mitigation measure is identical to Mitigation Measure SWQ-1A, as described in Chapter 14.0, “Hydrology – Surface Water quality.”

This impact would be **less than significant** after mitigation.

Impact GEO-2 (Alternative C2): ***Potential Loss of Availability of a Known Mineral Resource of Value – Program-Level.*** This impact would be the same as Impact GEO-2 for Alternative A1, as described for program-level impacts. This impact would be **less than significant**.

10.3.4 Project-Level Impacts and Mitigation Measures

This section determines the significance of project-level impacts related to the reoperation of Friant Dam, as defined in Chapter 2.0 of the PEIS/R, and based on the significance criteria identified in Section 10.3.2, “Criteria for Determining Significance of Effects.”

Project-level effects of the alternatives are related to mineral resources and erosion and deposition of soil due to changes in reservoir levels of Millerton Lake and flows in the San Joaquin River. Potential channel erosion rates under the program alternatives are summarized in Table 10-9. These impacts, and potential project-level impacts to soils, are discussed in detail below.

Table 10-9.
Summary of Potential Channel Erosion Rates Under Project-Level Alternatives

Reach/Bypass		Existing Conditions1	No-Action Alternative	Alternatives A1, B1, and C1 (475 cfs in Reach 4B1)	Alternatives A2, B2, and C2 (4,500 cfs in Reach 4B1)
Reach 1		Stable	Stable	Stable	Stable
Reach 2A		Erosion 3.3 feet	Erosion 3.85 feet	Erosion 2.09 feet	Erosion 2.09 feet
Reach 2B		Deposition 0.54 feet	Deposition 0.54 feet	Deposition 0.22 – 0.37 feet	Deposition 0.22 – 0.37 feet
Reach 3		Erosion 0.84 feet	Erosion 0.84 feet	Erosion 0.84 feet	Erosion 0.84 feet
Reach 4A		Stable	Stable	Erosion 0.26 feet	Erosion 0.26 feet
Eastside Bypass		Deposition 0.79 feet	Deposition 0.79 feet	Deposition 0.52 feet	Deposition 0.29 feet
Mariposa Bypass		Erosion 3.6 feet	Erosion 3.6 feet	Erosion 3.4 feet	Erosion 2.2 feet
Reach 4B1		Stable	Stable	Erosion 0.4 feet	Erosion 1.9 feet
Reach 4B2		Erosion 1.4 feet	Erosion 1.4 feet	Erosion 1.4 feet	Erosion 1.4 feet
Reach 5	Upstream Portion2	Erosion 3.2 feet	Erosion 3.2 feet	Erosion 3.1 feet	Erosion 3.0 feet
Reach 5	Middle Portion2	Erosion 1.8 feet	Erosion 1.8 feet	Erosion 1.8 feet	Erosion 1.7 feet
Reach 5	Downstream Portion2	Erosion 4.2 feet	Erosion 4.2 feet	Erosion 4.2 feet	Erosion 4.1 feet

Notes:
[1] Changes were modeled over 17 years for the existing conditions and over 23 years for the program alternatives. Supporting information is provided in Appendix N, “Geomorphology, Sediment Transport, and Vegetation Assessment,” of the PEIS/R.
[2] As described in Appendix N, “Geomorphology, Sediment Transport, and Vegetation Assessment,” of the PEIS/R, Reach 5 is modeled in three distinct sections, including upstream, middle, and downstream portions.
Key:
cfs = cubic feet per second

No-Action Alternative

This section describes potential project-level impacts that would occur under the No-Action Alternative.

Impact GEO-3 (No-Action Alternative): ***Potential Localized Soil Erosion, Sedimentation, and Inadvertent Permanent Soil Loss – Project-Level.*** Variation in reservoir levels of Millerton Lake due to operations of Friant Dam could result in erosion of soils and loss of soil horizons down to bedrock along the reservoir shore in the zone of water elevation variation. This impact would be **less than significant**.

No Interim or Restoration flows would be released from Friant Dam as a result of the No-Action Alternative. Water releases from the dam would continue to vary based on time of year, water year type, and system conditions, and would result in no change in reservoir level fluctuations or the rate of soil erosion on the reservoir shore compared to the existing conditions. Therefore, this impact would be less than significant.

Impact GEO-4 (No-Action Alternative): ***Potential Increase in Channel Erosion, Sediment Transport, and Meander Migration from San Joaquin River Flows – Project-Level.*** Release of flows from Friant Dam could increase downstream channel erosion and change downstream geomorphic characteristics. This impact would be **less than significant**.

No Interim or Restoration flows would be released from Friant Dam as a result of the No-Action Alternative. Water releases from the dam would continue to vary within their historical range based on time of year, water year type, and system conditions. This would result in the following rates of channel erosion and deposition, and changes in geomorphic characteristics, described below for each reach in the Restoration Area.

Reach 1. Modeling results suggest that under the No-Action Alternative, bed sediment size would not change, as shown in Table 10-9. Reach 1 would continue to experience minimal erosion and deposition, except during very high flood releases from Friant Dam when further channel erosion would occur. Overall, near equilibrium between erosion and deposition would continue under the No-Action Alternative. This impact would be less than significant.

Reach 2. Under the No-Action Alternative, modeling indicates that Reach 2A would continue to experience net erosion, with an average channel erosion of 3.85 feet in 23 years, which is within 0.5 feet of the erosion occurring over 17 years under existing conditions, as shown in Table 10-9. Nearly 10 percent of that erosion could occur during extreme high-flow events (such as flood releases during water year (WY) 1997). Sand erosion would continue to occur throughout Reach 2A, and gravels would be eroded in some parts of the reach and deposited in others, similar to existing conditions. This impact would be less than significant.

Under the No-Action Alternative, modeling indicates that Reach 2B would continue to experience net deposition, with an average channel deposition of 0.54 feet in 23 years, similar to under existing conditions. This impact would be less than significant.

Reach 3. Under the No-Action Alternative, Reach 3 would continue to be subject to net erosion as under existing conditions. Modeling indicates that channel erosion would average 0.84 feet in 23 years under the No-Action Alternative, similar to under existing conditions, as shown in Table 10-9. This impact would be less than significant.

Reach 4. Under the No-Action Alternative, Reach 4A would continue to receive minimal inflows from Reach 3, except under some flood conditions. Reach 4A would continue to be subject to minimal net erosion and deposition, and would remain stable, as under existing conditions. This impact would be less than significant.

Under the No-Action Alternative, Reach 4B1 would not receive upstream flows as under existing conditions, and would remain stable, also as under existing conditions. This impact would be less than significant.

Under the No-Action Alternative, Reach 4B2 would continue to be subject to net erosion, as under existing conditions. Modeling indicates that channel erosion would average

1.4 feet in 23 years under the No-Action Alternative, similar to under existing conditions, as shown in Table 10-9.

Reach 5. Under the No-Action Alternative, Reach 5 would continue to be subject to net erosion, as under existing conditions. Modeling indicates that under the No-Action Alternative, channel erosion would range from an average of 3.2 feet in 23 years in the upstream end of Reach 5 to 1.8 feet in the middle of the reach, and 4.2 feet at the downstream end of the reach, similar to under existing conditions, as shown in Table 10-9. This impact would be less than significant.

Eastside Bypass. Under the No-Action Alternative, the Eastside Bypass would continue to receive all flood flows from the Chowchilla Bypass, and to be subject to net deposition, as under existing conditions. Modeling indicates that channel deposition would average 0.79 feet in 23 years under the No-Action Alternative, similar to under existing conditions, as shown in Table 10-9. This impact would be less than significant.

Mariposa Bypass. Under the No-Action Alternative, the Mariposa Bypass would continue to route flood flows from the Eastside Bypass to Reach 4B2, and to be subject to net erosion, as under existing conditions. Modeling indicates that channel erosion would average 3.6 feet in 23 years under the No-Action Alternative, mostly as erosion of sand, similar to under existing conditions, as shown in Table 10-9. This impact would be less than significant.

All Reaches and Bypasses. Under the No-Action Alternative, the USACE policy on levee vegetation would remain in place (California Levees Roundtable 2009). This policy calls for the removal of vegetation from levees, as necessary, to maintain levee integrity and fire-fighting access. Removing vegetation from the river channel and bypasses could result in localized erosion in areas where the vegetation is removed. However, this vegetation removal would be within the range of historical vegetation removal and, therefore, potential erosion would likely be within the range of historical erosion rates and patterns. This impact would be less than significant.

Impact GEO-5 (No-Action Alternative): ***Potential Loss of Availability of a Known Mineral Resource of Value – Project-Level.*** Variation in San Joaquin River levels would result in inundation of existing gravel and sand mining locations. This impact would be **less than significant**.

No Interim or Restoration flows would be released from Friant Dam as a result of the No-Action Alternative. Water releases from the dam and San Joaquin River water levels would continue to vary within their historical range based on time of year, water year type, and system conditions. Flood releases would continue to inundate existing gravel and sand mining locations in some years, and excavation in the Chowchilla Bypass sediment detention basin would be impeded during release of flows to the Chowchilla Bypass. In recognition of the potential for inundation during flood releases, current excavation operations are not conducted during flood releases with the potential to inundate excavation sites. This impact would be less than significant.

Alternatives A1, B1, and C1

Project-level impacts under Alternatives A1, B1, and C1 include impacts due to reoperating Friant Dam, and would occur in the San Joaquin River upstream from Friant Dam, within the Restoration Area, below the Merced River confluence, and in the Delta, as described below.

San Joaquin River Upstream from Friant Dam. This section describes potential project-level impacts to the San Joaquin River upstream from Friant Dam under Alternatives A1, B1, and C1.

Impact GEO-3 (Alternatives A1, B1, and C1): ***Potential Localized Soil Erosion, Sedimentation, and Inadvertent Permanent Soil Loss – Project-Level.*** Variation in reservoir levels of Millerton Lake due to reoperating Friant Dam could result in erosion of soils and loss of soil horizons down to bedrock along the reservoir shore in the zone of water elevation variation. This impact would be **less than significant**.

Reoperating Friant Dam to release Interim and Restoration flows could change the timing, frequency, and duration of fluctuations in the water level of Millerton Lake. These fluctuations could cause continued soil erosion and loss of soil horizons down to bedrock along the reservoir shore in the zone of water elevation variation. However, release of Interim and Restoration flows falls within the historical range of reservoir releases, and attendant reservoir level fluctuations would be within the historical range of fluctuations. Therefore, this impact would be less than significant.

San Joaquin River from Friant Dam to Merced River. This section describes potential project-level impacts to the San Joaquin River from Friant Dam to the Merced River under Alternatives A1, B1, and C1.

Impact GEO-4 (Alternatives A1, B1, and C1): ***Potential Increase in Channel Erosion, Sediment Transport, and Meander Migration from San Joaquin River Flows – Project-Level.*** Release of Interim and Restoration flows from Friant Dam could increase downstream channel erosion and change downstream geomorphic characteristics. This impact would be **less than significant**.

Reoperating Friant Dam to release Interim and Restoration flows would change the timing, frequency, duration, and volume of flows in the San Joaquin River and bypasses, and could change rates of stream channel erosion and meander migration, including a reduction in the number of flood releases under the action alternatives, as described in Chapter 11.0, "Hydrology – Flood Management." Potential impacts are described below by reach.

Reach 1. Modeling results suggest that under Alternatives A1, B1, and C1, there would be no change in bed sediment size from the No-Action Alternative, as shown in Table 10-9. Compared with the No-Action Alternative, under Alternatives A1, B1, and C1 in Reach 1A, less erosion and deposition of sand and small gravel would occur. However, in Reach 1B, more erosion and deposition of small gravel would occur under Alternatives A1, B1, and C1 than under the No-Action Alternative. Reach 1 would continue to experience minimal erosion and deposition, except during very high flood releases from Friant Dam when further channel erosion could occur. Overall, near-equilibrium between erosion and deposition would continue under Alternatives A1, B1, and C1, as under the No-Action Alternative. This impact would be less than significant.

Release of Interim and Restoration flows under Alternatives A1, B1, and C1 would result in a flow regime more similar to that of the past. Comparison of past (1938) and recent (2007) aerial photographs (see Appendix N, "Geomorphology, Sediment Transport, and Vegetation Assessment") suggests that under Alternatives A1, B1, and C1, vegetated bars would gradually decrease and unvegetated bars would increase compared to the No-Action Alternative. Photograph assessment also suggests that there could be greater flow in existing side channels, and intermittent reconnection of currently abandoned side channels, under Alternatives A1, B1, and C1 than under the No-Action Alternative, depending on the height of the side channels above the active channel, and the magnitude of flows. Slight increases in channel width may also occur in association with removing vegetation along channel margins.

Reach 2. Under Alternatives A1, B1, and C1, Reach 2A would continue to experience net erosion, as under the No-Action Alternative. Channel erosion in Reach 2A would average 2.09 feet in 23 years, which is less than that predicted under the No-Action Alternative. Bed material in Reach 2A would remain similar to that of the No-Action Alternative. Sand erosion would continue to occur throughout Reach 2A, and gravels would be eroded in some parts of the reach and deposited in others, similar to the No-Action Alternative. Compared with the No-Action Alternative, less sand erosion would occur in most of the reach, although sand transport would increase by about 7 percent in the downstream end of the reach. Additionally, erosion and deposition of small gravel would be greater under Alternatives A1, B1, and C1 compared to the No-Action Alternative. More large gravels would be deposited in Reach 2A under Alternatives A1, B1, and C1 compared to the No-Action Alternative. However, overall net erosion in Reach 2A would be within 2 feet of the No-Action Alternative, and channel capacity would increase relative to the No-Action Alternative. This impact would be less than significant.

Under Alternatives A1, B1, and C1, Reach 2B would continue to experience net deposition, as under the No-Action Alternative. Reach 2B would experience a nearly five-fold increase in sand and small gravel transport capacity under Alternatives A1, B1, and C1 compared to the No-Action Alternative, which would decrease channel deposition. Reach 2B channel deposition would average 0.22 to 0.37 feet in 23 years, for wide and narrow levee setbacks in Reach 2B, respectively. However, this is 0.5 feet less than the deposition predicted under the No-Action Alternative. This impact would be less than significant.

Reach 3. Under Alternatives A1, B1, and C1, Reach 3 would continue to be subject to net erosion as under existing conditions. Modeling indicates that channel erosion would average 0.84 feet in 23 years under Alternatives A1, B1, and C1, similar to under the No-Action Alternative, as shown in Table 10-9. This impact would be less than significant.

Reach 4. Under Alternatives B1 and C1, erosion in Reach 4A would occur as under the No-Action Alternative. Under Alternative A1, Reach 4A would receive greater inflows than under the No-Action Alternative, including flows from both Reach 3 and the Mendota Pool Bypass. Modeling indicates that Reach 4 would be subject to net erosion of 0.26 feet in 23 years, greater than under the No-Action Alternative, (Table 10-9), and channel capacity would be increased relative to the No-Action Alternative. This impact would be less than significant.

Under Alternatives A1, B1, and C1, Reach 4B1 would be modified to convey 475 cfs. Model results indicate that Reach 4B1 would experience erosion as flows are routed into this reach (see Appendix N, “Geomorphology, Sediment Transport, and Vegetation Assessment”). Under Alternatives A1, B1, and C1, channel erosion would average 0.4 feet, in contrast to the No-Action Alternative, under which no erosion or sedimentation would occur. Channel capacity would therefore increase relative to the No-Action Alternative. This impact would be less than significant.

Under Alternatives A1, B1, and C1, Reach 4B2 would receive inflows from both Reach 4B1 and the Mariposa Bypass. Modeling indicates that Reach 4B2 would continue to be subject to net erosion, as under the No-Action Alternative. Modeling indicates that channel erosion would average 1.4 feet in 23 years under Alternatives A1, B1, and C1, as shown in Table 10-9, equivalent to net erosion under the No-Action Alternative. This impact would be less than significant.

Reach 5. Under Alternatives A1, B1, and C1, most erosion in Reach 5 would occur as under the No-Action Alternative. Reach 5 would continue to be subject to net erosion as under the No-Action Alternative. Modeling indicates that under Alternatives A1, B1, and C1, channel erosion would range from an average of 3.1 feet in 23 years at the upstream end of Reach 5 to 1.8 feet in the middle of the reach, and 4.2 feet at the downstream end of the reach, similar to under the No-Action Alternative, as shown in Table 10-9. This impact would be less than significant.

Eastside Bypass. Under Alternatives A1, B1, and C1, more flows would be routed away from the Chowchilla Bypass and into Reach 2B and the Mendota Pool Bypass; the Eastside Bypass would receive fewer flood flows from the Chowchilla Bypass and would be subject to less net deposition than under the No-Action Alternative. Modeling indicates that channel deposition would average 0.52 feet in 23 years under Alternatives A1, B1, and C1, as shown in Table 10-9, slightly less than deposition under the No-Action Alternative. This impact would be less than significant.

Mariposa Bypass. Under Alternatives A1, B1, and C1, the Mariposa Bypass would continue to route flows from the Eastside Bypass. Because flows would be less in the Eastside Bypass, less net erosion would occur in the Mariposa Bypass than under the No-Action Alternative. Modeling indicates that channel erosion would average 3.4 feet in 23 years under Alternatives A1, B1, and C1, as shown in Table 10-9, mostly as erosion of sand, slightly less than erosion under the No-Action Alternative. This impact would be less than significant.

San Joaquin River from Merced River to the Delta. This section describes potential project-level impacts to the San Joaquin River from the Merced River to the Delta under Alternatives A1, B1, and C1.

Impact GEO-4 (Alternatives A1, B1, and C1): *Potential Increase in Channel Erosion, Sediment Transport, and Meander Migration from San Joaquin River Flows – Project-Level.* Release of Interim and Restoration flows from Friant Dam could increase downstream channel erosion and change downstream geomorphic characteristics. This impact would be **less than significant**.

Reoperating Friant Dam to release Interim and Restoration flows would change the timing, frequency, duration, and volume of flows in the San Joaquin River from the Merced River to the Delta, including a reduction in the number of flood releases under the Action Alternatives, as described in Chapter 11.0, "Hydrology – Flood Management," and could change rates of stream channel erosion and meander migration. However, release of Interim and Restoration flows falls within the historical range of reservoir releases, and would result in no change in the historical rates of stream channel erosion and meander migration. Therefore, this impact would be less than significant.

Impact GEO-5 (Alternatives A1, B1, and C1): *Potential Loss of Availability of a Known Mineral Resource of Value – Project-Level.* Variation in San Joaquin River levels due to reoperating Friant Dam could result in inundation of existing gravel and sand mining locations. This impact would be **less than significant**.

Reoperating Friant Dam to release Interim and Restoration flows could change the timing, frequency, and duration of fluctuations in the water level of the San Joaquin River. However, release of Interim and Restoration flows falls within the historical range of reservoir releases, and attendant river-level fluctuations would be within the historical range of fluctuations. Furthermore, no Conditional Use Permits for mining activities in Reach 2A or in Eastside Bypass Reach 2 are on record with the appropriate counties or Department of Fish and Game. Excavation in the Chowchilla Bypass sediment detention basin would not be impeded because Interim and Restoration flows would not be routed through this reach. This impact would be less than significant.

Alternatives A2, B2, and C2

Project-level impacts upstream from Friant Dam under Alternatives A2, B2, and C2 would be the same as those described under Alternative A1. Additional impacts would occur in Reach 4B1 under Alternatives A2, B2, and C2 because of the release of higher flows to Reach 4B1, as described below.

Impact GEO-4 (Alternatives A2, B2, and C2): *Potential Increase in Channel Erosion, Sediment Transport, and Meander Migration from San Joaquin River Flows – Project-Level.* Release of Interim and Restoration flows from Friant Dam could increase downstream channel erosion and change downstream geomorphic characteristics. This impact would be **less than significant**.

This impact would be similar to Impact GEO-4 for Alternative A1, with the addition of the following potential impacts to Reaches 4B and 5, and the Eastside and Mariposa bypasses.

Reach 4B. Under Alternatives A2, B2, and C2, Reach 4B1 would be modified to convey 4,500 cfs. Model results indicate that Reach 4B1 would experience erosion as flows are routed into this reach. Under Alternatives A2, B2, and C2, channel erosion would average 1.9 feet. This contrasts with the No-Action Alternative, under which no flows would be routed into Reach 4B1 and no erosion or sedimentation would occur. Channel capacity would therefore increase relative to the No-Action Alternative. This impact would be less than significant.

Under Alternatives A2, B2, and C2, Reach 4B2 would receive inflows from both Reach 4B1 and the Mariposa Bypass. Modeling indicates that Reach 4B2 would continue to be subject to net erosion, as under the No-Action Alternative. Modeling indicates that channel erosion would average 1.4 feet in 23 years under Alternatives A2, B2, and C2, equivalent to net erosion under the No-Action Alternative. This impact would be less than significant.

Reach 5. Under Alternatives A2, B2, and C2, Reach 5 would continue to be subject to net erosion, as under the No-Action Alternative. Modeling indicates that under Alternatives A2, B2, and C2, channel erosion would range from an average of 3.0 feet in 23 years at the upstream end of Reach 5 to 1.7 feet in the middle of the reach, and 4.1 feet at the downstream end of the reach, similar to erosion under the No-Action Alternative. This impact would be less than significant.

Eastside Bypass. Under Alternatives A2, B2, and C2, more flows would be routed away from the Chowchilla Bypass and into Reach 2B and the Mendota Pool Bypass; the Eastside Bypass would receive fewer flows from the Chowchilla Bypass and would be subject to less net deposition than under the No-Action Alternative. Modeling indicates that channel deposition would average 0.29 feet in 23 years under Alternatives A2, B2, and C2, less than half the deposition under the No-Action Alternative. Channel capacity would therefore increase relative to the No-Action Alternative. This impact would be less than significant.

Mariposa Bypass. Under Alternatives A2, B2, and C2, the Mariposa Bypass would continue to route flows from the Eastside Bypass. Because flows would be lower in the Eastside Bypass, less net erosion would occur in the Mariposa Bypass than under the No-Action Alternative. Modeling indicates that channel erosion would average 2.2 feet in 23 years under Alternatives A2, B2, and C2, mostly as erosion of sand, almost half the possible erosion under the No-Action Alternative. This impact would be less than significant.

San Joaquin River from Merced River to the Delta. This section describes potential project-level impacts to the San Joaquin River from the Merced River to the Delta under Alternatives A2, B2, and C2.

Impact GEO-4 (Alternatives A2, B2, and C2): ***Potential Increase in Channel Erosion, Sediment Transport, and Meander Migration from San Joaquin River Flows – Project-Level.*** This impact would be the same as Impact GEO-4 for Alternative A1, as described for project-level impacts. This impact would be **less than significant**.

Impact GEO-5 (Alternatives A2, B2, and C2): ***Potential Loss of Availability of a Known Mineral Resource of Value – Project-Level.*** This impact would be the same as Impact GEO-5 for Alternative A1, as described for project-level impacts. This impact would be **less than significant**.

Chapter 11.0 Hydrology – Flood Management

This chapter describes the environmental and regulatory settings for flood management, including flood-related structures and operations, as well as potential environmental consequences and associated mitigation measures, as they pertain to implementation of the program alternatives. The discussion of flood management focuses on the Restoration Area, as well as the San Joaquin River upstream and downstream from the Restoration Area, and the Delta. Flood management is not discussed within the CVP/SWP water service areas, as implementing the Settlement would not affect flood management in these areas.

11.1 Environmental Setting

The environmental setting for flood management includes discussion of flood protection history in the San Joaquin River basin, flood management structures, project levees, nonproject levees, and flood management operations and conditions.

11.1.1 Historical Perspective of Flood Protection in the San Joaquin River Basin

Over time, the climate and geography of the Central Valley combined to produce an area where regular flooding occurred frequently. Runoff from rain and melting snow in the Sierra Nevada and the Coast Range would flow rapidly from the mountains to the valley floor in streams and rivers. Once flows exceeded channel capacities, the channels overflowed onto the surrounding countryside, forming vast floodplains.

Flow velocity in overbank areas was greatly reduced from velocity in the channels. Thus, the sediment-carrying capacity of the water was also reduced, allowing material naturally eroded from mountain and foothill areas, and carried in streams, to drop out of suspension. Over many years, the San Joaquin River built up its bed and formed natural levees composed of heavier, coarser material carried by flood flows. Finer material stayed in suspension much longer and dropped out when overflow water ponded in basins east and west of the river.

The higher elevation land formed by the natural levees attracted the first settlements in the Central Valley. In the early 1800s, settlers and Native Americans described the Sacramento and San Joaquin rivers as “miles wide” during flooding. See Chapter 10, “Geology and Soils,” for additional details about San Joaquin River geomorphology.

Early Flood Protection

Initial flood protection in the Central Valley developed in a piecemeal fashion with the construction of levees to protect local areas from flooding. Levees were typically constructed in response to a past flood, with little or no coordination between different localities.

Flood management in the San Joaquin Valley began with the construction of levees to reclaim fertile tule lands and to protect against out-of-bank flows. As a private levee system was developed to protect a different tract of land, floodwater would be redirected elsewhere, increasing the stage and flood risk. The protection afforded by individual levees would also decrease because of the increased stage of floodwaters constrained between the irregular levee system. The increased flood danger led to competition between landowners to continually raise and strengthen levees by stages to protect local areas.

In 1920, Colonel Robert Marshall, chief geographer for the USGS, proposed a major water storage and conveyance plan to transfer water from Northern California to meet urban and agricultural needs of central and Southern California. This plan ultimately provided the framework for development of the CVP and its associated flood damage reduction benefits. Under the Marshall Plan, a dam would be constructed on the San Joaquin River near Friant to divert water north and south to areas in the eastern portion of the San Joaquin Valley, and provide flood protection to downstream areas. The diverted water would be a supplemental supply to relieve some of the dependency on groundwater that had led to overdraft in areas of the eastern San Joaquin Valley. Water in the Sacramento Valley would be collected, stored, and transferred to the San Joaquin Valley by a series of reservoirs, pumps, and canals.

In 1933, the California State Legislature approved the Central Valley Project Act, which authorized construction of initial features of the CVP, including Shasta Dam; Friant Dam; power transmission facilities from Shasta to Tracy; and the Contra Costa, Delta-Mendota, Madera, and Friant-Kern canals (California State Legislature 1933). The act authorized the sale of revenue bonds to construct the project, but during the Great Depression, the bonds could not be sold. The State appealed to the Federal Government for assistance in constructing the CVP.

With the passage of the Rivers and Harbors Act of 1935 (U.S. Congress 1935), Congress appropriated funds and authorized construction of the CVP by the USACE. When the act was reauthorized in 1937, construction and operation of the CVP were assigned to Reclamation, and the project became subject to Reclamation Law. Construction of the CVP began on October 19, 1937, with the Contra Costa Canal. Construction of Shasta Dam began in 1938 and was completed for full operation in 1949. Friant Dam, on the San Joaquin River, was also completed in 1949.

The Flood Control Act of 1944 authorized the Lower San Joaquin River and Tributaries Project (U.S. Congress 1944). The project included constructing levees on the San Joaquin River below the Merced River, Stanislaus River, Old River, Paradise Cut, and Camp Slough. Construction was initiated on the Lower San Joaquin River and Tributaries

Project in 1956. The project also included construction of New Hogan Dam on the Calaveras River, New Melones Dam on the Stanislaus River, and Don Pedro Dam on the Tuolumne River. New Melones Dam was later reauthorized for construction under the Flood Control Act of 1962 (U.S. Congress 1962). The Chowchilla and Eastside bypasses were constructed by the State as part of the Lower San Joaquin River Flood Control Project.

The Flood Control Act of 1944 also authorized construction of Isabella, Success, Terminus, and Pine Flat dams on rivers in the Tulare Lake basin. Following major flooding in 1955, construction of levees and bypasses on the San Joaquin River upstream from the Merced River was authorized. In 1962 to 1963, Congress authorized construction of Buchanan Dam on the Chowchilla River and Hidden Dam on the Fresno River, and authorized Federal participation in the cost of New Exchequer Dam on the Merced River. In addition to flood protection, all of these reservoirs provide water supplies for irrigation uses and, in some cases, hydropower generation. Also, recreation facilities were developed at several of these reservoirs, and the dams are operated, in part, to meet downstream fish and wildlife requirements.

Several smaller flood management projects also have been developed in the Sierra Nevada foothills in the San Joaquin River basin. These projects generally consist of dry dams constructed to protect downstream metropolitan areas and nearby agricultural lands. The Merced County Stream Group Project was constructed to restrict flood flows on several streams to nondamaging levels from the foothill line to the City of Merced. The Redbank and Fancher Creeks Project was constructed to provide flood protection to the Fresno-Clovis metropolitan area and nearby agricultural land. Farmington Dam, on Little Johns Creek, provides flood protection for intensely developed agricultural lands below the dam, the City of Stockton, and the rural towns of Farmington and French Camp.

Major Recent Floods

Between 1900 and 1997, the Sacramento River and San Joaquin River basins experienced 13 destructive floods. Each flood resulted from a storm with unique characteristics, each located in a different portion of the Central Valley. In addition, these floods occurred under different levels of development of the flood management systems described in the previous sections. The most recent floods (1983, 1986, 1995, and 1997) caused extensive damage in both the Sacramento River and San Joaquin River basins and raised questions about the adequacy of the current flood management systems and land use in the floodplains (USACE 1999a). In response to these floods, Congress authorized USACE in 1997 to undertake a comprehensive study of the flood damage reduction facilities in the Sacramento River and San Joaquin River basins, and to prepare a summary of recent flood events (USACE 1999a). The following flood event descriptions are drawn from previous documentation (USACE 1999a).

Flood of 1955. The flood of December 1955 was centered north of Friant Dam, and was more intense in the northern portions of the San Joaquin Valley and in the Sacramento Valley. Before the start of the flood, Millerton Lake was well below flood management space and, as a result, flows on the San Joaquin River were completely controlled by Friant Dam. If storage had been at the allowable flood management level, releases from

Friant Dam would have exceeded 37,100 cfs and would have resulted in extensive damage between Friant Dam and the mouth of the Merced River. A peak flow of 62,500 cfs was a record on the Stanislaus River at Ripon, while the Middle Fork of the Tuolumne River at Oakland Recreation Camp reached a record flow of 4,920 cfs. During the 1955 floods, two of the three forks of the Tuolumne River also reached record flows.

Flood of 1967. Above-normal precipitation that occurred continuously from December 1966 through March 1967 resulted in the flooding of 35,000 acres of the San Joaquin River basin. A record-breaking storm in early December 1966 resulted in very high runoff from the San Joaquin River. The San Joaquin River above Millerton Lake experienced high runoff during early December with a maximum mean daily inflow of 18,450 cfs to the lake. A vast snowmelt from April to July resulted in significant flood damage from flooding in the lower portions of the Fresno and Chowchilla rivers. Nearly all of the flooded areas were cropland, improved pasture, or grazing land.

Flood of 1983. Northern and Central California experienced moderate flooding incidents from November through March because of numerous storms. In early May, snow water content in the Sierra Nevada exceeded 230 percent of normal, and the ensuing runoff resulted in approximately four times the average volume for Central Valley streams. The maximum daily flow on the San Joaquin River at Maze Road Bridge was about 38,400 cfs, and exceeded the estimated channel capacity (combined capacity of the San Joaquin River and Laird Slough) of 26,000 cfs. In the San Joaquin River basin, levee breaks caused flooding at four locations along the San Joaquin River. Four levees failed in the Delta, resulting in partial or total flooding of some islands. Estimated damages exceeded $324 million in the San Joaquin River basin (USACE 1999a).

Flood of 1986. Flooding in 1986 resulted from a series of four storms over a 9-day period during February. Rains from the first three storms saturated the ground and produced moderate to heavy runoff before the arrival of the fourth storm. Peak daily inflow to Millerton Lake was about 20,800 cfs. In the San Joaquin River basin and the Delta, levee breaks along the Mokelumne River caused flooding in the community of Thornton and the inundation of four Delta islands. Estimated damages exceeded $15 million in the San Joaquin River basin (USACE 1999a).

Flood of 1995. Weather conditions in the Pacific forced major storm systems directly into California during much of the winter and early spring of 1995. The largest storm systems hit California in early January and early March. The major brunt of the January storms hit the Sacramento River basin and resulted in small stream flooding primarily because of storm drainage system failures. The March 1995 storms were concentrated on the coastal range, and caused high flows in some of the west side tributaries to the San Joaquin River basin. In particular, Arroyo Pasajero produced extremely high flows that collapsed bridges on Interstate 5 near Coalinga, killing six people. Peak daily inflow to Millerton Lake was about 23,700 cfs. In total, estimated flood damages in 1995 exceeded $193 million in the San Joaquin River basin (USACE 1999a).

Flood of 1997. Watersheds in the Sierra Nevada already were saturated by the time three subtropical storms added more than 30 inches of rain in late December 1996 and early January 1997. The third and most severe of these storms lasted from December 31, 1996, through January 2, 1997. Record flows overwhelmed the flood management system in the San Joaquin River basin. Peak daily inflow to Millerton Lake was about 51,800 cfs, with a peak hourly inflow of about 95,000 cfs. Peak daily outflows to the San Joaquin River from Friant Dam were estimated at 37,500 cfs, with a peak hourly outflow of 62,900 cfs. Thirty-four levee failures occurred throughout the river system and widespread flooding ensued. The Delta also experienced several levee breaks and levee overtopping. Estimated damages exceeded $223 million in the San Joaquin River basin (USACE 1999a).

Flood of 2006. During late December of 2005 and early January 2006, several storms caused substantial runoff over large portions of Northern California. Localized flooding caused Federal disaster declarations in 10 counties and an estimated $300 million in damages, with most damage occurring in the Russian and Napa River basins (USGS 2006). Wet weather persisted through the late Winter and early Spring. Another large storm system hit California in early April, with the San Joaquin Valley receiving most of the precipitation. This storm system caused several days of high water in the San Joaquin River and associated flood bypass system. Stress was evident in the levee system, including boils and bank erosion. Active flood fighting limited the flood damage to mostly localized agricultural lands, though several trailer parks and low-lying homes were evacuated (NWS 2010). The wet 2006 winter, including the April storm, resulted in high snowmelt runoff volumes, and several weeks of sustained flood released from Millerton Lake. This period of high, sustained flows highlighted several vulnerabilities of the San Joaquin River levee system to such flows.

11.1.2 Flood Management Structures

The following is a description of flood management structures in the study area. Project and structure information in the sections below is from a 1997 USACE report titled *Water Management, Sacramento District Projects, California* (1997).

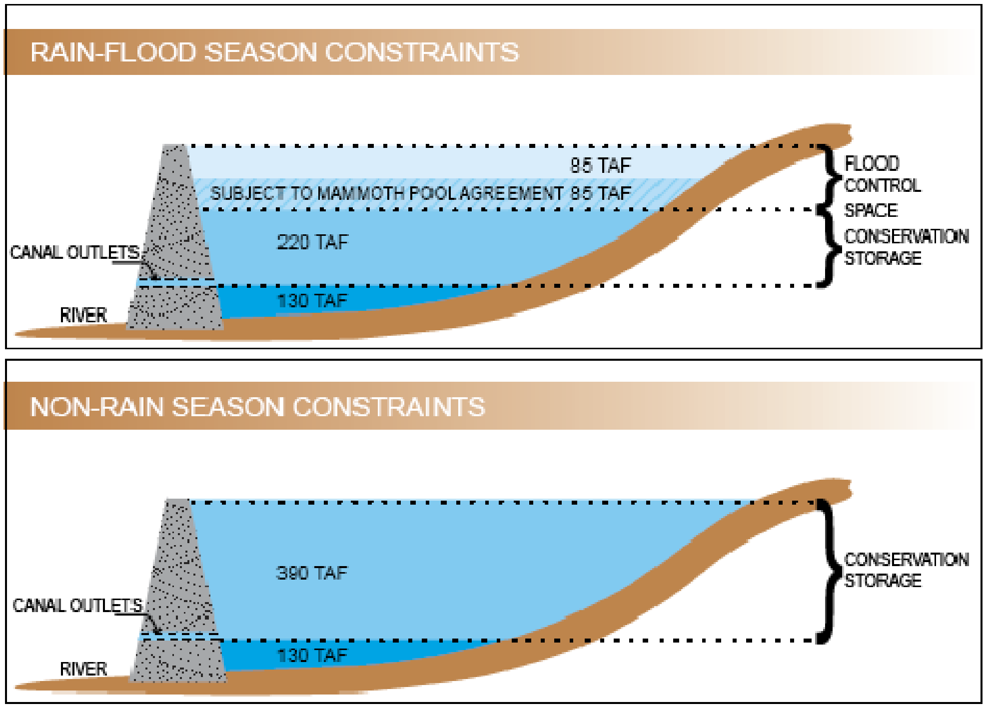
San Joaquin River Upstream from Friant Dam

Friant Dam is the principal flood damage reduction facility on the San Joaquin River and is operated to maintain combined releases to the San Joaquin River at or below a flow objective of 8,000 cfs. Several flood events in the past few decades have resulted in flows greater than 8,000 cfs downstream from Friant Dam and, in some cases, flood damages resulted.

Friant Dam is a concrete gravity structure with dual purposes of storage for irrigation and flood management. Millerton Lake has a volume of 524 TAF, a surface area of 4,905 acres, and an elevation of 580.6 feet above msl (NAVD 1988) (elevation 580.6) at top of active storage (Reclamation 2008). The flood pool elevation is 587.6 while the maximum observed water surface elevation was 583, experienced during the January 1997 flood. The reservoir has three small dikes to close low areas along the reservoir rim, one of which is located in the Millerton Lake SRA. Millerton Road, a two-lane paved secondary highway, passes over these dikes. Additional physical information pertaining to Friant

Dam and Millerton Lake are presented in Table 13-1 in Chapter 13.0, "Hydrology – Surface Water Supplies and Facilities Operations."

The minimum operating storage of Millerton Lake is 130 TAF, resulting in active available conservation storage of about 390 TAF (Figure 11-1). The minimum operating storage allows for diversion from dam outlets to the Friant-Kern canal (elevation 466.6), Madera canal (elevation 448.6), and the San Joaquin River (elevation 382.6).



Source: Reclamation, 2005.
Key: TAF = thousand acre-feet

Figure 11-1.
Conceptual Representation of Millerton Storage Requirements

San Joaquin River from Friant Dam to Merced River

The State constructed the San Joaquin River Flood Control Project which includes flood damage reduction structures and facilities within the Restoration Area (Figure 11-2). Construction of the original State system was initiated in 1959 and completed in 1966. These improvements were coordinated with the Federal Government to ensure the effectiveness of the Federal portion of the project. The bypass system consists primarily of man-made channels (Eastside, Chowchilla, and Mariposa bypasses), which divert and carry flood flows from the San Joaquin River at Gravelly Ford, along with inflows from the Kings River and other tributaries, downstream to the mainstem just above Merced River. The system consists of about 193 miles of levees, several control structures, and other appurtenant facilities, and about 80 miles of surfacing on existing levees. Operations and maintenance (O&M) of the completed State upstream bypass features of the project are accomplished by the LSJLD. The flood damage reduction structures and facilities within the Restoration Area are described below. Levees are separately described in a subsequent section.

Figure 11-2.
Existing Flood Management Facilities in the San Joaquin River Basin

Chowchilla Bypass and Bypass Bifurcation Structure. As a component of the Lower San Joaquin River and Tributaries Project, the Chowchilla Bypass begins at the Chowchilla Bypass Bifurcation Structure in the San Joaquin River and runs northwest, parallel to the San Joaquin River, to the confluence of the Fresno River, where the Chowchilla Bypass ends and becomes the Eastside Bypass. The design channel capacity of the Chowchilla Bypass is 5,500 cfs. The bypass is constructed in highly permeable soils, and much of the initial flood flows infiltrate and recharge groundwater. The Chowchilla Bypass Bifurcation Structure is a gated structure that controls the proportion of flood flows between the Chowchilla Bypass and Reach 2B of the San Joaquin River. The Chowchilla Bypass Bifurcation Structure is operated to keep flows in Reach 2B at a level less than 2,500 cfs because of channel capacity limitations, though significant seepage has been observed at flows above 1,300 cfs (RMC 2007). Historically, releases from the Chowchilla Bypass Bifurcation Structure to Reach 2B were limited to the 1,300 cfs capacity of Reach 2B, or to flows that would not exceed the capacity of Reaches 3 and 4A when combined with Kings River flood flows and irrigation delivery flows from Mendota Pool.

Eastside Bypass and Control Structure. The Eastside Bypass extends from the confluence of the Fresno River and the Chowchilla Bypass to its confluence with the San Joaquin River at the head of Reach 5. The Eastside Bypass is subdivided into three reaches. Eastside Bypass Reach 1 gradually increases in design channel capacity from 10,000 cfs to 17,000 cfs as it receives flows from the Fresno River, Berenda Slough, and Ash Slough, and ends at the downstream end of the Sand Slough Bypass, where it intercepts flows from the Chowchilla River. Eastside Bypass Reach 2, with a design channel capacity of 16,500 cfs, extends from the Sand Slough Bypass confluence to the Mariposa Bypass Bifurcation Structure at the head of the Mariposa Bypass and the Eastside Bypass Control Structure. Eastside Bypass Reach 3, with a design channel capacity of 13,500 cfs at the Eastside Bypass Control Structure, and a design channel capacity of 18,500 cfs at its confluence with Bear Creek, extends from the Eastside Bypass Control Structure to the head of Reach 5 of the San Joaquin River, and receives flows from Deadman, Owens, and Bear creeks. The gated Eastside Bypass Control Structure works in coordination with the Mariposa Bypass Bifurcation Structure to direct flows to either Eastside Bypass Reach 3 or to the Mariposa Bypass. The channel capacities described above are design capacities; current capacities may be reduced due to subsidence of Eastside Bypass levees. Eastside Bypass Reach 3 ultimately joins with Bear Creek to return flows to the San Joaquin River.

Mariposa Bypass and Bypass Bifurcation Structure. The Mariposa Bypass Bifurcation Structure controls the proportion of flood flows that continue down the Eastside Bypass or return the San Joaquin River through the Mariposa Bypass to Reach 4B2. The Mariposa Bypass delivers flow back into the San Joaquin River from the Eastside Bypass at the head of Reach 4B2. Of 14 bays on the Mariposa Bypass Bifurcation Structure, eight are gated. The operating rule for the Mariposa Bypass is to divert all flows to the San Joaquin River when flows in the Eastside Bypass above the Mariposa Bypass are less than 8,500 cfs, with flows greater than 8,500 cfs remaining in the Eastside Bypass, eventually discharging back into the San Joaquin River at the Bear Creek Confluence at the end of Reach 4B2 of the San Joaquin River. However, actual operations have deviated from this rule, flows of up to 2,000 cfs to 3,000 cfs have historically remained in the Eastside Bypass, and approximately one-quarter to one-third of the additional flows are released to the Mariposa Bypass (McBain and Trush 2002). Flood flows not diverted to the San Joaquin River via the Mariposa Bypass continue down the Eastside Bypass and are returned to the San Joaquin River via Bravel Slough and Bear Creek. Bravel Slough reenters the San Joaquin River at mile post 136 and is the ending point of the bypass system.

Sand Slough Control Structure/San Joaquin River Headgates. The Sand Slough Control Structure, located in the short connection between the San Joaquin River at mile post 168.5 and the Eastside Bypass between Eastside Bypass Reaches 1 and 2, is an uncontrolled weir working on coordination with the San Joaquin River Headgates to control the flow split between the mainstem San Joaquin River and the Eastside Bypass. The Sand Slough Control Structure diverts flows from the San Joaquin River to the Eastside Bypass, and the San Joaquin River Headgates control the timing and quantity of flows entering Reach 4A of the San Joaquin River into Reach 4B1. The operating rule for the control structure and headgates is to divert the first 50 cfs of San Joaquin River flow to Sand Slough, and then equally divide flow in excess of 50 cfs to Sand Slough and Reach 4B1. Historical operations have kept the headgates closed for many years, diverting all flood flows to Sand Slough (RMC 2007).

Mendota Dam. Mendota Dam is located at the confluence of the San Joaquin River and Fresno Slough. Fresno Slough connects the Kings River to the San Joaquin River, and delivers water to the south from Mendota Pool during irrigation season, and delivers water to the Mendota Pool and San Joaquin River from the Kings River when the Kings River is flooding. Mendota Pool is a small reservoir, with approximately 8,500 acre-feet of storage, created by the 23-foot-high Mendota Dam (Reclamation 2004). The Mendota Pool does not provide any appreciable flood storage. The water surface elevation in the pool is maintained by a set of gates and flashboards that are manually opened/removed in advance of high-flow conditions. This process lowers the water level in the pool for passing high flows to reduce seepage impacts to adjacent lands, but prevents diversions on Fresno Slough from the Delta-Mendota Canal and San Joaquin River flows.

Cyclically, the Mendota Pool fills with sediment during infrequent high-flow releases from Friant Dam. During times of high flows, some unknown portion of this sediment is able to flush and route downstream when flashboards have been pulled, restoring much of the Mendota Pool storage capacity. If the flashboards are not pulled before a high-flow event from either the San Joaquin River or Fresno Slough, the increased water surface elevations cause seepage problems on upstream and adjacent properties. Additionally, there have been recurring problems with water seeping under Mendota Dam, threatening the structural integrity of the dam. The Mendota Pool is drained every other year to allow for inspection of the dam.

Sack Dam. Sack Dam is 5-foot-high low-head structure used to control water released from the Delta-Mendota Canal into Arroyo Canal. All flows conveyed through San Joaquin River Reach 3 of less than 600 cfs are diverted into Arroyo Canal. Larger flows continue downstream to San Joaquin River Reach 4A and are subsequently diverted into the Eastside Bypass at the Sand Slough Control Structure.

Structures on the Kings River. Flood flows from the Kings River flows into the Mendota Pool at the confluence with the San Joaquin River. Due to this inflow, Kings River system operations influence operations on the San Joaquin River. Flood control facilities on the Kings River include the following:

- **James Bypass.** The James Bypass is a leveed channel beginning in the lower Kings River basin at the end of the Kings River North and running northwest to end at Fresno Slough. Fresno Slough transports overflows from the Kings River via the James Bypass to the Mendota Pool. Excess water in the Mendota Pool overflows into the San Joaquin River. The broad flood channels of Kings River North are farmed in the spring, and property owners are notified when flood releases are planned to be sent north so that farm equipment may be removed. Flows from the Kings River are controlled by Pine Flat Dam. Maximum flows in the James Bypass/Fresno Slough typically range from 4,500 cfs to 6,000 cfs (USACE 1993).

- **Pine Flat Dam.** Pine Flat Dam, completed in 1954, is owned, operated, and maintained by USACE. The dam is on the Kings River, about 28 miles northeast of Fresno, and provides flood protection to 200,000 acres of agricultural land in the Tulare Lake area. Pine Flat Dam is a 429-foot-high and 1,820-foot-long concrete gravity dam with a gross pool of 1,000 TAF and a flood management reservation of 475 TAF. The major goal of flood operations at Pine Flat Dam, and the objective release of 4,750 cfs below the Crescent Weir, is to prevent flooding of farmland along over 100 miles of the Kings River (in the Tulare Lake bed) and along the San Joaquin River.

- **Army Weir.** The Army Weir, constructed in 1943, controls the flow split between Kings River South (south to the Tulare Lake bed) and Kings River North (north to the San Joaquin River). Although constructed by, and under the jurisdiction of, USACE, permission was granted to the Kings River Water Association to operate the structure according to agreements among the water users. The association operates the weir to maximize flow north into the San Joaquin River up to a total of 4,750 cfs to partially relieve flooding within the Tulare Lake bed to the south. When flows exceed 4,750 cfs, the excess, up to 1,200 cfs, is diverted to the south. All flows over 5,950 cfs are sent north until maximum diversions at the Crescent Weir are reached.

- **Crescent Weir.** The Crescent Weir, downstream from the Army Weir, began operation on Kings River North in 1939; it is maintained and operated by the Crescent Canal Company under an agreement with the Zalda Reclamation District. The concrete weir has 18 openings and uses flashboards for flow control. The Zalda Reclamation District controls flows greater than 4,750 cfs at the Crescent Weir by sending the first 4,750 cfs north, and the excess, up to a maximum of 2,000 cfs, to the south. Flows greater than 7,950 cfs in the Kings

River North (4,750 cfs north, 1,200 cfs south from the Army Weir, and 2,000 cfs south from the Crescent Weir) are divided by the Army and Crescent weirs equally between north and south, respectively, with consideration of existing levee and channel conditions.

Structures on Other Major San Joaquin River Tributaries Upstream from Merced River. Each major tributary to the San Joaquin River has existing flood control facilities, including the following:

- **Hidden Dam and Hensley Lake.** Hidden Dam, completed in 1975, is on the Fresno River about 15 miles northeast of the City of Madera, and is owned, operated, and maintained by USACE. It provides flood protection to the City of Madera and agricultural lands downstream. Hidden Dam has a gross pool of 90 TAF and a flood management reservation of 65 TAF. Hensley Lake is formed by the 163-foot-high and 5,730-foot-long earthfill dam.
- **Buchanan Dam and H. V. Eastman Lake.** Buchanan Dam, completed in 1975, is owned, operated, and maintained by USACE to provide flood protection to the City of Chowchilla and the highly developed agricultural areas below the dam. The project is on the Chowchilla River about 16 miles northeast of the City of Chowchilla. The Buchanan Dam is a 206-foot-high and 1,800-foot-long rockfill dam and has a gross pool of 150 TAF, a 45 TAF flood management reservation, and a combined downstream objective release of 7,000 cfs via Ash (5,000 cfs) and Berenda (2,000 cfs) sloughs.
- **Redbank and Fancher Creeks Flood Control Project.** The Redbank and Fancher Creeks Flood Control Project is owned and operated by the Fresno Metropolitan Flood Control District. This is a single-purpose project that provides flood protection to the Fresno-Clovis metropolitan area and nearby agricultural land. This project has a storage capacity of approximately 42 TAF and includes five facilities: (1) Big Dry Creek Dam and Diversion, (2) Alluvial Drain Detention Basin, (3) Fancher Creek Dam and Reservoir, (4) Pup Creek Detention Basin, and (5) Redbank Creek Detention Basin.
- **Los Banos Detention Dam.** Los Banos Detention Dam, completed in 1965, is a joint CVP/SWP dam located on Los Banos Creek, a westside tributary to the San Joaquin River. This dam provides flood protection to the San Luis Canal and DMC, the community of Los Banos, and the agricultural lands downstream. Los Banos Detention Dam on Los Banos Creek has a storage capacity of 34.6 TAF and a flood management reservation of 14 TAF to control flows to a maximum of 1,000 cfs. (USACE 1999a).
- **Merced County Streams Group Project.** The Merced County Stream Group Project, with a storage capacity of approximately 41 TAF, consists of five dry dams (Bear, Burns, Owens, Mariposa, and Castle), located in the foothills east of Merced on tributaries of the San Joaquin River, which provide flood protection to the City of Merced. USACE owns and maintains the first four dams. Castle is

owned by the State and Merced County and is operated and maintained by the Merced ID. The project objective is to restrict the flood flows of several streams in the Merced County Stream Group to the nondamaging capacity of the valley floor channels from the foothill line to the City of Merced. This project also includes two diversion structures (Black Rascal Creek to Bear Creek diversion and the Owens Creek to Mariposa Creek diversion).

San Joaquin River from Merced River to the Delta

Flood management facilities on major tributaries which affect flood conditions in the San Joaquin River from the Merced River to the Delta include New Exchequer Dam and Lake McClure, on the Merced River; Don Pedro Dam and Lake on the Tuolumne River; and New Melones Dam and Lake on the Stanislaus River.

New Exchequer Dam and Lake McClure. New Exchequer Dam is on the Merced River about 25 miles northeast of the City of Merced. The dam has a top of active storage capacity of 1,024 TAF, a maximum flood management reservation of 350 TAF, and a downstream objective release of 6,000 cfs in the Merced River at Stevinson. The dam, completed in 1966, is a 1,220-foot-long and 490-foot-high rockfill structure, with a 1,500-foot-long and 62-foot-high rock and earthfill dike. The dam and lake, which are owned, operated, and maintained by the Merced ID, provide flood protection to agricultural lands below the dam and to the communities of Livingston, Snelling, Cressy, and Atwater.

Don Pedro Dam and Lake. Don Pedro Dam is on the Tuolumne River, about 28 miles west of Modesto. The dam has a top of active storage capacity of 2,030 TAF of water, a maximum flood management reservation of 340 TAF, and an objective release of 9,000 cfs below Dry Creek. The dam was constructed in 1971 jointly by Turlock ID and Modesto ID with participation by the City and County of San Francisco for water supply, hydropower, and flood control purposes. However, only Turlock ID operates and maintains the dam. Don Pedro Dam is an earth and rockfill structure 580 feet high and 1,900 feet long. This dam provides flood management for agricultural property, infrastructure, and some low areas in suburban Modesto by controlling rain and snowmelt floods.

New Melones Dam and Lake. New Melones Dam replaced the original Melones Dam, and was completed by USACE in 1978 and approved to begin operation in 1983. The dam is on the Stanislaus River, 35 miles northeast of Modesto, and is operated as part of the CVP for water supply, hydropower, flood control, water quality, and environmental purposes. The dam has a top of active storage capacity of 2,420 TAF, a maximum flood management reservation of 450 TAF and a downstream objective release of 8,000 cfs or less at Orange Blossom Bridge in the Stanislaus River. New Melones Dam and Lake are owned, operated, and maintained by Reclamation as a unit of the CVP. The dam is an earth and rockfill structure 625 feet high and 1,560 feet long. New Melones Lake flood management protects more than 35,000 acres of leveed agricultural land, infrastructure, and some limited urbanized areas in Oakdale, Riverbank, and Ripon along the Stanislaus and San Joaquin rivers (USACE 1980).

11.1.3 Levees

There are two classes of levees along the San Joaquin River and associated flood bypass channels, including the following:

- **Project levees** – Levees constructed by USACE as part of the San Joaquin River Flood Control Project or Lower San Joaquin River and Tributaries Project
- **Nonproject levees** – Levees constructed by individual landowners to protect site-specific properties, and thus not associated with the San Joaquin River Flood Control Project

San Joaquin River from Friant Dam to Merced River

The San Joaquin River Flood Control Project consists of a parallel conveyance system that includes the following:

- A leveed bypass system on the east side of the San Joaquin Valley
- A leveed flow conveyance system in the mainstem of the San Joaquin River

The mainstem San Joaquin River levee system within the study area is composed of approximately 192 miles (see Figure 11-3) of project levees and various nonproject levees located upstream from the Merced River confluence. Project levees are levees constructed by USACE, and are part of the San Joaquin River Flood Control Project. Project levees occur in Reach 2A downstream from Gravelly Ford and extend downstream to the Chowchilla Bypass Bifurcation Structure. A small section of project levees extends into Reach 4A upstream of Sand Slough. They begin again in Reaches 4B and 5 at the Mariposa Bypass confluence downstream to the Merced River confluence.

Nonproject levees are typically associated with levees and dikes constructed on the San Joaquin River by early flood control districts and adjacent landowners between the Chowchilla Bypass Bifurcation Structure and the Mariposa Bypass confluence. Canal embankments bordering both sides of the San Joaquin River between the Mendota Dam and approximately two miles upstream of the Sand Slough Control Structure effectively form a set of nonproject levees that have significantly reduced the width of the floodplain, primarily on the east side of the river. The existing channel capacity in this reach is approximately 4,500 cfs, but flows of this magnitude can cause seepage and levee stability problems (RMC 2007). High, sustained flows during the 2006 snowmelt runoff period highlighted this capacity issue. In addition, local landowners have constructed other low-elevation berms within the reach creating a narrower floodplain.

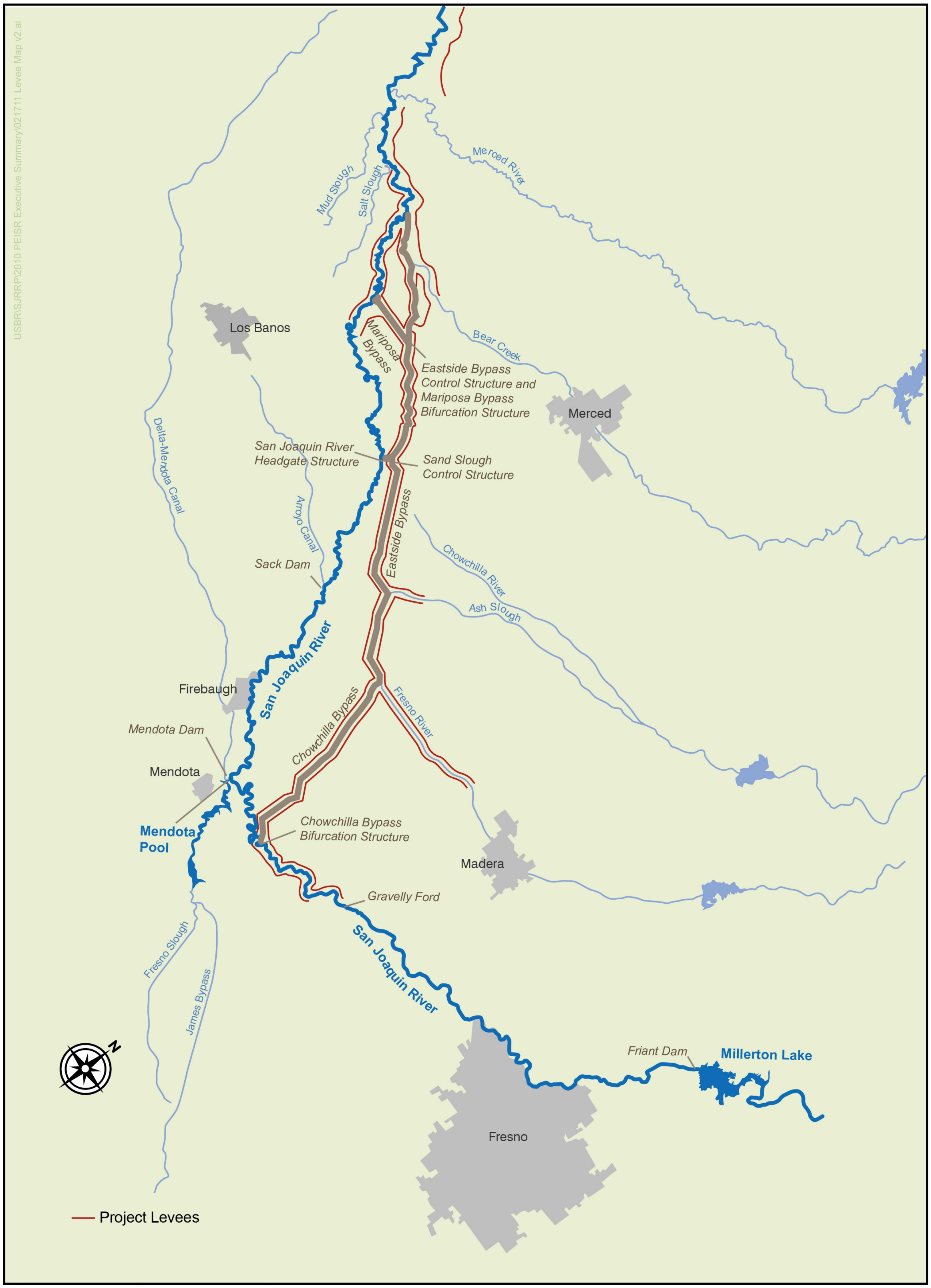


Figure 11-3.
Project Levees Along the San Joaquin River from Friant Dam to the Merced River Confluence

San Joaquin River from Merced River to the Delta

From about 1956 to 1972, the USACE constructed the Lower San Joaquin River and Tributaries Project from the Delta upstream to the Merced River, under the authorization of the 1944 Flood Control Act. Additional modifications to the Lower San Joaquin River and Tributaries Project were completed in the mid-1980s. The Federally constructed portion of the Lower San Joaquin River and Tributaries Project consists of about 100 miles of intermittent levees along the San Joaquin River, Paradise Cut, Old River, and the lower Stanislaus River. These levees vary in height from about 15 feet at the downstream end to an average of 6 to 8 feet over much of the project. The levees, along with upstream flow regulation, were designed to contain floods occurring, on average, once every 60 years at the lower end of the project to floods occurring, on average, once every 100 years at the upper limits. Local levees are located along many reaches of the river in the gaps between the Lower San Joaquin River and Tributaries Project levees.

11.1.4 Flood Management Operations and Conditions

The following sections contain information about flood management operations in the study area.

San Joaquin River Upstream from Friant Dam

Friant Dam and Millerton Lake are operated for flood management in accordance with rules and regulations prescribed by the CFR Title 33 Part 208.11, the Field Working Agreement for CVP dams and reservoirs, and the Flood Control Manual. The Flood Control Manual states the flood management objectives for Friant Dam and Millerton Lake (USACE 1955):

- Control the sum of flows from Friant Dam without exceeding 8,000 cfs below Cottonwood Creek and Little Dry Creek, or 6,500 cfs at the USGS gaging station “San Joaquin River near Mendota.”
- Permit use of the maximum practical amount of storage space for conservation and other purposes without impairing the flood control functions.

According to the Flood Control Manual, flood management operation is determined daily, as described in the Flood Control Diagram (Chart A-11 of Flood Control Manual), which prescribes the required flood management space in Millerton Lake and gives the schedule for releasing water from the flood management space (Figure 11-1). Two types of flood management space and their characteristics are summarized as follows:

- **Rain flood space:** This space increases from zero on October 1 to 170 TAF on November 1 and decreases from 170 TAF on February 1 to zero on April 1. Water stored in rain flood space is released as rapidly as possible without violating the flood management objective release. The Mammoth Pool Agreement allows for rain flood space in excess of 85 TAF to be replaced by an equal amount of space in Mammoth Pool from November 1 to February 1, if available. Mammoth Pool is a 123,000 acre-foot reservoir upstream from Millerton Lake.

- **Conditional space:** This space is required from February 1 to June 30 for snowmelt runoff management. This variable space is predicated on filling the reservoir (if possible) by the end of the snowmelt season without exceeding downstream design flows. The required conditional space and supplemental releases on a given date are determined from the Flood Control Diagram. This diagram uses the following data: forecasted unimpaired runoff into Millerton Lake, amount of upstream storage available, and forecasted irrigation demand from that date to June 15 (after May 31, forecasted irrigation demand for the next 15 days or until August is used, whichever is less).

Use of the 170 TAF flood management reservation, as directed by the Flood Control Manual, provides for an objective release of 8,000 cfs with consideration of the following:

- Downstream flow changes are limited to 500 cfs per hour for the safety of recreation users along the river, and to minimize damage to riverbanks from sloughing and erosion (USACE 1999a).
- Downstream property owners would prefer that releases to evacuate flood management storage be made at less than design flow rates to avoid damage to property encroaching on the floodplain, as well as the river channel (USACE 1999a).
- Flows from Friant Dam must be adjusted to account for uncontrolled flows that enter the San Joaquin River below the dam to avoid exceeding the design channel capacity downstream (8,000 cfs). These local peak flows can easily exceed channel capacity. When Big Dry Creek Dam is diverting flood flows (700 cfs) into Little Dry Creek, Friant Dam outflow is limited to 7,300 cfs or less (other local flow would further limit Friant outflows to the river) (USACE 1999a).

San Joaquin River from Friant Dam to Merced River

Information on dimensions of estimated channel capacities for locally constructed levees are difficult to obtain and, in some cases, currently unavailable. Design capacity was authorized as the amount of water that can pass through a given reach with a levee freeboard of 3 feet within the historical San Joaquin River and 4 feet of freeboard along the bypasses, except along the left side of the Eastside Bypass, which has 3 feet of design freeboard (USACE 1993). Design capacities are generally considered to be safe carrying capacities, though some flood damages to adjacent land developments can occur when design flows are passed (USACE, 1993). These damages can occur because of levee under-seepage and through-seepage, and backwater effects on local storm drainage systems. Levee subsidence and sediment accumulation can decrease channel capacities, increasing these damages. The design capacities for the various San Joaquin River reaches are illustrated in Table 11-1.

Table 11-1.
Design Capacities of San Joaquin River and Bypasses Within the Restoration Area

Reach		Upstream Extent	Downstream Extent	Levee Type	Design Capacity (cfs)
San Joaquin River	Reach 1A	Friant Dam	State Route 99	None	8,000
	Reach 1B	State Route 99	Gravelly Ford	None	8,000
	Reach 2A	Gravelly Ford	Chowchilla Bypass Bifurcation Structure	Project	8,000
	Reach 2B	Chowchilla Bypass Bifurcation Structure	Mendota Dam	Nonproject	2,500
	Reach 3	Mendota Dam	Sack Dam	Nonproject	4,500
	Reach 4A	Sack Dam	Sand Slough Control Structure	Nonproject	4,500
	Reach 4B1	Sand Slough Control Structure	Confluence with Mariposa Bypass	Nonproject	1,500
	Reach 4B2	Confluence with Mariposa Bypass	Confluence with Bear Creek and Eastside Bypass	Project	10,000
	Reach 5	Confluence with Bear Creek and Eastside Bypass	Confluence with Merced River	Project	26,000
Chowchilla Bypass		Chowchilla Bypass Bifurcation Structure	Confluence with Fresno River and Eastside Bypass	Project	5,500
Eastside Bypass	Reach 1	Fresno River	Sand Slough Bypass	Project	10,000 -17,000
	Reach 2	Sand Slough Bypass	Mariposa Bypass Bifurcation Structure/Eastside Bypass Bifurcation Structure	Project	16,500
	Reach 3	Mariposa Bypass Bifurcation Structure/Eastside Bypass Bifurcation Structure	Head of Reach 5	Project	13,500-18,500
Sand Slough Bypass		Sand Slough Control Structure	Eastside Bypass	Project	3,000
Mariposa Bypass		Mariposa Bypass Bifurcation Structure	Confluence with San Joaquin River	Project	8,500
Kings River North		Fresno Slough Bypass	Mendota Pool	Nonproject	4,750

Note:
[1] Summarized from results of one-dimensional HEC-RAS hydraulic modeling described in Appendix H, "Modeling."
Key:
cfs = cubic feet per second

Reach 1. Reach 1 begins at Friant Dam and continues 37 miles downstream to Gravelly Ford. Reach 1A extends from Friant Dam to SR 99. Flows within Reach 1A are predominantly influenced by releases from Friant Dam. Reach 1B continues from SR 99 to Gravelly Ford. Flows within Reach 1B are also predominantly influenced by releases from Friant Dam, along with diversions and seepage losses within Reach 1A. Stormwater runoff from the Fresno metropolitan area is managed by the Fresno Metropolitan Flood Control District. All but five of the District's 161 drainage basins route stormwater to retention and detention facilities, limiting the urban surface runoff into Reach 1.

Reach 2. Reach 2 begins at Gravelly Ford and extends approximately 24 miles downstream to the Mendota Pool. This reach marks the end of the incised channel, and is a meandering channel of low gradient. Reach 2 is subdivided at the Chowchilla Bypass Bifurcation Structure into two subreaches. Reach 2A extends from Gravelly Ford to the Chowchilla Bypass Bifurcation Structure; Reach 2B extends from the Chowchilla Bypass Bifurcation Structure to the Mendota Pool.

The Reclamation Board (1969) guidelines describe how the Lower San Joaquin River Flood Control Project system is designed to be operated in Reach 2.

- The first increment of flow down the San Joaquin River may be routed through either the San Joaquin River or the Chowchilla Bypass. Up to 2,500 cfs shall normally be routed through the San Joaquin River insofar as it does not exceed the capacity of the river when added to the releases from Pine Flat Dam and the remaining increment flow (excess water from the Kings River system has priority to available capacity in the San Joaquin River below the Mendota Pool).

- Up to 5,500 cfs shall be passed through the Chowchilla Bypass Bifurcation Structure. A total flow of 8,000 cfs will normally be divided with up to 2,500 cfs passing to the river and 5,500 cfs passing to the Chowchilla Bypass.

- Should the flows exceed 8,000 cfs at the control structures or 10,000 cfs at the latitude of Mendota (i.e., the total flow in the San Joaquin River, via Reach 2 and James Bypass/Fresno Slough, and the Chowchilla Bypass at the latitude of Mendota), LSJLD will operate the control structures at their own discretion with the objective of minimizing damage to the flood control project and protected area.

LSJLD operates the Lower San Joaquin River Flood Control Project for safety purposes, taking into account channel capacity limitations and flows from the San Joaquin River, James Bypass/Fresno Slough, and water supply deliveries to Mendota Pool. When Reach 2A flow is between 0 and 8,000 cfs, historical operations typically route up to 1,300 cfs to the Reach 2B, with the remaining flow going to the Chowchilla bypass.

Reach 3. Reach 3 flows 23 miles along a sandy channel from Mendota Dam to Sack Dam, where flows are diverted to the Arroyo Canal. The design channel capacity of Reach 3 is 4,500 cfs. Significant bed lowering has been measured within Reach 3; however, it is unknown to what extent this lowering is due to subsidence from groundwater overdraft, or human-induced sediment and hydrology modification within the channel. Kings River flood flows, via the James Bypass/Fresno Slough, also affect instream flow in Reach 3, and have priority to use available conveyance capacity over San Joaquin River flows from Reach 2B. During large release events at Friant Dam, San Joaquin River flows can be diverted at the Chowchilla Bypass Bifurcation Structure to allow incremental flow from James Bypass into Reach 3, as described in the Lower San Joaquin River Flood Control Project guidelines (Reclamation Board 1969).

Reach 4. Reach 4 is subdivided into three segments: Reach 4A, 4B1, and Reach 4B2. Reach 4A extends from Sack Dam to the Sand Slough Control Structure, and has a design capacity of 4,500 cfs. Reach 4B1 extends from the Sand Slough Control Structure to the Mariposa Bypass confluence. This reach has a design capacity of 1,500 cfs; the Sand Slough Control Structure is used to maintain this design discharge. Actual San Joaquin River capacity, however, is limited. Operations have kept the gates closed, diverting all flow to the Eastside Bypass over the last few decades (RMC 2007). Reach 4B1, therefore, is dry until downstream agricultural return flows contribute to its baseflow.

Reach 4B2 begins at the confluence of the Mariposa Bypass and extends to the confluence of the Eastside Bypass. The design channel capacity is 10,000 cfs and handles returned tributary and flood flows from the bypass system.

Reach 5. Reach 5 of the San Joaquin River extends approximately 18 miles from the confluence of the Eastside Bypass downstream to the Merced River confluence. The design channel capacity of Reach 5 is 26,000 cfs, and it receives flow from Reach 4 and from the Eastside Bypass.

San Joaquin River from Merced River to the Delta

The three mainstem tributaries of the lower San Joaquin River downstream from the Restoration Area include the Merced, Tuolumne, and Stanislaus rivers. Dams on the Merced and Tuolumne rivers are both privately owned, and have well-developed stakeholder organizations and restoration programs. New Melones Reservoir, which is owned and operated by Reclamation, regulates the Stanislaus River. Table 11-2 shows USACE design capacities for the San Joaquin River below the Merced River for use in flood management operation of the reservoirs within the system.

Table 11-2.
Design Capacity of Lower San Joaquin River and Tributaries Flood Control Project

San Joaquin River Reach	USACE Design Capacity with 3-Foot Freeboard (cfs)
Merced River to Tuolumne River	45,000
Tuolumne River to Stanislaus River	46,000
Stanislaus River to Paradise Dam (at head of Paradise Cut)	52,000
Paradise Dam to Old River	37,000
Old River to Stockton Deep Water Ship Channel	22,000

Source: California Resources Agency 1976
Key: cfs = cubic feet per second

11.2 Regulatory Setting

The Federal, State, and regional and local regulatory setting of the SJRRP as it pertains to flood management is described below.

11.2.1 Federal

The Federal regulatory setting includes the role of USACE in the San Joaquin River study area, applicable USACE regulations and legislation, EO 11988 (Flood Hazard Policy), Section 404 of the CWA, the role of the Federal Emergency Management Agency (FEMA), Section 408 of the RHA, and the ESA.

U.S. Army Corps of Engineers

USACE has nationwide responsibility for flood management. In California, flood management on the San Joaquin River system and other rivers is a combination of USACE, Reclamation, State, and private projects, all operated under the USACE official flood management plans. USACE has emergency authority under Public Law 84-99, enacted June 1955, to fight any flood to protect life and property and to rehabilitate Federal flood management facilities that are maintained by State and local entities.

Reservoir Regulation for Flood Control at Friant Dam and Millerton Lake. Friant Dam and Millerton Lake will be operated for flood management in accordance with rules and regulations prescribed in CFR Title 33 Part 208, Report on Reservoir Regulation for Flood Control, Friant Dam and Millerton Lake, San Joaquin River, California (USACE 1955). The regulations set limitations on storage space in Millerton Lake and flow releases from Friant Dam for flood management.

Flood Control Act of 1936. As part of "New Deal" Federal legislation to stimulate the national economy during the Great Depression, the Flood Control Act of 1936 was passed to declare flooding to be a menace to the national welfare, and to direct the Federal Government (USACE and the USDA) to improve or participate in improving navigable waters or their tributaries if the benefits would exceed costs, and if the lives and social security of people would be adversely affected. The legislation also enabled the Federal Government to enter into compacts with states or other local agencies for flood management projects.

Flood Control Act of 1944. The Flood Control Act of 1944 was passed (and amended in 1950) to formally assign the duties of flood management and navigation to USACE, and for Federal authorization of the Lower San Joaquin River and Tributaries Projects, which included construction of levees on the San Joaquin River (below the Merced River), Stanislaus River, Old River, Paradise Cut, and Camp Slough. This project also included construction of New Hogan Dam on the Calaveras River, New Melones Dam on the Stanislaus River (reauthorized in 1962), Don Pedro Dam on the Tuolumne River, and the Chowchilla and Eastside bypasses (U.S. Congress 1944). The State Legislature approved the plan for the Lower San Joaquin River and Tributaries Project in 1945.

Emergency Flood Control Funds Act (Public Law 84-99). The Emergency Flood Control Funds Act (Public Law 84-99) was passed by the Federal Government following major flooding in the eastern United States and the Central Valley in 1955. The legislation included Federal authorization of levees and bypasses on the San Joaquin River above the Merced River confluence. Under this act, USACE has emergency authority to fight any flood to protect life and property and to rehabilitate Federal flood management facilities that are maintained by State and local entities (U.S. Congress 1955).

Water Resources Development Act of 1986. The Water Resources Development Act (WRDA) of 1986 directed the Secretary of the Army to issue guidelines for crediting against the non-Federal share of project costs for flood management any compatible work carried out by local interests. WRDA of 1986 prohibited the Federal Government from initiating any feasibility study for a water resources project until non-Federal interests agree to cover 50 percent of the costs during the period of study, but exempted from such prohibition any study designed for purposes of navigational improvements. It also prohibited the Federal Government from initiating any planning or engineering authorized by the act until non-Federal interests agree to contribute 50 percent of the costs during the period of planning and engineering (U.S. Congress 1986).

Water Resources Development Act of 1990. WRDA of 1990 added environmental protection as a primary USACE mission. WRDA of 1990 amended WRDA of 1986 to treat as construction the costs of planning and engineering of projects for which non-Federal interests contributed 50 percent or more of the cost of the feasibility study (U.S. Congress 1990).

Water Resources Development Act of 1999. WRDA of 1999 amended the Flood Control Act of 1936 to authorize funds contributed by states and other political subdivisions for environmental restoration (not just flood management) work (U.S Congress 1999).

Executive Order 11988 (Flood Hazard Policy)

EO 11988 is a flood hazard policy for all Federal agencies that manage Federal lands, sponsor Federal projects, or provide Federal funds to State or local projects. It requires that all Federal agencies take necessary action to reduce the risk of flood loss; restore and preserve the natural and beneficial values served by floodplains; and minimize the impacts of floods on human safety, health, and welfare. Specifically, EO 11988 dictates that all Federal agencies avoid construction or management practices that would adversely affect floodplains unless that agency finds no practical alternative, and the proposed action has been designed or modified to minimize harm to or within the floodplain.

Clean Water Act Section 404

(See Chapter 14.0, “Hydrology – Water Quality”)

Federal Emergency Management Agency

Congress established the National Flood Insurance Program (NFIP) to address both the need for flood insurance and the need to lessen the devastating consequences of flooding. FEMA works closely with State and local officials to identify flood hazard areas and flood risks. Floodplain management requirements within high-risk areas, known as Special Flood Hazard Areas (SFHA), are designed to prevent new development from increasing the flood threat, and to protect new and existing buildings from anticipated flood events.

Section 408 of the Rivers and Harbors Act

Section 14 of the Rivers and Harbors Act (commonly known as Section 408) was approved by the Federal Government on March 3, 1899, (33 USC 408). The act provides that the Secretary of the Army, on the recommendation of the Chief of Engineers, may grant permission for the temporary occupation or use of any sea wall, bulkhead, jetty, dike, levee, wharf, pier, or other work built by the United States. This permission is granted by an appropriate real estate instrument in accordance with existing real estate regulations (USACE 1899).

11.2.2 State of California

The State regulatory setting describes the State CVFPB, DWR, and SB 1324.

Central Valley Flood Protection Board

The CVFPB was established to accomplish the following:

- Control flooding along the Sacramento and San Joaquin rivers and their tributaries, in cooperation with USACE. This includes working with all permit requests for construction of improvements of any nature within the limits of a federal project right-of-way, which shall be referred to the USACE District Engineer for review (in accordance with the provisions of Title 33, CFR section 208.10)

- Cooperate with various agencies of the Federal, State, and local governments in establishing, planning, constructing, operating, and maintaining flood control works

- Maintain the integrity of the existing flood control system and designated floodways through the CVFPB's regulatory authority by issuing permits for encroachments

California Department of Water Resources

DWR established the Division of Flood Management in November 1977, although flood forecasting and flood operations had been integral functions of the DWR and its preceding agencies for about a century. The DWR itself was created following severe flooding across Northern California in December 1955.

Today, the functions of statewide flood forecasting, flood operations, and other key flood emergency response activities are the primary missions of the Division of Flood Management Hydrology and Flood Operations Office. Other components of the Division of Flood Management include the Delta-Suisun Marsh Office, the Flood Projects Office, the Levee Repairs and Floodplain Management Office, and the Flood Maintenance Office.

The Division of Flood Management, among several others, is carrying out the work of DWR’s FloodSAFE California Program, which partners with local, regional, State, Tribal, and Federal officials in creating sustainable, integrated flood management and emergency response systems throughout California. DWR is responsible for inspecting levees and has an obligation to prepare a State Plan of Flood Control and Central Valley Flood Protection Plan. Both plans are required to incorporate any modifications to the flood management system anticipated under the Settlement.

Senate Bill 1324

SB 1324 was passed by the State in 1955 to amend Section 8621 of the CWC to “provide that the CVFPB, with the approval of the Department of Finance, may execute in connection with any flood management project a substitute plan which includes provision for the State to construct works of the project when in lieu of acquiring all or any portion of the lands, easements, or rights of way in connection therewith, a saving to the State will result." The bill was also amended to state that in carrying out its provisions, the CVFPB may adopt on behalf of the State any necessary revision of any flood management project authorized under Chapter 2, Part 6, Division 6, of the CWC, but that no money shall be expended to meet the requirements of the Federal Government for local cooperation in connection with such projects unless the Federal Government agrees to accept the substitute plan.

11.2.3 Regional and Local Agencies

The LSJLD and Fresno Metropolitan Flood Control District have responsibilities related to flood management in the study area, and are described below.

Lower San Joaquin Levee District

The LSJLD was created in 1955 by a special act of the State Legislature to operate, maintain, and repair levees, bypasses, and other facilities built in connection with the Lower San Joaquin River Flood Control Project. The district encompasses approximately 468 square miles (300,000 acres) in Fresno, Madera, and Merced counties, of which 94 square miles are in Fresno County.

Fresno Metropolitan Flood Control District

The Fresno Metropolitan Flood Control District is authorized to control storm waters within an urban and rural foothill watershed of approximately 400 square miles, known as the Fresno County Stream Group. The watershed extends eastward into the Sierra Nevada to an elevation of approximately 4,500. The district service area includes most of the Fresno-Clovis metropolitan area (excluding the community of Easton), and unincorporated lands to the east and northeast. The District comprises 161 drainage areas that service approximately one to two square miles each. All but five of the developed drainage areas discharge to a retention or detention facility, which limits stormwater runoff to natural water bodies.

11.3 Environmental Consequences and Mitigation Measures

The purpose of this section is to provide information about the environmental consequences of the program alternatives on the flood management system. This section describes the impact assessment methodology, including criteria for determining significance of effects, and environmental consequences and mitigation measures associated with the effects of the program alternatives on the flood management system. The program alternatives evaluated in this chapter are described in detail in Chapter 2.0, "Description of Alternatives," and summarized in Table 11-3.

Table 11-3.
Actions Included Under Action Alternatives

Level of NEPA/CEQA Compliance	Actions[1]		Action Alternative					
			A1	A2	B1	B2	C1	C2
Project-Level	Reoperate Friant Dam and downstream flow control structures to route Interim and Restoration flows		✓	✓	✓	✓	✓	✓
	Recapture Interim and Restoration flows in the Restoration Area		✓	✓	✓	✓	✓	✓
	Recapture Interim and Restoration flows at existing CVP and SWP facilities in the Delta		✓	✓	✓	✓	✓	✓
Program-Level	Common Restoration actions[2]		✓	✓	✓	✓	✓	✓
	Actions in Reach 4B1 to provide at least:	475 cfs capacity	✓	✓	✓	✓	✓	✓
		4,500 cfs capacity with integrated floodplain habitat		✓		✓		✓
	Recapture Interim and Restoration flows on the San Joaquin River downstream from the Merced River at:	Existing facilities on the San Joaquin River			✓	✓	✓	✓
		New pumping infrastructure on the San Joaquin River					✓	✓
	Recirculation of recaptured Interim and Restoration flows		✓	✓	✓	✓	✓	✓

Notes:

[1] All alternatives also include the Physical Monitoring and Management Plan and the Conservation Strategy, which include both project- and program-level actions intended to guide implementation of the Settlement.

[2] Common Restoration actions are physical actions to achieve the Restoration Goal that are common to all action alternatives and are addressed at a program level of detail.

Key:
CEQA = California Environmental Quality Act
cfs = cubic feet per second
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
NEPA = National Environmental Policy Act
PEIS/R = Program Environmental Impact Statement/Report
SWP = State Water Project

Implementing the action alternatives would affect the flood management system of the San Joaquin River system upstream from Friant Dam, and from Friant Dam to the Delta. A summary of the impacts and mitigation measures are summarized in Table 11-4. Groundwater seepage and related effects on agriculture, land use, and socioeconomics are described in Chapter 13.0, "Hydrology – Groundwater," Chapter 16.0, "Land Use Planning and Agricultural Resources," and Chapter 22.0, "Socioeconomics."

Table 11-4. Summary of Environmental Consequences and Mitigation Measures – Flood Management

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Hydrology – Flood Management: Program-Level				
FLD-1: Expose People or Structures to a Significant Risk of Loss, Injury, or Death Involving Flooding, Including Flooding as a Result of the Failure or a Levee or Dam	No-Action	No Impact	--	No Impact
	A1	PS	FLD-1: Implement Design Standards to Minimize Risk of Loss, Injury, or Death Involving Flooding	LTS
	A2	PS		LTS
	B1	PS		LTS
	B2	PS		LTS
	C1	PS		LTS
	C2	PS		LTS
FLD-2: Substantially Reduce Opportunities for Levee and Flood System Facilities Inspection and Maintenance	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FLD-3: Substantially Alter the existing Drainage Pattern of the Site or Area, Including Through the Alteration of the Course of a Stream or River, or Substantially Increase the Rate or Amount of Surface Runoff in a Manner Which Would Result in Flooding On- or Off-Site	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FLD-4: Placement of Structures Within a 100-Year Flood Hazard Area Structures That Would Impede or Redirect Flood Flows	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS

Table 11-4. Summary of Environmental Consequences and Mitigation Measures – Flood Management (contd.)

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Hydrology – Flood Management: Program-Level (contd.)				
FLD-5: Placement of Housing Within a 100-Year Flood Hazard Area, as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
Hydrology – Flood Management: Project-Level				
FLD-6: Expose People or Structures to a Significant Risk of Loss, Injury, or Death Involving Flooding, Including Flooding as a Result of the Failure or a Levee or Dam	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FLD-7: Substantially Reduce Opportunities for Levee and Flood System Facilities Inspection and Maintenance	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FLD-8: Substantially Alter the Existing Drainage Pattern of the Site or Area, Including Through the Alteration of the Course of a Stream or River, or Substantially Increase the Rate or Amount of Surface Runoff in a Manner Which Would Result in Flooding On- or Off-Site	No-Action	No Impact	--	No Impact
	A1	No Impact	--	No Impact
	A2	No Impact	--	No Impact
	B1	No Impact	--	No Impact
	B2	No Impact	--	No Impact
	C1	No Impact	--	No Impact
	C2	No Impact	--	No Impact

Table 11-4.
Summary of Environmental Consequences and Mitigation Measures – Flood Management (contd.)

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Hydrology – Flood Management: Project-Level (contd.)				
FLD-9: Placement of Structures Within a 100-Year Flood Hazard Area Structures That Would Impede or Redirect Flood Flows	No-Action	No Impact	--	No Impact
	A1	No Impact	--	No Impact
	A2	No Impact	--	No Impact
	B1	No Impact	--	No Impact
	B2	No Impact	--	No Impact
	C1	No Impact	--	No Impact
	C2	No Impact	--	No Impact
FLD-10: Placement of Housing Within a 100-Year Flood Hazard Area, as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS

Key:
LTS = less than significant
PS = potentially significant

11.3.1 Impact Assessment Methodology

Modeling tools used to evaluate the potential effects of the program alternatives on flood management include CalSim-II, UNET, and HEC-FDA. CalSim-II was used to evaluate expected reservoir levels during the flood season for each program alternative. UNET and HEC-FDA were used to model system-wide hydraulics and flood damage reduction impacts. More detailed explanations, assumptions, and results of these models are found in Appendix H, “Modeling.”

UNET provides steady-state water-surface profiles and output for various hydraulic parameters, such as water depth, channel and floodplain velocities, and inundation areas. These outputs were used as a tool to identify existing reach capacities, and ranges of potential channel cross-section widths corresponding to different restoration flows, water depth, and channel roughness. The model was used to determine the non-damaging flow capacities in Reaches 2A, 2B, 3, 4A, and 4B in an effort to define the capability of existing channels to carry flows.

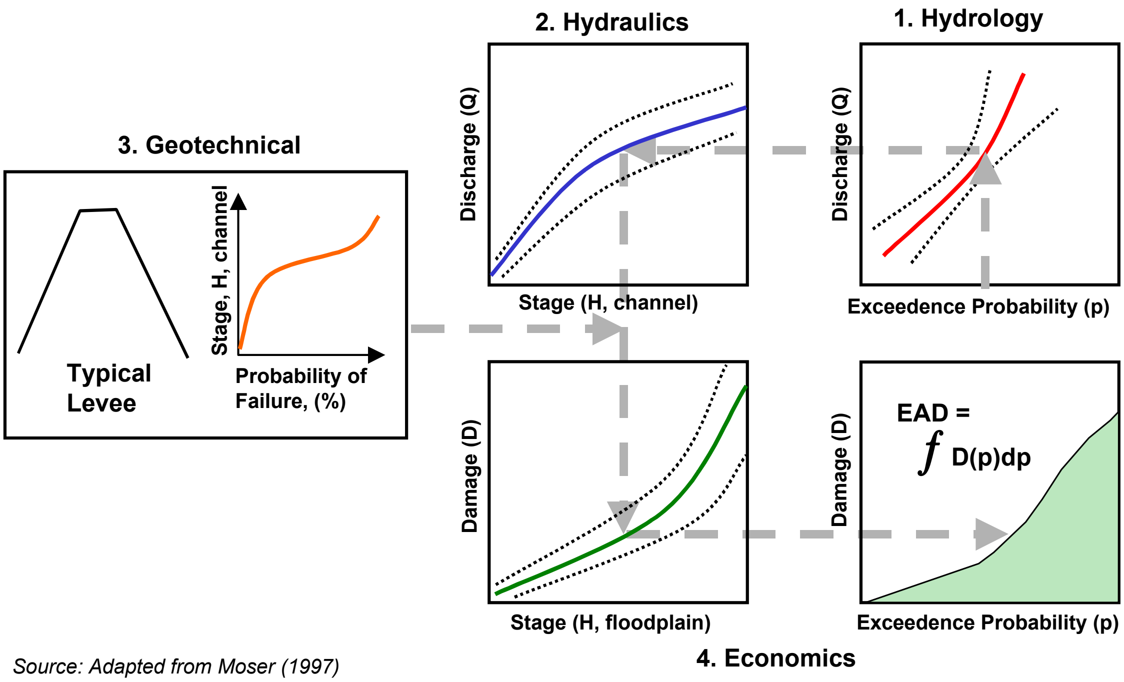
Levee failure is simulated by UNET as a levee breach at a Breakout Point that sends water into the overbank storage areas. Potential expected annual damages (EAD) resulting from levee failure simulated in UNET was then determined through HEC-FDA, which combines stage-frequency and stage-damage functions and integrates the resulting damage-frequency function. EAD is determined for eight damage categories (commercial, crops, farms, industrial, multi-family residence, mobile homes, public, single-family residence) in discrete areas associated with an Index Point. All changes in EAD from the No-Action condition to the action alternatives are attributable to changes in the stage-frequency curves. Each curve constrains water surface elevations for the nondamaging frequency, each flood flow that was modeled and the Likely Failure Point translated from the Breakout Point to the Index Point. Increases in the flood stage leads to an increase in EAD.

The determination of EAD incorporates hydrologic, hydraulic, geotechnical, and economic information:

- **Hydrologic –** The discharge-frequency function describes the probability of floods equal to or greater than some discharge (derived from CalSim-II modeling)
- **Hydraulics –** The stage-discharge function describes how high (stage) the flow of water in a river channel might be for a given flow discharge (derived from UNET modeling)
- **Geotechnical –** The geotechnical levee failure function describes the levee failure probabilities associated with stages in channel, and establishes associated water stages in the floodplain (derived from UNET modeling)
- **Economics –** The stage-damage function describes the amount of damage that might occur given certain floodplain stages (derived from HEC-FDA modeling)

Figure 11-4 conceptually illustrates the risk approach for flood damage analyses. To find the damage for any given flood frequency:

1. The discharge for that frequency is first located in the discharge-frequency panel (panel No. 1).
2. Then the river channel stage associated with that discharge value is determined in the stage-discharge panel (panel No. 2).
3. All levees have a probability of failure that increases with increasing water stage (panel No. 3).
4. Once levees have failed and water enters the floodplain, then stages (water depths) in the floodplain inundate structures and crops and cause damage (panel No. 4, left side).
5. By plotting this damage and repeating for process many times, the damage-frequency curve is determined (panel No. 4, right side). EAD is then computed by finding the area under the flood damage-frequency curve by integration for both with and without project conditions independently. Reductions in EAD attributable to projects are flood reduction benefits, while increases in EAD are impacts.



Source: Adapted from Moser (1997)

Figure 11-4.
Conceptual Risk Approach for Estimating Flood Damage

11.3.2 Significance Criteria

The thresholds of significance for impacts are based on the environmental checklist in Appendix G of the State CEQA Guidelines, as amended. These thresholds also encompass the factors taken into account under NEPA to determine the significance of an action in terms of its context and the intensity of its impacts. Impacts to flood management resulting from the program alternatives would be significant if they would cause any of the following:

- Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure or a levee or dam, including:
  - Increase risk of levee failure due to underseepage, through-seepage, or associated landside slope stability mechanisms
  - Increase risk of levee failure due to erosion or associated landside slope stability mechanisms
- Substantially reduce opportunities for levee and flood system facilities inspection and maintenance
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase

the rate or amount of surface runoff in a manner which would result in flooding on- or off-site

- Place within a 100-year flood hazard area structures that would impede or redirect flood flows
- Place housing within a 100-year flood hazard area, as mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map

Significance standards are relative to both existing conditions (2005) and future conditions (2030) unless stated otherwise.

11.3.3 Environmental Consequences and Mitigation Measures

This section describes the environmental consequences of the program alternatives, and proposed mitigation measures for any impacts determined to be significant or potentially significant. All alternatives are evaluated under existing and future conditions and compared to existing and future baselines. Each of the alternatives is simulated using the same level of development so that any changes from the basis of comparison in flood management can be attributed to the alternative.

11.3.4 Program-Level Impacts and Mitigation Measures

This section determines the significance of potential program-level impacts under the program alternatives.

No-Action Alternative

Under the No-Action Alternative, the Settlement would not be implemented. The No-Action Alternative includes conditions as they would exist in the study area at the end of the PEIS/R planning horizon (2030). Channel improvements to address these deficiencies for increased flood protection have not yet been identified and evaluated, and are not included in the Settlement (and therefore are not part of the action alternatives).

Potential channel improvements to increase channel capacity for reaches not specified in the Settlement may be implemented by parties other than Reclamation to improve levee integrity for conveyance of flood flows. These modifications are not included as part of the alternatives evaluated in this Draft PEIS/R, and future NEPA and/or CEQA compliance documentation would be required for these project-level actions. Specific modifications to the flood control system under the FloodSAFE initiative are uncertain and are not considered reasonably foreseeable or probable future actions at this time. Reclamation and DWR recognize the importance of coordination and communication in planning and implementing projects that affect the flood control system in order to prevent impacts to flood management. Therefore, the potential for cumulative effects associated with implementation of the Settlement and FloodSAFE programs and projects is presented in Chapter 26.0, “Cumulative Impacts.”

Impact FLD-1 (No-Action Alternative*): Expose People or Structures to a Significant Risk of Loss, Injury, or Death Involving Flooding, Including Flooding as a Result of the Failure or a Levee or Dam – Program-Level.* No actions would be undertaken that would impact the study area under the No-Action Alternative. There would be **no impact.**

Impact FLD-2 (No-Action Alternative): *Reduced Opportunity for Levee and Flood System Facilities Inspection and Maintenance – Program-Level.* No actions would be undertaken that would impact the study area under the No-Action Alternative. There would be **no impact**.

Impact FLD-3 (No-Action Alternative): *Substantially Alter the existing Drainage Pattern of the Site or Area, Including Through the Alteration of the Course of a Stream or River, or Substantially Increase the Rate or Amount of Surface Runoff in a Manner Which Would Result in Flooding On- or Off-Site – Program-Level.* No actions would be undertaken that would impact the study area under the No-Action Alternative. There would be **no impact**.

Impact FLD-4 (No-Action Alternative): *Placement of Structures Within a 100-Year Flood Hazard Area Structures That Would Impede or Redirect Flood Flows – Program-Level.* No actions would be undertaken that would impact the study area under the No-Action Alternative. There would be **no impact.**

Impact FLD-5 (No-Action Alternative): *Placement of Housing Within a 100-Year Flood Hazard Area, as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map – Program-Level.* No actions would be undertaken that would impact the study area under the No-Action Alternative. There would be **no impact.**

Alternatives A1 Through C2

Program-level effects of implementing Alternatives A1 through C2 on the flood management system would occur within the Restoration Area and the San Joaquin River from the Merced River to the Delta, as described below.

Impact FLD-1 (Alternatives A1 Through C2*): Expose People or Structures to a Significant Risk of Loss, Injury, or Death Involving Flooding, Including Flooding as a Result of the Failure or a Levee or Dam – Program-Level.* Program-level construction, such as new levees, has the potential to transfer flood risk to downstream areas and expose people or structures to increased risk. Proposed physical modifications to existing facilities or new facilities would incorporate features to maintain current levels of flood protection, and minimize redirected flood risk. Program-level activities include development of floodplain and riparian habitat in Reaches 2B and 4B1, which would increase vegetation or changes sediment deposition patterns within these river reaches. Hydraulic modeling of these actions demonstrates little to no changes in water level frequencies throughout the system. These changes are considered less than significant; however, due to lack of recent and consistent information regarding channel and levee conditions within the Restoration Area, this impact is considered **potentially significant**.

Levee improvements in Reaches 2B and 4B1 would expand the existing local channel capacity. These improvements could redirect flood flows to downstream Restoration Area reaches. Redirection of flood flows through the Restoration Area could also affect flood operations in the San Joaquin River downstream from the Merced River confluence. By strengthening the levees in Reaches 2B or 4B1, flood breakouts that would occur in that reach under existing conditions or under the No-Action Alternative would be less likely to occur under the Program Alternatives, potentially increasing the risk of levee overtopping or failure in downstream reaches. Changes in water level frequencies within the system would indicate a redirecting of flood flows due to the upstream channel capacity or floodplain modifications.

Table 11-5 shows the system wide impacts on estimated annual damages (EAD) for areas shown in Figure 11-5. Because the hydraulic model shows little to no changes in water level frequencies, the minor differences seen in Table 11-5 can be attributed to hydraulic data variability and perturbation effects of the Monte Carlo simulation. These changes are considered less than significant; however, due to lack of current information regarding levee conditions within the Restoration Area, this impact is considered potentially significant in the Restoration Area. Downstream from the Restoration Area, the changes in water level frequencies and EAD are smaller than within the Restoration Area and separated by distance from the potential effects of redirected flows; therefore, impacts outside of the Restoration Area are considered less than significant.

Table 11-5.
Estimated Annual Damages Under Program Alternatives

Area	Alternative	Estimated Annual Damages by Damage Category ($1,000)								Total ($1,000)
		Commercial	Crops	Farms	Industrial	Multi-Family Residence	Mobile Homes	Public	Single-Family Residence	
Restoration Area (SJ 1-19)	No-Action	$187	$20,541	$349	$81	$87	$42	$42	$952	$22,280
	A1, B1, C1	$187 (0.4%)	$20,598 (0.3%)	$354 (1.4%)	$84 (3.7%)	$87 (0.3%)	$42 (0.0%)	$43 (1.2%)	$955 (0.4%)	$22,3512 (0.3%)
	A2, B2, C2	$187 (0.4%)	$20,593 (0.3%)	$353 (1.0%)	$84 (3.8%)	$87 (0.3%)	$42 (0.0%)	$43 (1.2%)	$955 (0.4%)	$22,345 (0.3%)
Merced to Delta (SJ 20-27)	No-Action	$189	$6,966	$388	$663	$64	$0	$93	$1,192	$9,556
	A1, B1, C1	$189 (0.0%)	$6,992 (0.4%)	$388 (0.1%)	$664 (0.1%)	$64 (0.0%)	$0 (0.0%)	$93 (0.2%)	$1,193 (0.0%)	$9,582 (0.3%)
	A2, B2, C2	$189 (0.0%)	$6,974 (0.1%)	$388 (0.1%)	$664 (0.1%)	$64 (0.0%)	$0 (0.0%)	$93 (0.3%)	$1,193 (0.1%)	$9,566 (0.1%)
Delta (SJ 28-42)	No-Action	$1,323	$3,447	$2,368	$4,269	$199	$19	$767	$2,599	$14,991
	A1, B1, C1	$1,306 (-1.3%)	$3,422 (-0.7%)	$2,314 (-2.3%)	$4,182 (-2.0%)	$195 (-1.9%)	$20 (0.7%)	$763 (-0.5%)	$2,576 (-0.9%)	$14,778 (-1.4%)
	A2, B2, C2	$1,298 (-1.9%)	$3,326 (-3.5%)	$2,229 (-5.9%)	$4,120 (-3.5%)	$190 (-4.5%)	$20 (0.7%)	$746 (-2.8%)	$2,541 (-2.2%)	$14,470 (-3.5%)
Total	No-Action	$1,699	$30,954	$3,104	$5,013	$350	$62	$902	$4,743	$46,827
	A1, B1, C1	$1,683 (-0.9%)	$31,012 (0.2%)	$3,055 (-1.6%)	$4,930 (-1.7%)	$347 (-1.0%)	$62 (0.2%)	$898 (-0.4%)	$4,725 (-0.4%)	$46,712 (-0.2%)
	A2, B2, C2	$1,675 (-1.4%)	$30,896 (-0.2%)	$2,969 (-4.4%)	$4,868 (-2.9%)	$342 (-2.5%)	$62 (0.2%)	$882 (-2.3%)	$4,690 (-1.1%)	$46,381 (-1.0%)

Source: Summarized from Flood Damage Analysis model output. Additional detail provided in Appendix H, "Modeling."

Note:

(%) = indicates percent change from No-Action Alternative

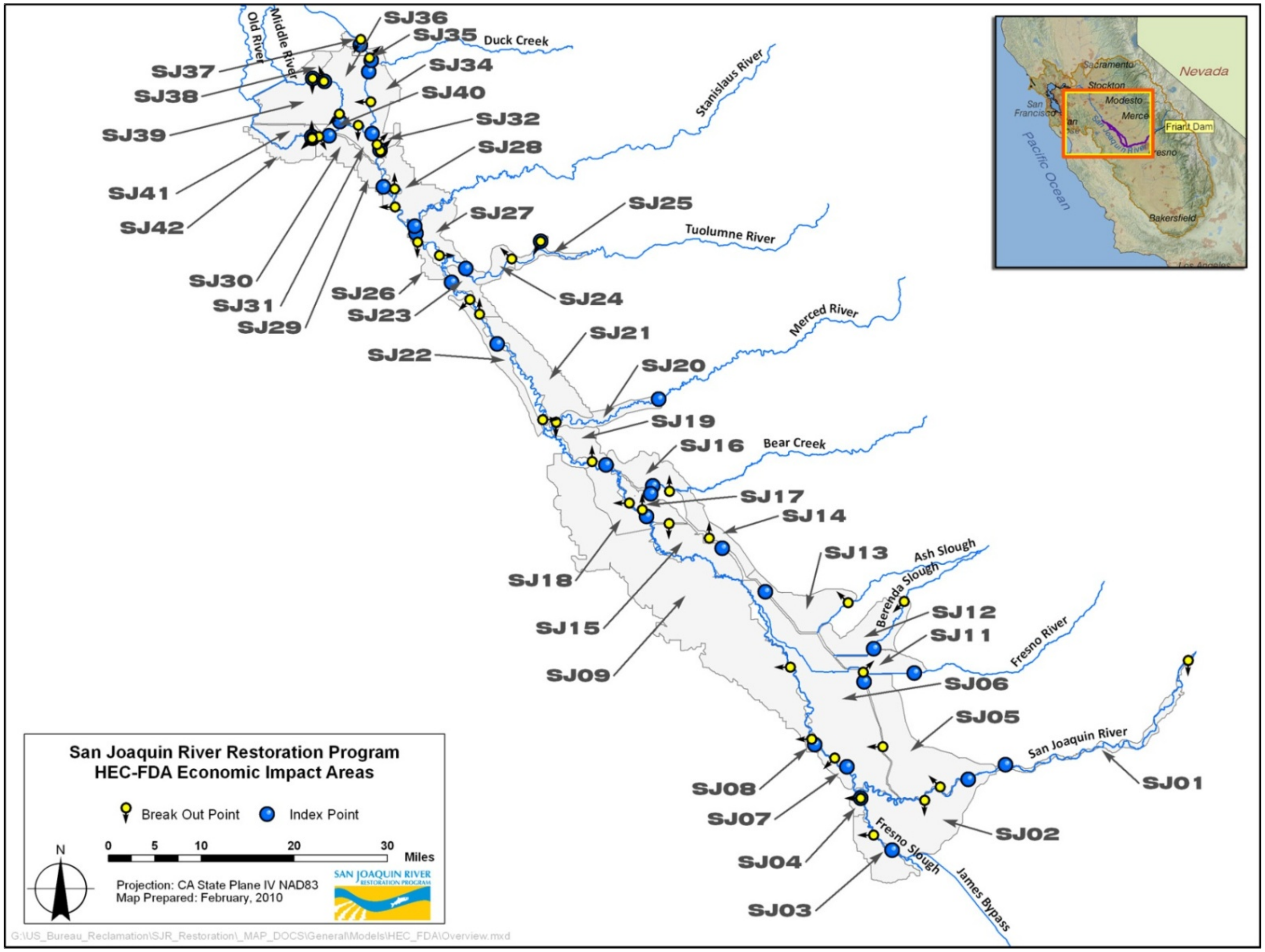


Figure 11-5.
Economic Impact Areas in the Flood Damage Assessment Model

As previously described, two classes of levees and dikes are present within the Restoration Area: (1) those associated with the San Joaquin River Flood Control Project (project levees), and (2) those constructed by individual landowners to protect site-specific properties, and thus not associated with the San Joaquin River Flood Control Project (nonproject levees). Nonproject levees in Reaches 3 and 4A, while estimated to provide sufficient cross-sectional capacity to convey Interim and Restoration flows (see Table 11-1) and subject to minor or no changes in water level frequencies under the program alternative (Figures 11-6 through 11-10), may experience seepage and levee stability problems at flows within the design capacity (RMC 2007). In addition, local landowners have constructed other low-elevation berms within these reaches creating a narrower floodplain. Recent and consistent information on dimensions and geotechnical conditions of these channels and nonproject levees and berms are difficult to obtain and, in some cases, currently unavailable. Because of the uncertainty regarding current conditions, and the direct relationship to flood flows that could be redirected by modifications in Reach 2B, the potential for impacts in Reaches 3 and 4A from redirected flood flows are potentially significant.

The system-wide hydraulic analysis completed for this study contains preliminary representations of potential levee modifications in Reaches 2B and 4B1. Additional program-level structures and modifications not included in the hydraulic model are gravel pit isolation, berms, floodplain reconfiguration, bifurcation structures, and diversion, road, and bridge modifications. These features could create localized backwater and redirection effects, though site-specific impacts would be minor because designs would include features to limit changes in system hydraulics. Designs and impacts of all program-level actions would be further refined under site-specific studies.

Floodplain restoration could increase vegetation and alter sediment deposition patterns within river reaches. Planning and design of floodplain restoration, however, would be completed concurrently with levee and channel improvements. These improvements would be developed to meet the specified Settlement channel capacities, increasing the given capacity in those reaches. In addition, the action alternatives include monitoring and response actions to manage vegetation within the Restoration Area. This impact would be less than significant.

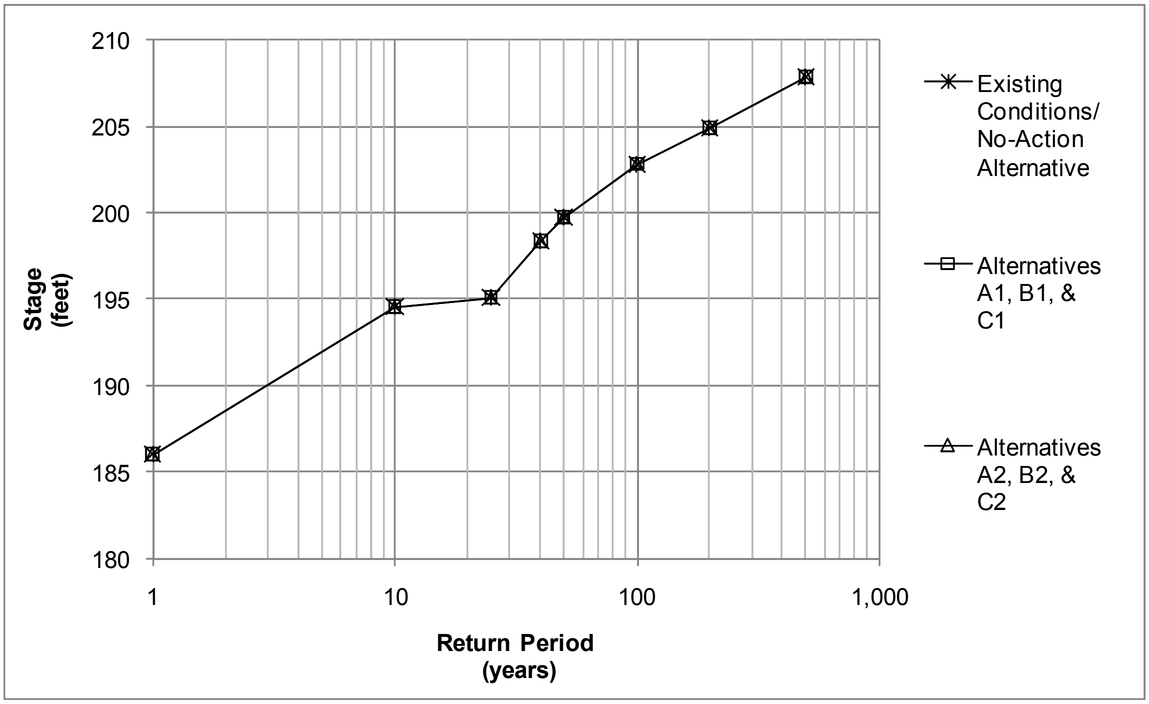


Figure 11-6.
Stage-Frequency Curve for Economic Impact Area SJ2

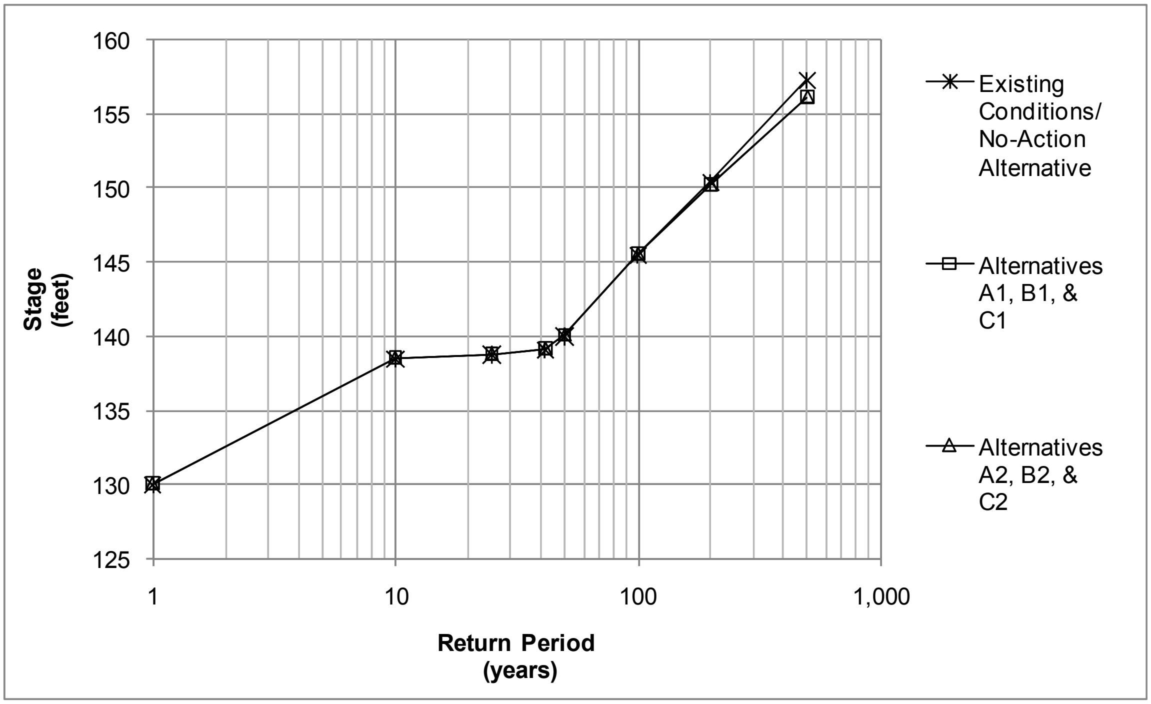


Figure 11-7.
Stage-Frequency Curve for Economic Impact Area SJ8

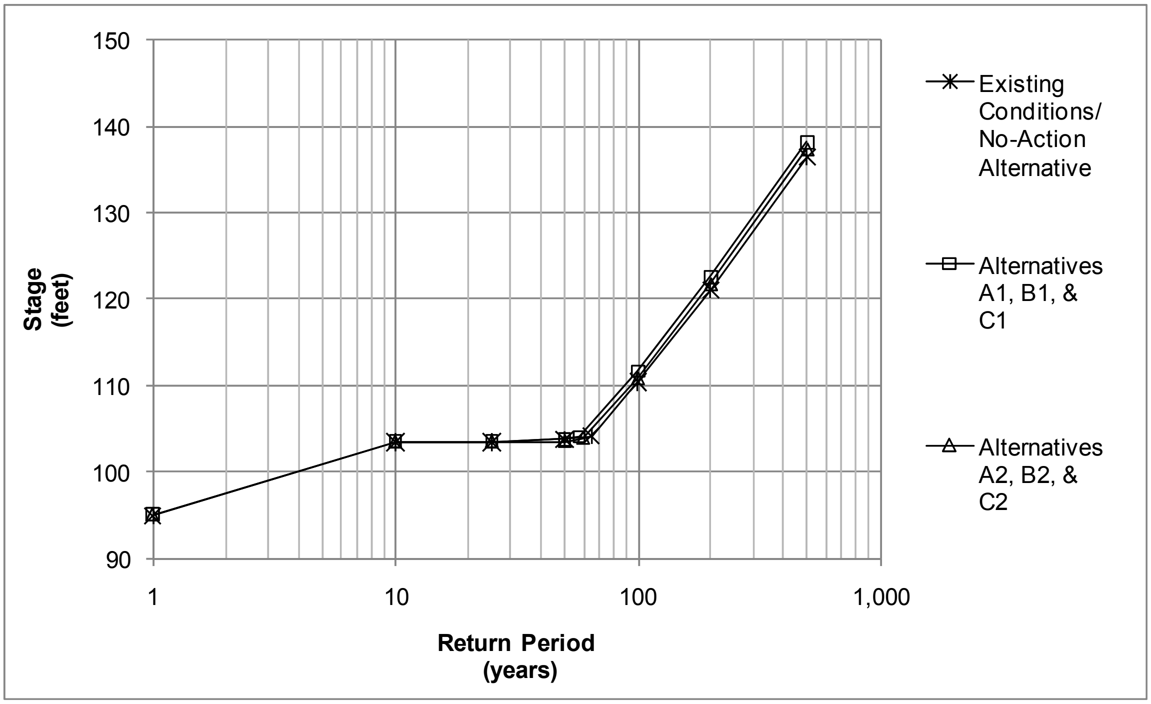


Figure 11-8.
Stage-Frequency Curve for Economic Impact Area SJ14

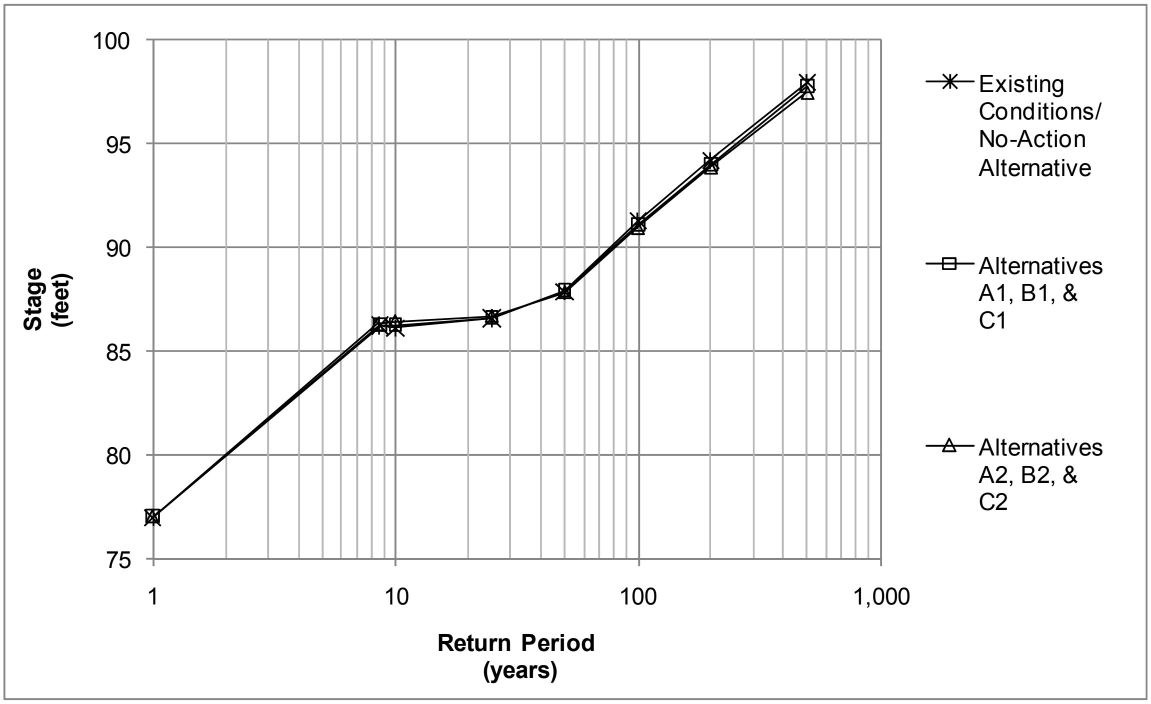


Figure 11-9.
Stage-Frequency Curve for Economic Impact Area SJ18

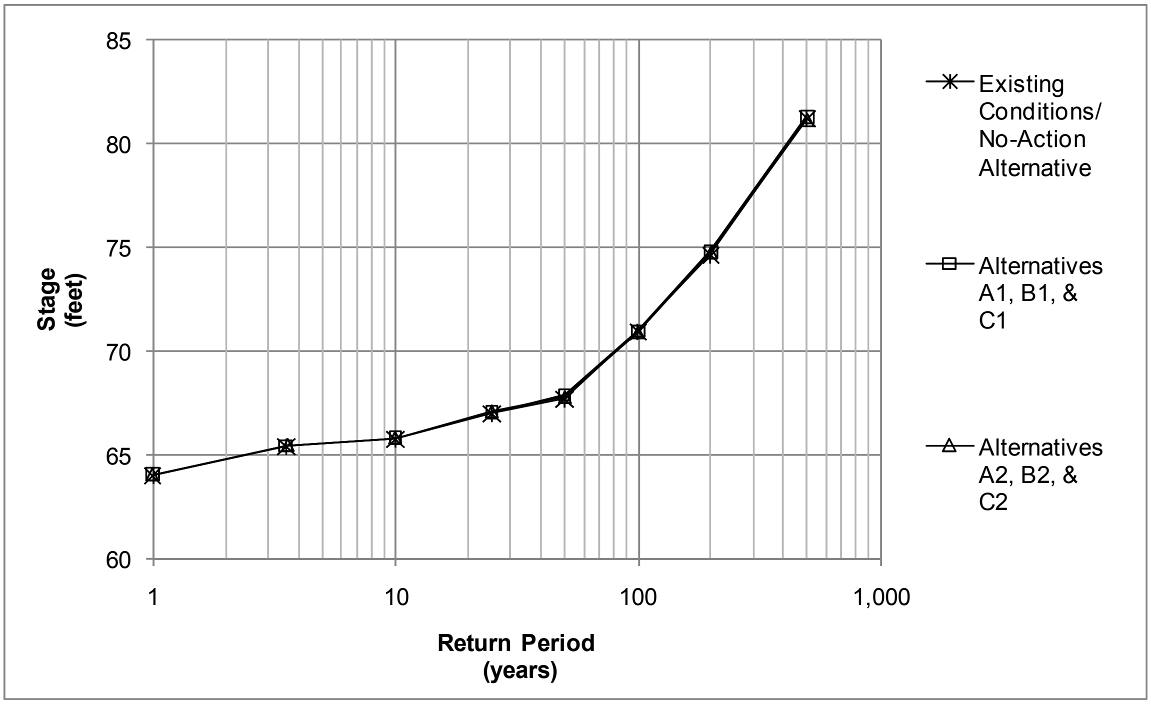


Figure 11-10.
Stage-Frequency Curve for Economic Impact Area SJ19

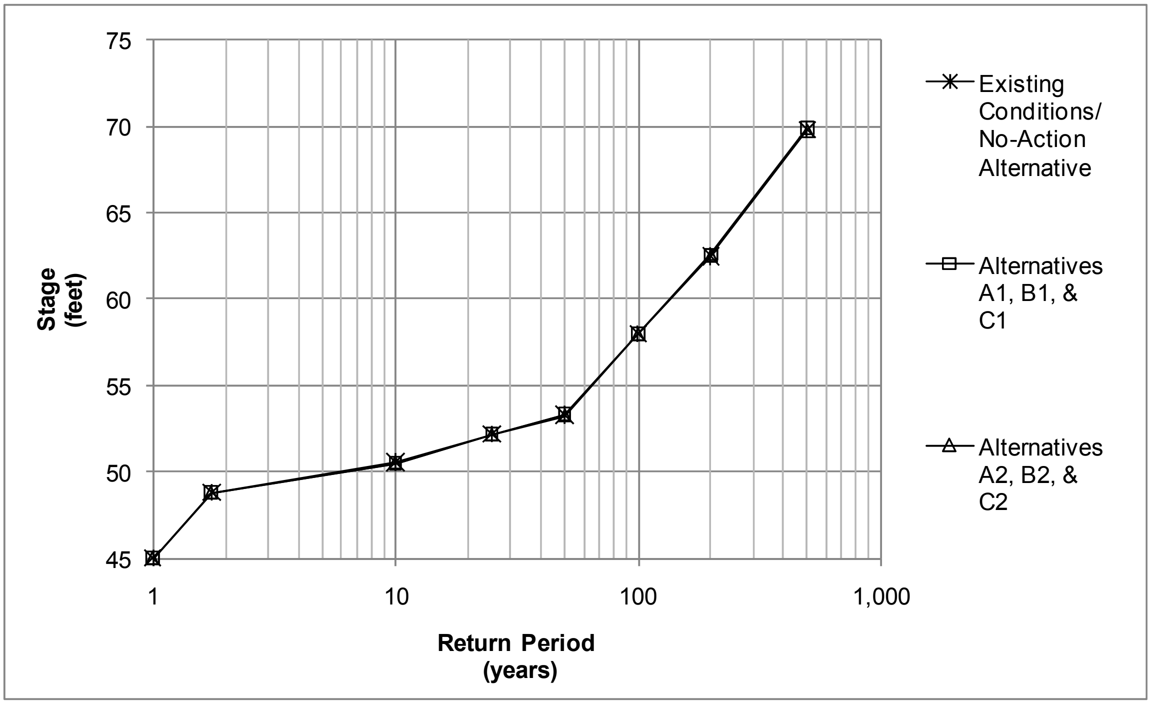


Figure 11-11.
Stage-Frequency Curve for Economic Impact Area SJ21

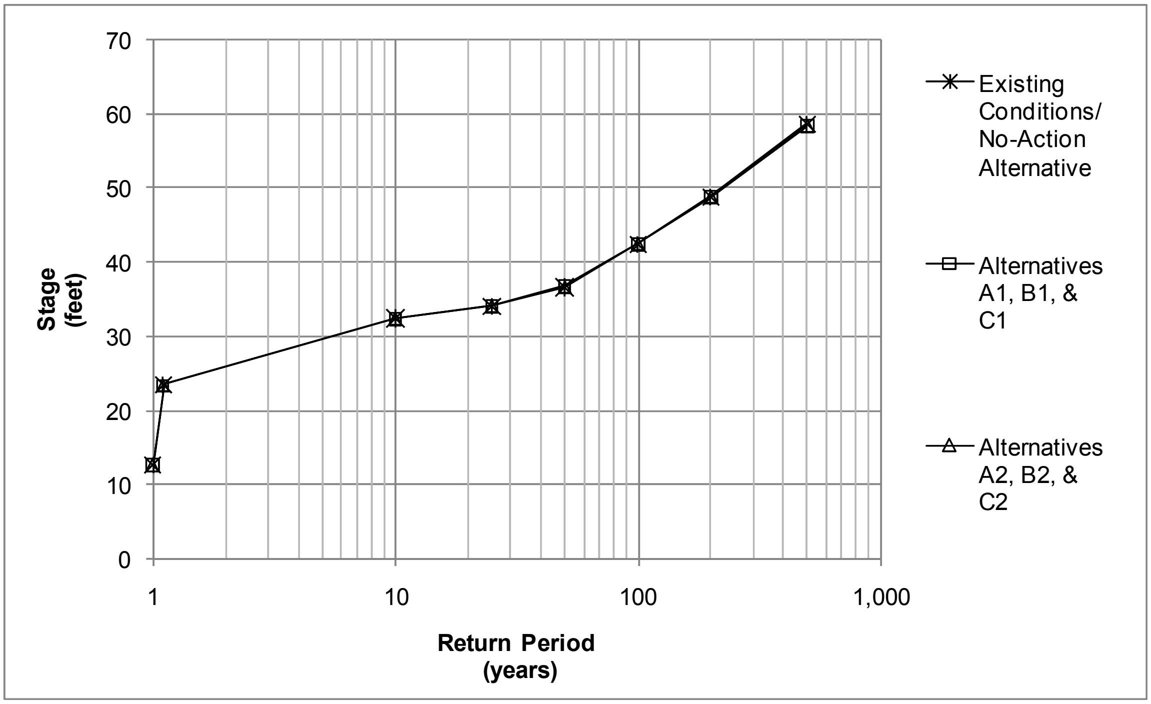


Figure 11-12.
Stage-Frequency Curve for Economic Impact Area SJ26

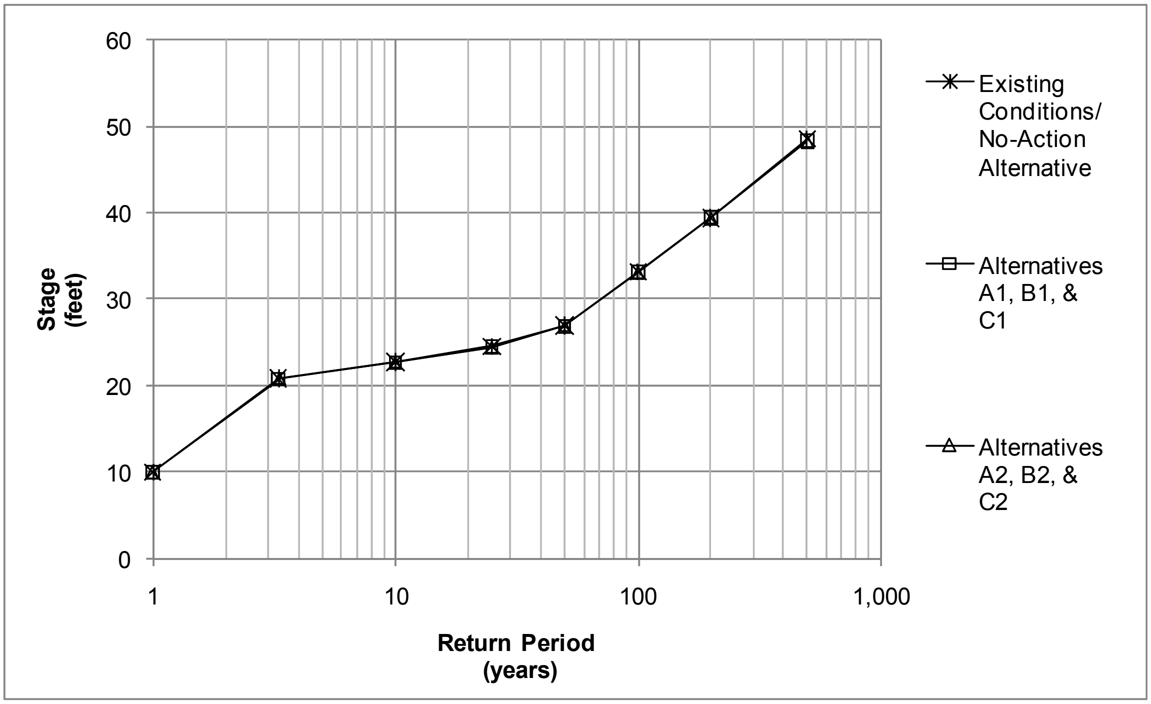


Figure 11-13.
Stage-Frequency Curve for Economic Impact Area SJ29

Mitigation Measure FLD-1 (Alternatives A1 through C2): ***Implement Design Standards to Minimize Risk of Loss, Injury, or Death Involving Flooding – Program-Level.*** Each site-specific study will include an analysis of the potential of that project to locally impede flow or transfer flood risk to downstream areas as a result of changes in velocity, stage, or cross-section. If a site-specific study identifies the potential for a program-level action to locally impede flow or transfer flood risk to downstream areas, the project proponents for the site-specific project will incorporate actions into site-specific design of individual projects to reduce redirected flood flow impacts to less-than-significant levels. Site-specific projects that cannot or do not reduce redirected flood impacts to less than significant levels will not be implemented as part of the SJRRP.

Because the details of the program-level actions are not known at this time, there is insufficient information available to describe specific actions that would reduce this impact to less than significant levels. However, incorporating actions into project design and mitigation measures to reduce redirected flood flow impacts to less than significant levels will be accomplished using known and accepted engineering design standards and features. Actions could include but would not be limited to modifications to project design, modifications to existing levees, providing a larger floodplain between levees through the acquisition of land and construction of setback levees, or regrading of land between levees. With mitigation, this impact would be **less than significant.**

Impact FLD-2 (Alternatives A1 through C2): ***Substantially Reduce Opportunities for Levee and Flood System Facilities Inspection and Maintenance – Program-Level.*** Program-level construction activities may temporarily limit access for maintenance and inspection staff. The duration of this impact, however, would not completely impede these inspection and maintenance activities, but rather require minor coordination of such activities. This impact would be **less than significant**.

Impact FLD-3 (Alternatives A1 through C2): ***Substantially Alter the Existing Drainage Pattern of the Site or Area, Including Through the Alteration of the Course of a Stream or River, or Substantially Increase the Rate or Amount of Surface Runoff in a Manner Which Would Result in Flooding On- or Off-Site – Program-Level.*** Program-level construction activities would alter local drainage patterns, and could create interior drainage, ponding, or other site-specific flooding issues. Project-specific actions would be taken to avoid interior drainage issues of proposed levees or other hydraulic structures. This impact would be **less than significant.**

The construction of levees and berms in Reach 1 (to isolate gravel pits) or in Reaches 2B and 4B1 (to convey flows and provide floodplain habitat) could affect existing drainage outside the main stem of the river by blocking channels, or by redirecting overland flow, creating interior drainage issues and potential ponding on the landward side of levees. This drainage impact would then affect crops and public and private facilities. Construction of additional hydraulic structures associated with program-level actions to reconfigure floodplains and modify diversion structures, roads, and bridges also would impact internal drainage channels and facilities. As these program-level structures are further studied and designed in project-specific investigations, their impacts to interior drainage features would be further refined and actions would then be taken to avoid these impacts. These actions could include the installation of flap gates on new or modified levees, as well as realignment or modification of existing drainage channels. This impact would be less than significant.

Impact FLD-4 (Alternatives A1 through C2): ***Placement of Structures Within a 100-Year Flood Hazard Area That Would Impede or Redirect Flood Flows – Program Level.*** Program-level construction of structures within the floodplain include a fish screen and other modifications at Sack Dam and Arroyo Canal, as well as other minor modifications to various small diversions and structures within the Restoration Area to allow fish passage. Project-specific actions would be taken to avoid impacts to flood flow passage. This impact would be **less than significant**.

Fish passage facilities could create localized backwater and redirection effects, though site-specific impacts would be minor because designs would include features to limit changes in system hydraulics. Designs and impacts of all program-level actions would be further refined under site-specific studies. This impact would be less than significant.

Impact FLD-5 (Alternatives A1 through C2): ***Placement of Housing Within a 100-Year Flood Hazard Area, as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map – Program-Level.*** Program-level activities would not alter the 100-year flood hazard area and would not place additional housing within a 100-year flood hazard area. This impact would be **less than significant**.

Figure 11-5 shows the economic impact areas assessed for impacts from potential flood flow redirection. Water level frequency curves from the hydraulic model for many points in Figure 11-5 are shown in Figures 11-6 through 11-13. These curves show little to no change in water levels throughout the system. This impact would be less than significant. Figures 11-6 through 11-13 above show little to no change in water level frequencies associated with rainflood events. The extent of the floodplain is not affected and would not place existing houses that are currently outside a 100-year flood hazard area within a 100-year flood hazard area. This impact is less than significant.

New housing development is not part of the program alternatives. This impact is less than significant.

11.3.5 Project-Level Impacts and Mitigation Measures

This section determines the significance of impacts related to project-level actions defined in Chapter 2.0, "Description of Alternatives." These project-level actions deal primarily with the reoperation of Friant Dam to provide Interim and Restoration flows to the San Joaquin River.

Reoperation of Friant Dam to provide Interim and Restoration flows is the main driver in changes to flow and flood conditions downstream from Millerton Lake under the action alternatives. Flood operation rules require a storage limit of approximately 350 TAF in Millerton Lake during the rain-flood season, with higher storage targets for the remainder of the year, up to 520 TAF. These flood rules operating Millerton Lake would not change under the action alternatives.

The increase in flows in the San Joaquin River below the Merced River confluence would be minor compared to the available capacity, and no impacts would occur outside of the Restoration Area. Therefore, these areas are not discussed further.

No-Action Alternative

Under the No-Action Alternative, the Settlement would not be implemented. The No-Action Alternative includes conditions as they would exist in the study area at the end of the PEIS/R planning horizon (2030), such as those projects and programs considered reasonably foreseeable by that time. As previously mentioned, the potential for cumulative effects associated with implementation of the Settlement and FloodSAFE programs and projects is presented in Chapter 26.0, "Cumulative Impacts."

Impact FLD-6 (No-Action Alternative): ***Expose People or Structures to a Significant Risk of Loss, Injury, or Death Involving Flooding, Including Flooding as a Result of the Failure or a Levee or Dam – Project-Level.*** No actions would be undertaken that would impact the study area under the No-Action Alternative. There would be **no impact**.

Impact FLD-7 (No-Action Alternative): ***Substantially Reduce Opportunities for Levee and Flood System Facilities Inspection and Maintenance – Project-Level.*** No actions would be undertaken that would impact the study area under the No-Action Alternative. There would be **no impact**.

Impact FLD-8 (No-Action Alternative): ***Substantially Alter the Existing Drainage Pattern of the Site or Area, Including Through the Alteration of the Course of a Stream or River, or Substantially Increase the Rate or Amount of Surface Runoff in a Manner Which Would Result in Flooding On- or Off-Site – Project Level.*** No actions would be undertaken that would impact the study area under the No-Action Alternative. There would be **no impact**.

Impact FLD-9 (No-Action Alternative): ***Placement of Structures Within a 100-Year Flood Hazard Area That Would Impede or Redirect Flood Flows – Project-Level.*** No actions would be undertaken that would impact the study area under the No-Action Alternative. There would be **no impact**.

Impact FLD-10 (No-Action Alternative): ***Placement of Housing Within a 100-Year Flood Hazard Area, as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map – Project-Level.*** No actions would be undertaken that would impact the study area under the No-Action Alternative. There would be **no impact**.

Alternatives A1 through C2

Project-level effects of implementing Alternatives A1 through C2 would be associated with Friant Dam reoperation and release of Interim and Restoration flows. The effects of these project-level actions on the flood management system would occur within the Restoration Area, as described below.

Impact FLD-6 (Alternatives A1 through C2): ***Expose People or Structures to a Significant Risk of Loss, Injury, or Death Involving Flooding, Including Flooding as a Result of the Failure or a Levee or Dam – Project-Level.*** As described in Chapter 2.0, "Description of Alternatives," Interim and Restoration flows would be constrained to then-existing channel capacities. The actions included in Alternatives A1 through C2 would reduce or avoid potential substantial increases in flood risk which might otherwise occur. Therefore, this impact would be **less than significant.**

Under Alternatives A1 through C2, Reclamation would implement three integrated measures that would collectively avoid a potentially significant increase in the risk of flood damage or levee failure due to underseepage, through-seepage, erosion, or landside slope stability issues (as described in Chapter 2.0, "Description of Alternatives," in the section describing actions to minimize flood risk). These three measures include: (1) establishing a Channel Capacity Advisory Group and determining and updating estimates of then-existing channel capacities as needed; (2) maintaining Interim and Restoration flows below estimates of then-existing channel capacities; and (3) closely monitoring erosion and performing maintenance and/or reducing Interim and Restoration flows as necessary to avoid erosion-related impacts.

Then-existing channel capacities would be estimated as flows that would correspond to a Factor of Safety of 1.4 or greater, as calculated using standard USACE criteria for levees under a steady state of saturation for a prolonged time (USACE 2000). The application of these criteria requires the collection and evaluation of data at locations throughout the Restoration Area. Until adequate data are available to apply the USACE criteria, Reclamation would limit the release of Interim and Restoration flows to those which would remain in-channel. In-channel flows are flows that maintain a water surface elevation at or below the elevation of the landside levee toe (i.e., the base of the levee). When sufficient data are available to determine the Factor of Safety, Reclamation would limit Interim and Restoration flows to levels that would correspond to a Factor of Safety of 1.4 or higher at all times. Observation of levee erosion, seepage, boils, impaired emergency levee access, or other indications of increased flood risk identified through ongoing monitoring at potential erosion sites would indicate that the minimum Factor of Safety is not met and would trigger immediate response actions to reduce Interim and Restoration flows as described in Chapter 2.0, "Description of Alternatives." Such observations would supersede channel capacity estimates, and Interim and Restoration flows would be reduced in areas where these conditions occur.

Implementation of Alternatives A1 through C2 would change flow patterns in the San Joaquin River downstream from the Merced River, as shown in Figure 11-14. To assess the effect of flow timing changes on levee stability risk caused by Interim or Restoration flows pre-wetting levees antecedent to flood flows, the following three patterns evident in the simulation time series are considered:

- **Pattern 1 – Flood releases exceed Exhibit B flow targets**. Figure 11-15 shows that during a wet year, flood releases could potentially exceed Interim and Restoration flow targets for most of the year. In such a condition, because Interim and Restoration flow targets would be satisfied by flood releases, Interim and Restoration releases would not be made. Because flow magnitude and duration would not change under this condition, levee saturation and stability risk also would not change, relative to the existing conditions and No-Action Alternative. Figure 11-16 shows a similar pattern, comparing the 2006 historical Friant Dam releases to the Restoration release target. These data suggests that this impact would be less than significant.

- **Pattern 2 – Flood releases are not required.** Figure 11-17 is an example of drier years, where no flood releases occur and levee saturation and stability risk would not change, relative to the Existing Condition and No-Action Alternative. These data suggests that this impact for these two types of years would be less than significant.

- **Pattern 3 – Exhibit B flow targets precede or follow flood releases**. Figures 11-18 and 11-19 illustrate a pattern where flood flows and Interim and Restoration flows occur within the same year.

    - **Precede flood releases** – Figure 11-18 shows how Restoration Flows could create additional space in Millerton Lake during early spring months, thereby reducing, delaying, or avoiding peak snowmelt releases and reducing levee stability risks during these events. These data suggests that this impact would be less than significant.

    - **Follow flood releases** – Peak Interim and Restoration flows (April – June) occur after rain-flood events (October – March). As shown during 1997 in Figure 11-19, Interim and Restoration flows would be low preceding the rain-flood season of October through March, and would not be anticipated to substantially increase levee saturation prior to these events. These data suggests that this impact would be less than significant.

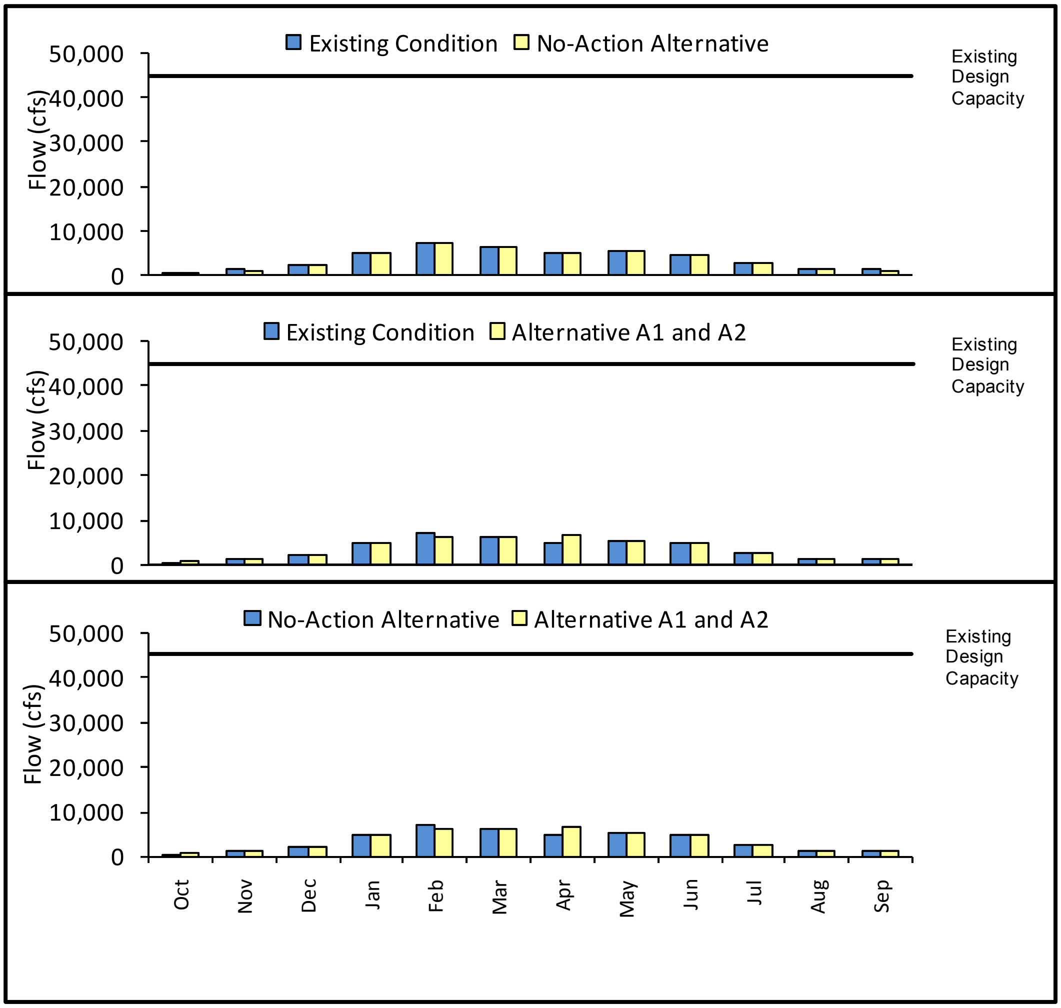
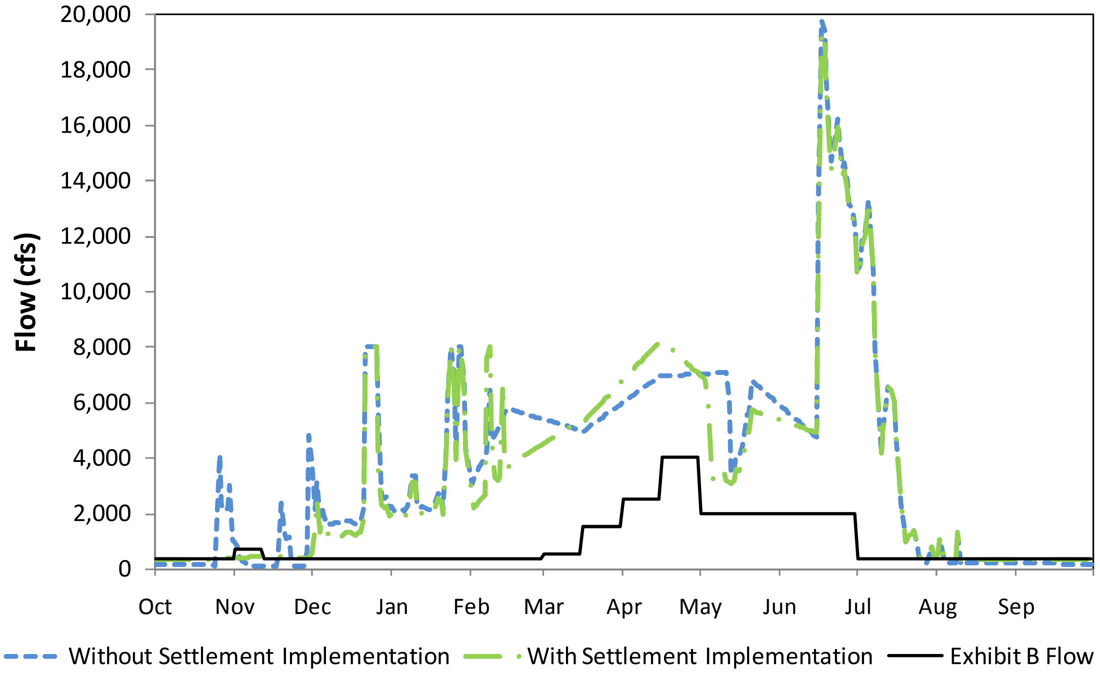
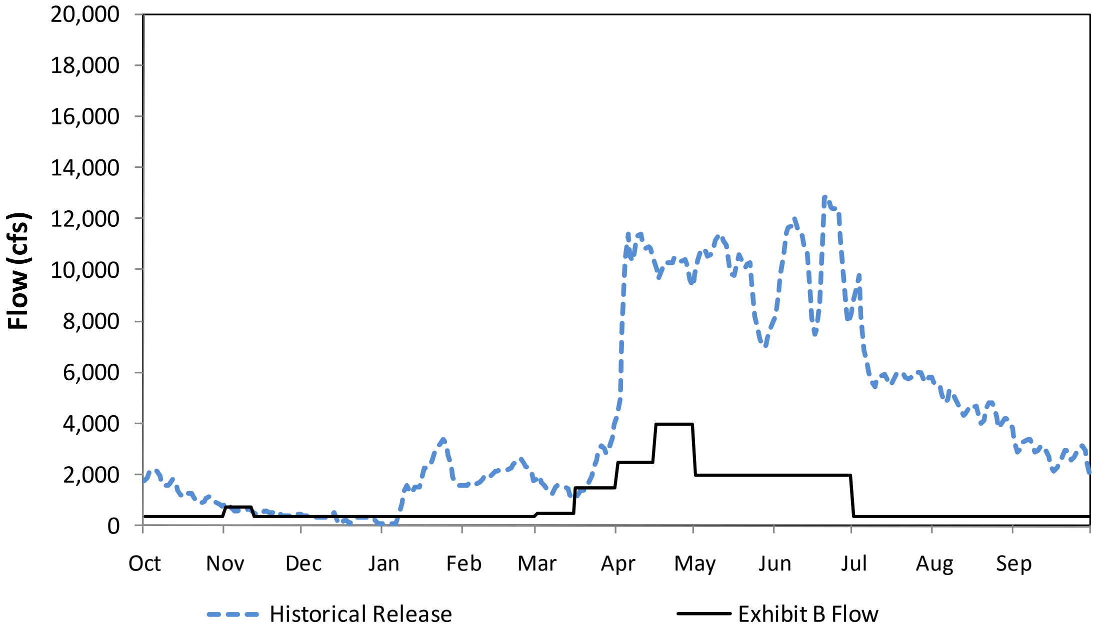


Figure 11-14.
Averages of Simulated San Joaquin River Downstream from the Merced River Flow in Wet Years



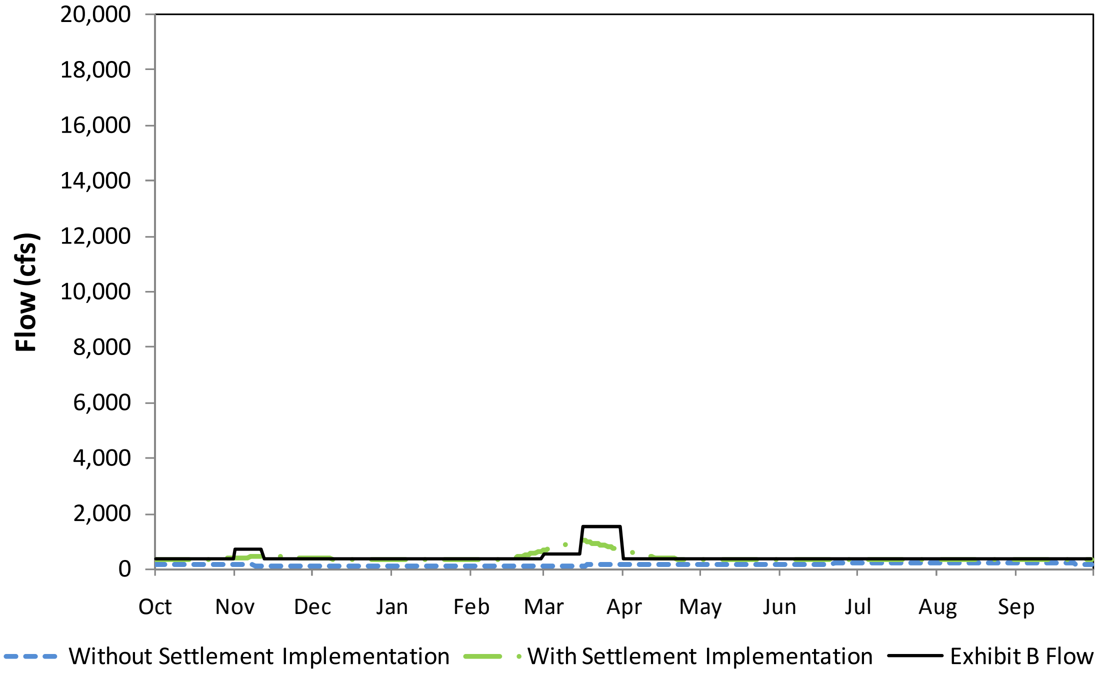
Note: Releases include flood flows, holding contract requirements, and Restoration flows, where applicable.

Figure 11-15.
Simulated Friant Dam Releases for 1983 Water Year – Flood Releases Exceed Exhibit B Flow Targets



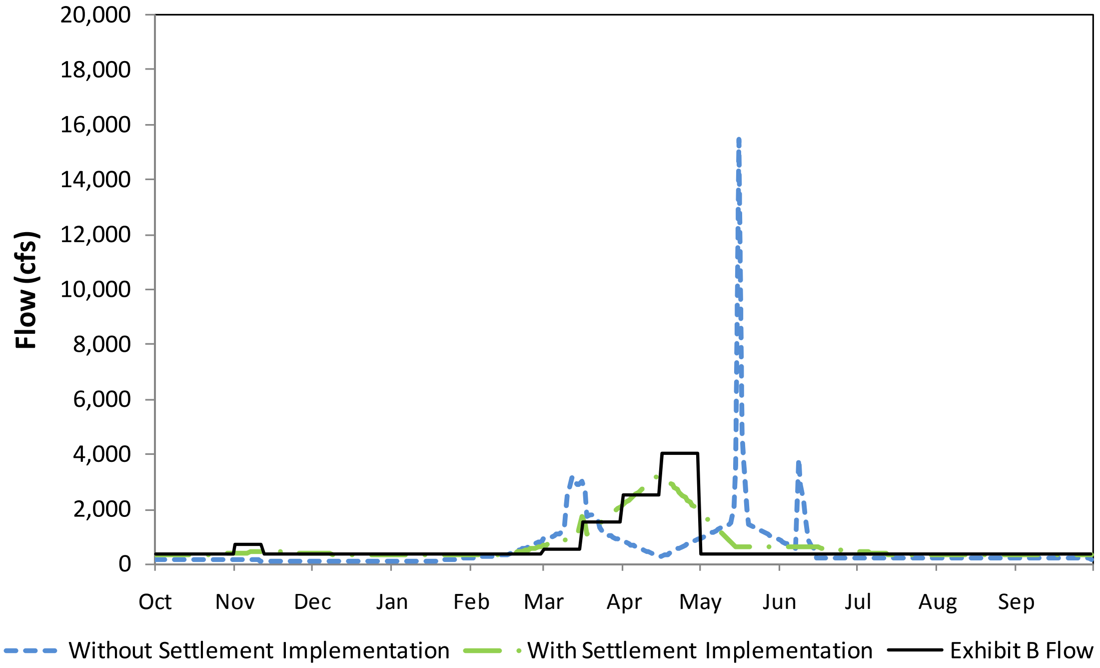
Note: Releases include flood flows, holding contract requirements, and Restoration flows, where applicable.

Figure 11-16.
Historical Friant Dam Releases for 2006 Water Year – Flood Releases Exceed Exhibit B Flow Targets



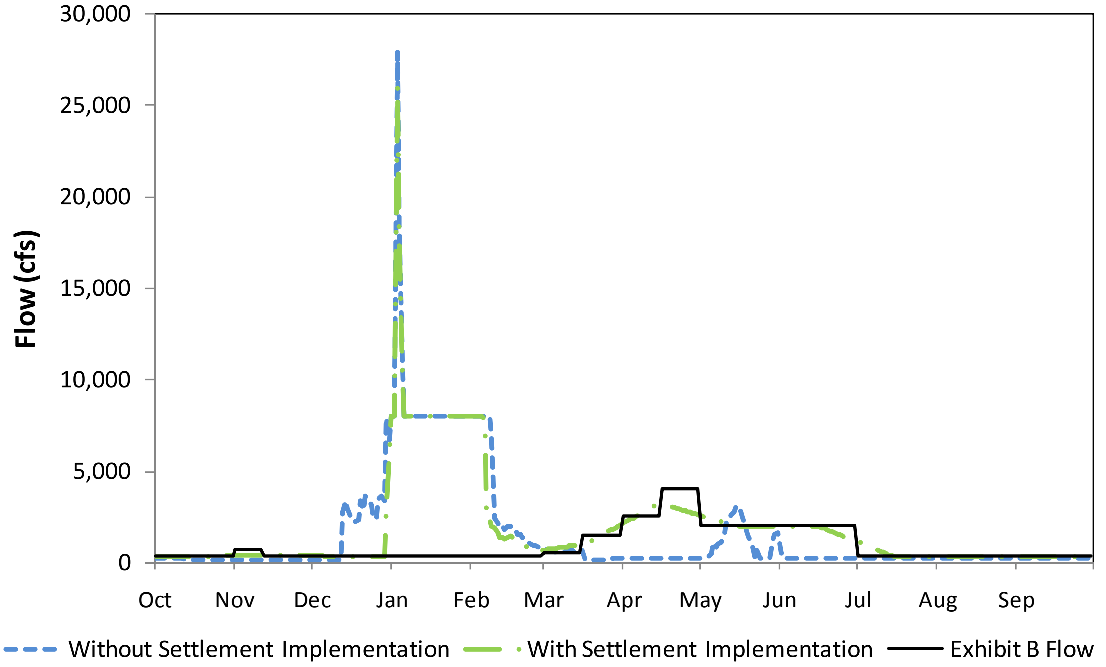
Note: Releases include flood flows, holding contract requirements, and Restoration flows, where applicable.

Figure 11-17.
Simulated Friant Dam Releases for 1992 Water Year – Flood Releases Do Not Occur



Note: Releases include flood flows, holding contract requirements, and Restoration flows, where applicable.

Figure 11-18.
Simulated Friant Dam Releases for 1996 Water Year – Exhibit B Flow Targets Precede Flood Releases



Note: Releases include flood flows, holding contract requirements, and Restoration flows, where applicable.

Figure 11-19.
Simulated Friant Dam Releases for 1997 Water Year – Exhibit B Flow Targets Follow Flood Releases

The release of Interim and Restoration Flows would have the potential to increase vegetation growth and sediment erosion and deposition in all reaches in the Restoration Area. As described in Chapter 2.0, "Description of Alternatives" and in Appendix D of this PEIS/R, the Physical Monitoring and Management Plan specifies guidelines for observing and adjusting to changes in physical conditions related to flow, seepage, channel capacity, native vegetation, and spawning gravel. Specific portions of the Physical Monitoring and Management Plan relevant to vegetation growth and sediment erosion and deposition include the Channel Capacity monitoring and management plan (Chapters 5 of Appendix D) and the monitoring programs identified therein. The objective of the Channel Capacity Monitoring and Management Plan is to maintain existing or not reduce existing channel capacity within the Restoration Area. Potential immediate responses to a reduction in channel capacity include removal of vegetation and debris. Vegetation removal would be conducted by mechanical or chemical means. Nonnative plant removal would receive priority over removal of native species. The results of monitoring and management activities performed as part of the SJRRP would used to inform estimates of then-existing channel capacities, and would be included for review in reports to the Channel Capacity Advisory Group, as described in Chapter 2.0, "Description of Alternatives."

Through the measures to reduce flood risk described in Chapter 2.0, "Description of Alternatives," and summarized above, Alternatives A1 through C2 would not expose people or structures to a significant risk of loss, injury, or death involving flooding. Therefore, this impact would be less than significant.

Impact FLD-7 (Alternatives A1 through C2): ***Substantially Reduce Opportunities for Levee and Flood System Facilities Inspection and Maintenance – Project-Level.*** Under Alternatives A1 through C2, increased durations of elevated instream flows would subject the channels and, at times, the levees in the Restoration Area to increased periods of saturation. DWR is currently identifying and prioritizing locations at which advance measures will be taken to benefit flood operations (an initial assessment of potential locations is provided in Appendix I). Maintenance activities such as placing rock on levee crowns to enable access by large vehicles are anticipated at such locations. These activities are anticipated to be completed as part of normal flood system maintenance prior to the implementation of the action alternatives, and are therefore not included in the action alternatives. Because regular maintenance activities within the Restoration Area maintain levee access for inspection and maintenance, this impact would be **less than significant**.

It is reasonably foreseeable that additional channel improvements will likely be developed and implemented in the future as part of other ongoing or potential future "projects" independent of the SJRRP which may directly or indirectly allow an increase in Interim and Restoration flows and contribute to achieving the Restoration Goal of the Settlement. Programs to better evaluate flood risk and develop projects to improve flood protection are currently underway. However, there is large variability in the location and type of improvements that could be developed in the future to increase channel capacity. Given that at this time substantial uncertainty exists regarding the location, nature, and timing of such improvements, they are considered speculative and pursuant to Section 15145 of the State CEQA Guidelines no further analysis of such projects is appropriate or possible at this time. Therefore, the potential cumulative effects of implementing Alternatives A1 through C2 taken together with potential future modifications to the flood control system under NULE or other programs and projects is presented in Chapter 26.0, "Cumulative Effects."

Increased average flows in Restoration Area reaches could result in less opportunity for levee and flood system facilities inspection and maintenance. If increased maintenance activities and costs are required as a result of implementing the Settlement, including additional erosions management actions identified through the monitoring activities described in this section, Reclamation would conduct or enter into an agreement with others to conduct such additional maintenance activities. Currently, Reclamation is working with LSJLD to develop and implement an agreement to provide financial assistance for additional costs incurred by LSJLD. The financial assistance agreement is intended to assist LSJLD in adapting to changes in operations and maintenance activities, as needed to maintain the existing level of flood management under release of Interim and Restoration flows. This impact would be less than significant.

Several of the flood system structures (e.g. bifurcation structures, flap gates) are not subject to continuous flow under the No-Action Alternative. Interim and Restoration flows would subject these structures to year-round flow, which would hinder current inspection and maintenance procedures. The long-term agreement would identify and provide additional resources and methods for performing regular maintenance activities at an increased frequency to maintain existing flood management capacity. This impact would be less than significant.

Overall, for the reasons stated above, this impact would be less than significant.

Impact FLD-8 (Alternatives A1 through C2): ***Substantially Alter the Existing Drainage Pattern of the Site or Area, Including Through the Alteration of the Course of a Stream or River, or Substantially Increase the Rate or Amount of Surface Runoff in a Manner Which Would Result In Flooding On- or Off-Site – Project Level.*** No project-specific actions would physically alter the drainage pattern of the site or area. There would be **no impact**.

Impact FLD-9 (Alternatives A1 through C2): ***Placement of Structures Within a 100 Year Flood Hazard Area That Would Impede or Redirect Flood Flows – Project Level.*** No project-specific actions would place structures within a 100-year flood hazard area. There would be **no impact**.

Impact FLD-10 (Alternatives A1 through C2): ***Placement of Housing Within a 100-Year Flood Hazard Area, as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map – Project-Level.*** Project level activities would not place additional housing within a 100-year flood hazard area. This impact would be **less than significant**.

Interim and Restoration flows in the Restoration Area are well below the 100-year flood event. As an example, the 100-year flow at the head of Reach 2A is approximately 70,000 cfs (USACE 1999a). Project-level actions regarding reoperating Friant Dam and the release of Interim and Restoration flows would not place additional housing within a 100-year flood hazard area, compared to the Existing Condition or No Action Alternative. This impact would be less than significant.