San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix A1: Alternatives Development

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Appendix A1
Alternatives Development

This Alternatives Development Appendix documents the alternatives development process for the San Luis Low Point Improvement Project (SLLPIP) Environmental Impact Statement/Environmental Impact Report (EIS/EIR).

A1.1 Alternatives Development and Screening Process

The Lead Agencies used a comprehensive process to develop initial alternatives that included review of existing material, public input, and comparison and evaluation of initial alternatives using the Federal planning criteria and the purpose and need/project objectives.

A1.1.1 Alternatives Screening Criteria

The Federal planning process outlined in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*[1] (P&Gs) (U.S. Water Resources Council 1983) guides the formulation and evaluation studies of major Federal water resources development agencies. The planning process is intended to formulate reasonable plans responsive to Federal, State, and local objectives.

The P&Gs state that the Federal objective of water and related land resource planning is to contribute to National Economic Development (NED) while protecting the nation's environment. The P&Gs describe the Federal objective as a national goal. The process, which includes evaluation and consideration of all possible alternatives, is designed to develop a plan that provides the most economical and environmentally acceptable Federal action. The P&Gs distinguish the study objective from the Federal objective as more specific in terms of expected or desired outputs.

To meet the study objectives, the planning process follows the P&Gs' structured six-step planning approach. The structured approach, listed below, adjusts to the

[1] The SLLPIP Feasibility Study was initiated by Reclamation in 2004 and as such, has been developed consistent with the guidelines presented in the P&Gs. In 2015, the Department of the Interior released the *Department of Interior Agency Specific Procedures for implementing the Council on Environmental Quality's Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies (PR&G)* (United States Department of the Interior 2015). These new PR&Gs are being used to provide input on the SLLPIP Feasibility Study process but are not required.

identification of new information relevant to the alternatives plans with a reiteration of the initial steps in the planning process.

1. Define the water and related land resource problems, opportunities, objectives, and constraints while coordinating among Federal, State, and local authorities, and the public.

2. Inventory and forecast existing and without project future conditions in the study area relative to the identified problems, opportunities, and constraints.

3. Formulate alternative plans by exploring a full range of possible solutions.

4. Evaluate plans relative to existing and without project future conditions.

5. Compare the plans among each other.

6. Select the recommended plan based on the comparison of plans.

Alternatives are screened in the Federal planning process based on how well they would meet the Federal screening criteria:

- *Completeness* is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure realization of the planned effects. This may require relating the plan to other types of public or private plans if the other plans are crucial to realization of the contributions to the objective.

- *Effectiveness* is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities.

- *Efficiency* is the extent to which an alternative plan is the most cost effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment.

- *Acceptability* is the workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations, and public policies.

A1.1.2 Alternatives Identification and Screening

This section presents an overview of how the Federal planning process was used to develop the SLLPIP initial alternatives. This identification and formulation process is consistent with National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA), which require a lead agency to consider a reasonable range of alternatives.

A1.1.2.1 Management Measures

The first step in the development of initial alternatives was the identification of potential management measures, which could include programs, projects, or policies, that would help achieve the project objectives. The Lead Agencies identified management measures based on Santa Clara Valley Water District's (SCVWD's) past work on the project, other water resources studies, and the team's technical understanding of the project's problems, opportunities, and objectives. SCVWD's previous efforts included an extensive public outreach effort, which resulted in the inclusion of management measures suggested by the project stakeholders and the general public.

The initial list of management measures was presented in the February 2008 *SLLPIP Initial Alternatives Information Report* (IAIR). The 87 management measures identified in the IAIR were grouped into six categories: (1) Institutional Agreements; (2) Source Water Quality Control; (3) Water Treatment; (4) Conveyance; (5) Local Reservoir Storage; and (6) Alternate Water Supplies.

These management measures were then screened according to their technical and institutional viability[2] as well as the degree to which their implementation would achieve the SLLPIP objectives. This screening did not evaluate management measures in detail, but rather looked for fatal flaws that would make a measure not viable. Management measures that were technically and institutionally viable and made some contribution towards meeting the project objectives were carried forward.

A1.1.2.2 Initial Alternatives and Screening

A total of 26 initial alternatives were developed from the management measures. Initial alternatives included one management measure or a combination of management measures to achieve good performance relative to the project objectives. The 26 initial alternatives were screened for how well they would meet the Federal planning criteria.

In the next step, at least one initial alternative from each category and for some categories multiple initial alternatives were selected to carry forward for analysis, maintaining a reasonable range of alternative types. At the end of the process, 17 initial alternatives that were carried forward from the IAIR (United States Department of the Interior, Bureau of Reclamation [Reclamation] 2008a). The IAIR focused on existing information, so some alternatives were carried forward because the information was not adequate to determine if the alternative could be eliminated.

[2] In the IAIR, technical viability was related to the general engineering viability of measures and assessed whether a measure could be constructed or implemented to effectively address the low point issue. Institutional viability accounted for the institutional aspects of a measure, including regulatory and environmental compliance and public acceptance.

A1.1.2.3 Plan Formulation

In the Plan Formulation Phase, alternatives carried forward from the IAIR were further developed to allow a more detailed analysis of their ability to meet the four Federal planning criteria: completeness, effectiveness, acceptability, and efficiency. The IAIR focused on available information, but the Lead Agencies developed additional information in the Plan Formulation Phase to help evaluate potential alternatives.

The goal of this re-evaluation was to develop updated information and data to identify and screen out alternatives that would not meet the planning criteria prior to development of comprehensive plans in the *SLLPIP Plan Formulation Report* (PFR). As a result, 14 alternatives were screened out, eliminating them from further consideration. Three alternatives, the Lower San Felipe Intake Alternative, the Combination Alternative and the Pacheco Reservoir Alternative, remained for further analysis in the Feasibility Report and EIS/EIR. The results of the screening and evaluation are described in the PFR (Reclamation 2009).

A1.1.3 Scoping of Alternative Measures and Pre-Screening Process

The SLLPIP study team held a series of three public open house scoping meetings in September 2008 to present the public with the alternatives' issues and potential impacts identified during plan formulation, agency roles, and opportunities for public involvement. The meetings were held in San Jose, Los Banos, and Sacramento. Attendees included members of the public and representatives from public agencies.

During each of the scoping meetings, the public was encouraged to voice questions or comments. Members of the public also submitted comments in writing during and after the public scoping meetings. Comments received included questions on the project status, plans for future public involvement, and the roles of resource agencies in the planning process. Commenters also asked questions about the alternative screening process, the alternatives that had been screened, and the alternatives that would be evaluated in the EIS/EIR. Specifically, commenters were interested in the interaction of an expanded Pacheco Reservoir with Henry Coe State Park, the addition of an alternative to treat water to reduce algae growth, and the structure of institutional measures. Multiple comments were also received on the planned analysis of alternative effects. Commenters had questions about the planned analysis process for fish in San Luis Reservoir and the Sacramento- San Joaquin Delta (Delta), potential effects on wildlife habitat in the study area, water quality effects, changes in electricity consumption resulting from changed water system operations, and recreation effects.

Reclamation prepared an *Environmental Scoping Report* (Reclamation 2008b) that documented the comments captured at the scoping meetings in detail. This

information was included during development of alternatives. The specific comments related to alternatives were incorporated as follows:

- Pacheco Reservoir: commenters expressed concerns about impacts to the Pacheco Creek watershed and long-term operations and maintenance requirements. They also expressed concerns about inundating portions of Henry Coe State Park. The Pacheco Reservoir Alternative was previously eliminated related to the acceptability and effectiveness criteria, because it had more potential for environmental effects and the greatest costs. However, in August 2017, SCVWD submitted an application for funding for the expansion of Pacheco Reservoir under the Water Storage Investment Program (WSIP). Based on the public and non-public benefits identified from the evaluation conducted for the WSIP application and the stakeholder support for the project, SCVWD requested that Reclamation reevaluate the Pacheco Reservoir Expansion Alternative in the SLLPIP Feasibility Report and EIS/EIR.

- Algae Treatment: commenters suggested treating algae before it enters San Luis Reservoir. While pre-treatment was challenging based on the quantity of inflow, an alternative was added to analyze treatment after the water is withdrawn from San Luis Reservoir (the Treatment Alternative).

- Institutional Measures: commenters expressed concerns that the institutional measures included in the alternatives (such as water transfers and exchanges) were not reliable. These measures are no longer included in the action alternatives.

A1.1.4 Alternatives Eliminated as Part of Pre-Screening Process

As was noted above in Section A1.1.2, 26 initial alternatives were screened down to 17 in the IAIR of which 14 were screened out in the PFR. Table A-1 displays the alternatives screened in the IAIR and PFR and the reason that they were screened.

During the feasibility phase of the alternatives evaluation, the Lead Agencies reconsidered the alternatives recommended for consideration in the EIS/EIR. The PFR considered but eliminated the Treatment Alternatives; however, new treatment methods suggested during the feasibility phase resulted in this alternative being recommended for consideration in the EIS/EIR. In addition, actions taken by SCVWD outside of this feasibility study effort to complete upgrades at the Rinconada Water Treatment Plant (WTP) will improve its capacity to address low point related water quality conditions and has resulted in the narrowing of the Treatment Alternative to focus on upgrades to the Santa Teresa WTP.

Table A1-1. Alternative Screening Results

Category	IAIR Screening		PFR Screening		Feasibility Report
	Alternative	Screening Result	Alternative	Screening Result	
Institutional	Institutional Alternative	Retained	Institutional Alternative	Screened out as a standalone plan under the completeness criterion	
Source Water Quality Control	Algae Harvesting Alternative	Eliminated because it had similar benefits to algaecide and was economically infeasible when compared to algaecide			
	Algaecide Alternative	Retained	Algaecide Alternative	Screened out under the effectiveness and acceptability criteria given concerns over potential capacity to treat SLR algae and the difficulty permitting the application of algaecide on a drinking water reservoir at this scale	
	Managed Stratification Alternative	Eliminated because it had similar benefits to algaecide and was economically infeasible when compared to algaecide			
Treatment	Treatment at San Felipe Intake Alternative	Retained	Treatment at San Felipe Intake Alternative	Screened out under the acceptability criterion given SCVWD's determination that DAF treatment is not an acceptable remedy to the low point issue because evaluation during previous WTP upgrades indicated DAF is less effective and more difficult to operate than current treatment methods	
	Treatment at WTPs Alternative	Retained	Treatment at WTPs Alternative		Treatment Alternative – carried forward following further analysis of developing Raw Water Ozonation at the Santa Teresa WTP.
	Treatment at Pumping Plant Alternative	Retained	Treatment at Pumping Plant Alternative		
Conveyance	Lower San Felipe Intake Alternative	Retained	Lower San Felipe Intake Alternative	Retained	Lower San Felipe Intake
	Holladay Aqueduct Alternative	Eliminated because it had similar benefits to the Lower San Felipe Intake and Southerly Bypass Alternatives and was economically infeasible when compared to those options			
	Northerly Bypass Corridor Alternative	Eliminated because it had similar benefits to the Lower San Felipe Intake and Southerly Bypass Alternatives and was economically infeasible when compared to those options			

Table A1-1. Alternative Screening Results

Category	IAIR Screening		PFR Screening		Feasibility Report
	Alternative	Screening Result	Alternative	Screening Result	
	Southerly Bypass Corridor Alternative	Retained	Southerly Bypass Corridor Alternative	Screened out under the efficiency criterion given the alternative's economic infeasibility when compared to the Lower San Felipe Intake Alternative	
Storage	Anderson Reservoir Expansion Alternative	Retained	Anderson Reservoir Expansion Alternative	Screened out under the efficiency criterion given the alternative's economic infeasibility when compared to the Pacheco B Alternative	
	Chesbro Reservoir Expansion Alternative	Retained	Chesbro Reservoir Expansion Alternative	Screened out because additional engineering, geotechnical, geological and hydraulic analysis determined that an alternate site between the Pacheco A and Pacheco B locations was the most efficient storage site available	
	Lower Pacheco Reservoir Alternative	Retained	Lower Pacheco Reservoir Alternative		
	Pacheco A Reservoir Alternative	Retained	Pacheco A Reservoir Alternative	Retained as a single alternative with two storage capacity configurations and a final site to be determined during development of the Feasibility Report	Pacheco Reservoir Expansion Alternative
	Pacheco B Reservoir Alternative	Retained	Pacheco B Reservoir Alternative		
	San Benito Canyon Reservoir Alternative	Retained	San Benito Canyon Reservoir Alternative	Screened out because small size made reservoir less efficient than other options	
	San Luis Reservoir Expansion Alternative	Eliminated because it had similar benefits to the other storage alternatives and was economically infeasible when compared to those options			San Luis Reservoir Expansion Alternative - multiple configurations of a reservoir expansion alternative considered by analysis of the potential combination with the connected CAS action. The Central Valley Project only dedication of the expanded reservoir was selected to move forward for further evaluation.
	Del Puerto Canyon Reservoir Alternative	Retained	Del Puerto Canyon Reservoir Alternative	Screened out under the efficiency criterion given the alternative's economic infeasibility when compared to the Pacheco Alternative	
	Ingram Canyon Reservoir Alternative	Retained	Ingram Canyon Reservoir Alternative		
	Quinto Creek Reservoir Alternative	Retained	Quinto Creek Reservoir Alternative		

Table A1-1. Alternative Screening Results

Category	IAIR Screening		PFR Screening		Feasibility Report
	Alternative	Screening Result	Alternative	Screening Result	
Alternate Water Supplies	Monterey Bay Desalination Alternative	Eliminated because it was economically infeasible when compared to any of the other alternatives under consideration in the IAIR			
	San Francisco Bay Desalination Alternative	Eliminated because it was economically infeasible when compared to any of the other alternatives under consideration in the IAIR			
	Combined Desalination Alternative	Eliminated because it was economically infeasible when compared to any of the other alternatives under consideration in the IAIR			
	Enlarged SBA/Los Vaqueros Expansion Alternative	Expansion of the SBA was screened out but enlarging Los Vaqueros Reservoir was retained	Los Vaqueros Expansion Alternative	Screened out under the completeness criterion given the ongoing development of the project in the Los Vaqueros Expansion Project Feasibility Study	
	Los Vaqueros Expansion Alternative	Retained			
Combination	Combination Alternative	Retained	Combination Alternative	Retained	Eliminated related to the acceptability criterion given the identification of issues with the feasibility of the Anderson Reservoir reoperation and groundwater components.

Key:
CAS = Safety of Dams Corrective Action Study
DAF = Dissolved Air Floatation
IAIR = Initial Alternatives Information Report
PFR = Plan Formulation Report
SBA = South Bay Aqueduct
SCVWD = Santa Clara Valley Water District
SLR = San Luis Reservoir
WTP = water treatment plant

The PFR also recommended consideration of the Combination Alternative; however, detailed review of the alternative by SCVWD during development of the Feasibility Report and this EIS/EIR identified issues with the feasibility of the alternative's Anderson Reservoir reoperation component and its groundwater extraction and recharge components. These issues included concerns over the potential for future changes to operating rules for releases to Coyote Creek under the Fisheries and Aquatic Habitat Collaborative Effort Settlement Agreement between SCVWD, the Guadalupe Coyote Resource

Conservation District, and the resource agencies—California Department of Fish and Wildlife; U. S. Fish and Wildlife Service, and National Marine Fisheries Service (SCVWD 2017). These changes are anticipated with implementation of the Anderson Dam Seismic Retrofit Project currently under design (SCVWD 2017). SCVWD also determined that the operation of the groundwater extraction and recharge components of the Combination Alternative that were originally formulated by the District during development of an Infrastructure Reliability Plan, would be infeasible given issues identified with conflicts to operation of existing wells by SCVWD contractors during completion of the Infrastructure Reliability Plan (SCVWD 2017). Without these major components, the Combination Alternative would be unable to adequately address low point generated water supply interruptions (SCVWD 2017).

The IAIR considered but eliminated the Expansion of San Luis Reservoir Alternative given its higher cost and similar benefits to the other storage alternatives that were identified in the IAIR. Potential dam safety issues at Sisk Dam have been under review in a Safety of Dams Corrective Action Study (CAS) being prepared by Reclamation at the same time the SLLPIP Feasibility Study has been underway. While geologic studies and engineering design of structural alternatives to raise the dam embankment and adding abutments were underway to support development of the CAS, Reclamation completed the San Luis Reservoir Expansion Draft Appraisal Report (Reclamation 2013) that evaluated the potential water supply benefits generated by a reservoir expansion completed in coordination with the dam safety action to potentially reduce the costs of the standalone reservoir expansion alternative identified and screened in the IAIR. Results from the 2013 appraisal study indicated that inclusion of the Expansion of San Luis Reservoir Alternative in the SLLPIP Feasibility Report and EIS/EIR was warranted (Reclamation 2013).

The feasibility study considered multiple operational configurations for an expanded San Luis Reservoir. These configurations evaluated the potential water supply benefits of different dedications of the additional water stored in the reservoir – a Central Valley Project (CVP) storage only configuration, a split CVP and State Water Project (SWP) storage configuration, and a configuration that would allow CVP operators to carryover supply in this expanded space for delivery to CVP contractors in subsequent years. Table A-2 presents the results of potential water supply benefit evaluations that were completed for these optional configurations. The CVP only dedication of the expanded 120 TAF was selected to move forward for further evaluation.

Table A1-2. Changes in San Felipe Division and CVP/Municipal and Industrial Water Supply Benefits with San Luis Reservoir Expansion

Alternative[1]	Average Annual Change in San Felipe Division Municipal and Industrial Deliveries in years with Low Point Interruptions (Acre-Feet)	Average Annual Change in San Felipe Division Municipal and Industrial Deliveries in years without Low Point Interruptions (Acre-Feet)	Average Annual Change in CVP Deliveries	Average Annual Change in SWP Deliveries[2]
CVP Reservoir Expansion	200	700	16,700	-5.600
Shared CVP and SWP Reservoir Expansion	100	370	8,400	1,200
Increased San Luis Reservoir Carryover Storage	700	>100	10,300	0

Notes:

[1] All reservoir expansion configurations considered 120,000 acre-feet of additional storage capacity in San Luis Reservoir consistent with the 10 foot embankment raise under consideration in the feasibility study.

[2] Includes changes in SWP Table, Article 21 and Article 56 deliveries

A1.2 References

Santa Clara Valley Water District (SCVWD). 2017. San Luis Low Point EIR/EIS, Screening of Combination Alternative from Further Evaluation. Letter from Melih Ozbilgin, SCVWD to Nicole Johnson, Reclamation. April 21, 2017.

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U.S. Water Resources Council. 1983. *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies.* Accessed on: 11/06/2012. Available at: http://planning.usace.army.mil/toolbox/library/Guidance/Principles_Guidelines.pdf.

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San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix A2: Project Description

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Appendix A2
Project Description

This section summarizes the alternatives development process for the San Luis Low Point Improvement Project (SLLPIP) and describes the alternatives analyzed in this Environmental Impact Statement/Environmental Impact Report (EIS/EIR).

A2.1 Project Alternatives

The following sections describe the alternatives that are evaluated in this EIS/EIR, including the No Action/No Project Alternative and three action alternatives.

A2.1.1 Alternative 1 - No Action/No Project Alternative

A2.1.1.1 NEPA/CEQA

Both National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) require the evaluation of a No Action or No Project Alternative, which presents the reasonably foreseeable future conditions in the absence of the proposed project. The purpose of the No Action or No Project Alternative is to allow decision makers to compare the impacts of approving the project to the impacts of not approving the project. Under NEPA, the No Action Alternative also serves as the baseline to which action alternatives are compared to determine potential impacts. This differs from CEQA, where existing conditions serve as the baseline to determine potential impacts of the alternatives. The No Action/No Project Alternative may differ from the Affected Environment/Existing Conditions if there are actions that could occur in the project area in the future, that 1) currently do not exist and 2) do not rely on approval or implementation of the proposed project. However, because substantive changes in the area of analysis are not expected, the No Action Alternative would be the same as existing conditions/No Project Alternative. The No Action/No Project Alternative reflects, for most resources evaluated in this EIS/EIR, existing and expected future conditions in the project area if no action is taken.

A2.1.1.2 San Luis Reservoir Operations

The No Action/No Project Alternative would leave the current operations at San Luis Reservoir unchanged. Santa Clara Valley Water District (SCVWD) would

continue annual operations planning to anticipate curtailment of Central Valley Project (CVP) supply, and would manage its uses and sources of imported and local water supplies.

SCVWD seeks a stable supply of CVP surface water as a part of its larger water supply portfolio that includes imported surface water supplies from the CVP and State Water Project (SWP), local groundwater, and local surface water supplies. Low point supply interruptions reduce the reliability of SCVWD's CVP supply, which could jeopardize the short and long term reliability of other supplies intended for other uses. For instance, groundwater normally reserved for drought or emergency use may be relied upon during a low point event. A low point supply interruption—and even the threat of an interruption—can result in the immediate reduction of the amount of treated water available for delivery by SCVWD's customers, because it requires the re-operation of SCVWD's surface and groundwater systems and requires the use of alternative water supplies that would otherwise be dedicated to other uses. The effects resulting from delivery reductions and/or curtailments due to a low point would continue to pose a significant threat to the customer's short and long term water supply reliability.

Under this alternative, water supply modeling results have predicted that there would be 17 years (out of the 82 modeled years)[1] where the San Luis Reservoir would be drawn below 300 thousand acre-feet (TAF) of storage, i.e. low point years.

A2.1.1.3 Pacheco Reservoir Operations

The No Action/No Project Alternative would leave the current operations at Pacheco Reservoir unchanged. North Fork Dam is currently under restricted-operation criteria through an April 5, 2017 order of the California Department of Water Resources (DWR) Division of Safety of Dams (DSOD) due to existing spillway deficiencies. The Pacheco Pass Water District (PPWD) is coordinating with Federal Emergency Management Agency (FEMA) and DSOD on short-term and long-term repairs. The DSOD has stated that if satisfactory progress is not made to address spillway deficiencies, additional remedies would be invoked, inclusive of revocation of the PPWD's Certificate of Approval to store water. If such certification is revoked, the lake would be drained and the Dam's outlet structures would be left open, a step that would reduce, among other things, existing fisheries habitat. For the purpose of this EIS/EIR, in order to eliminate the risk of overestimating benefits, it is assumed that the existing reservoir is operated at full operational capacity and consistent with recommendations in the *2014 Report on Comprehensive Strategy and Instructions for Operation of Pacheco Reservoir* (i.e., optimized operations for steelhead habitat).

[1] Appendix B presents in detail the assumptions and methods used by the CalSim II model to estimate effects from the No Action/No Project and action alternatives

A2.1.2 Alternative 2 - Lower San Felipe Intake Alternative

The Lower San Felipe Intake Alternative includes construction of a new, lower San Felipe Intake to allow reservoir drawdown to its minimum operating level without algae reaching the San Felipe Intake. Moving the San Felipe Intake to an elevation equal to that of the Gianelli Intake would allow operation of San Luis Reservoir below the 300 TAF level without creating the potential for a water supply interruption to SCVWD.

As part of this alternative, a new intake (see Figure A2-1 for a schematic) would be constructed and connected to the existing San Felipe Division Intake via approximately 20,000 feet of new pipeline or tunnel. The top of the Lower San Felipe Intake is currently at elevation 334 feet and the bottom of the intake is at 313 feet. Algae-laden water can reach the intake when reservoir levels reach approximately 369 feet (approximately 300 TAF in storage). Because the Gianelli Intake Facility is at elevation 296 feet (approximately 30 feet lower than the minimum operating pool), algae-laden water does not typically reach the Gianelli Intake. The new intake in this alternative would be at elevation 296 feet, the same elevation as the Gianelli Intake. The lower intake facility would allow the San Felipe Division to receive water from the lower reservoir levels that do not contain high concentrations of algae. A hypolimnetic aeration facility would also be constructed to increase dissolved oxygen levels in lower reservoir levels to prevent taste and odor issues.

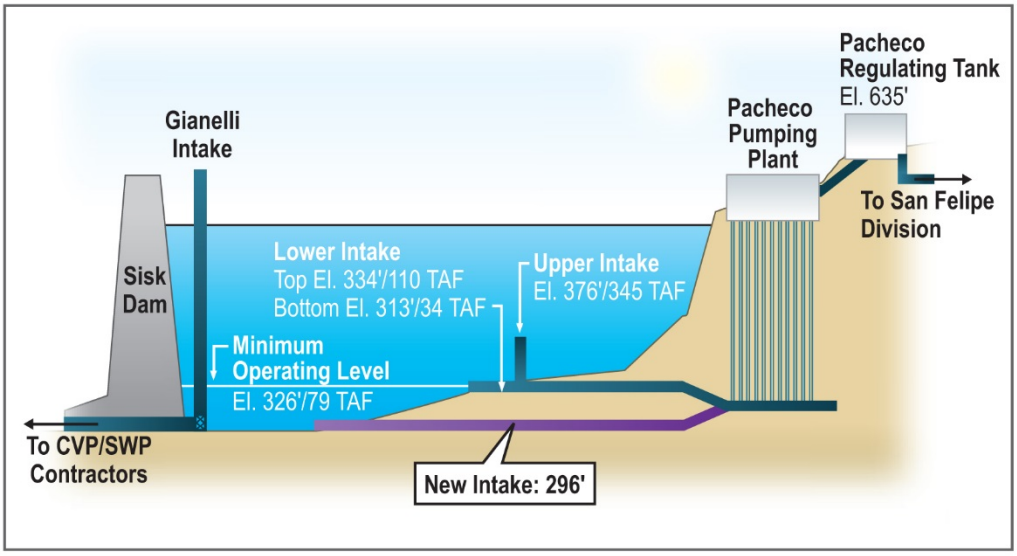


Figure A2-1. Lower San Felipe Intake Alternative

A2.1.2.1 Project Facilities

The facilities for the Lower San Felipe Intake Alternative include:

- New intake structure
- Extended intake conveyance, either a tunnel or underwater pipeline
- Connection to existing intake
- Aeration system
- Site access improvements
- Improved site utilities

Figure A2-2 shows the locations of existing and proposed facilities at San Luis Reservoir under this alternative. Table A2-1 summarizes key features of the project facilities. Modifications to the existing Pacheco Pumping plant are not expected.

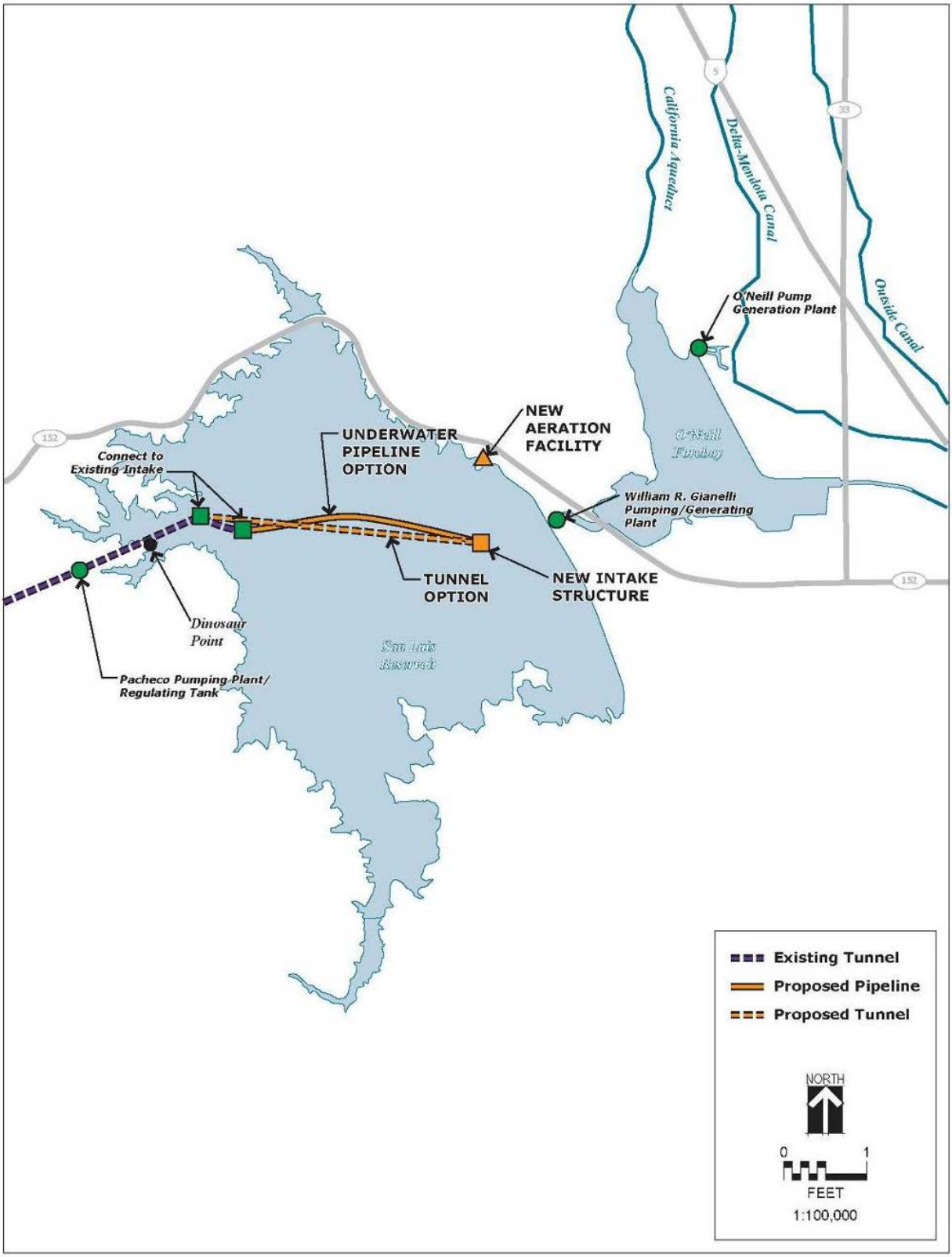


Figure A2-2. Pipeline and Tunnel Alignment for the Lower San Felipe Intake Alternative

Table A2-1. Lower San Felipe Intake Alternative – Key Design and Project Facilities Information

Parameter	Specification[1]
System Information	
Conveyance Capacity	490 cfs
Pacheco Pump Station Static Lift	80 to 310 feet [2,3]
San Luis Reservoir Minimum Operating Elevation	326 feet (79 TAF minimum pool elevation)
Connection to Existing Intake	
Tunnel option	
New vertical shaft	On Gate Shaft Island
Elevation	250 feet [3]
Diameter	35 to 40 feet
Pipeline Option	
Connection to Existing Intake	At existing lower intake at invert 313 feet
Intake Extension (Pipeline or Tunnel Option)	
Inner Diameter	13 feet
Length	20,000 feet
Head Loss	6 feet
New Intake Structure	
Elevation (top of structure)	296 feet [3]
Other Facilities	
Hypolimnetic Aeration	

[1] cfs = cubic feet per second; TAF = thousand acre-feet
[2] Unchanged from existing conditions
[3] feet above mean sea level

A2.1.2.1.1 New Intake Structure

The new intake structure would allow water to be drawn from an elevation of 296 feet to continue deliveries to the San Felipe Division during a low point event. The intake structure would consist of a vertical steel riser pipe, with a trash rack at the intake opening similar to the two existing intake structures. The conduit invert elevation at the new intake would be approximately 250 feet for the tunnel option and 280 feet for the pipeline option.

The existing upper and lower intakes would still be functional after the new conduit and lower intake are operational; however, valves or other means of isolation would be installed such that the existing intake structures could be isolated from service prior to low point events.

A2.1.2.1.2 Intake Extension

Lowering the San Felipe Intake would require an extension of the intake for the Pacheco Pumping Plant because the reservoir is higher on the west side than at the site of the Gianelli Intake. The conveyance structure from the new intake to the existing intake would be either a submerged pipeline along the bottom of the reservoir or a tunnel beneath the bottom of the reservoir.

Tunnel Option

A tunnel would be constructed beneath the reservoir floor to convey water from the new intake to the existing intake. The tunnel option includes a new vertical shaft on Gate Shaft Island to tie into the existing intake and serve as a beginning point to launch the tunnel boring equipment. The tunnel would be about 20,000 feet long, 15 feet in diameter, and the liner would have an inner diameter of 13 feet. Figure A2-3 shows the tunnel profile.

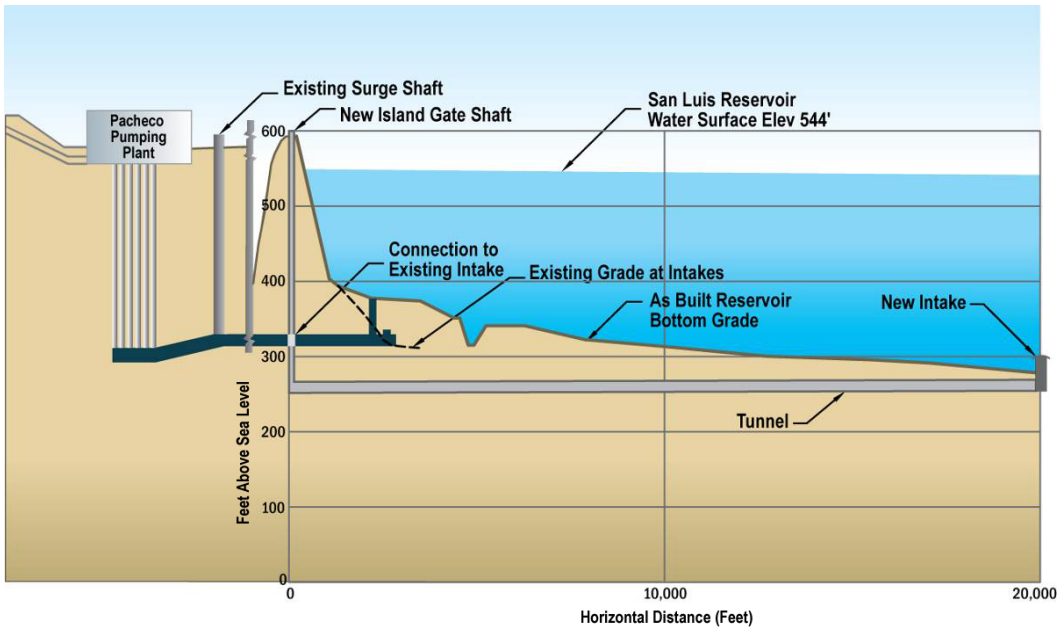


Figure A2-3. Lower San Felipe Intake Alternative Tunnel Profile

Pipeline Option

For the pipeline option, a new 13 foot diameter reinforced concrete cylinder pipe would be laid along the bottom of San Luis Reservoir. The pipeline would be about 20,000 feet. The pipe would have a constant slope upward from the new intake and tie into the invert of the existing lower intake at elevation 313 feet. An existing intake channel is graded along the bottom of the reservoir. To reduce the amount of dredging required, the pipeline's alignment would match the alignment of the existing intake channel. Figure A2-4 shows the pipeline profile.

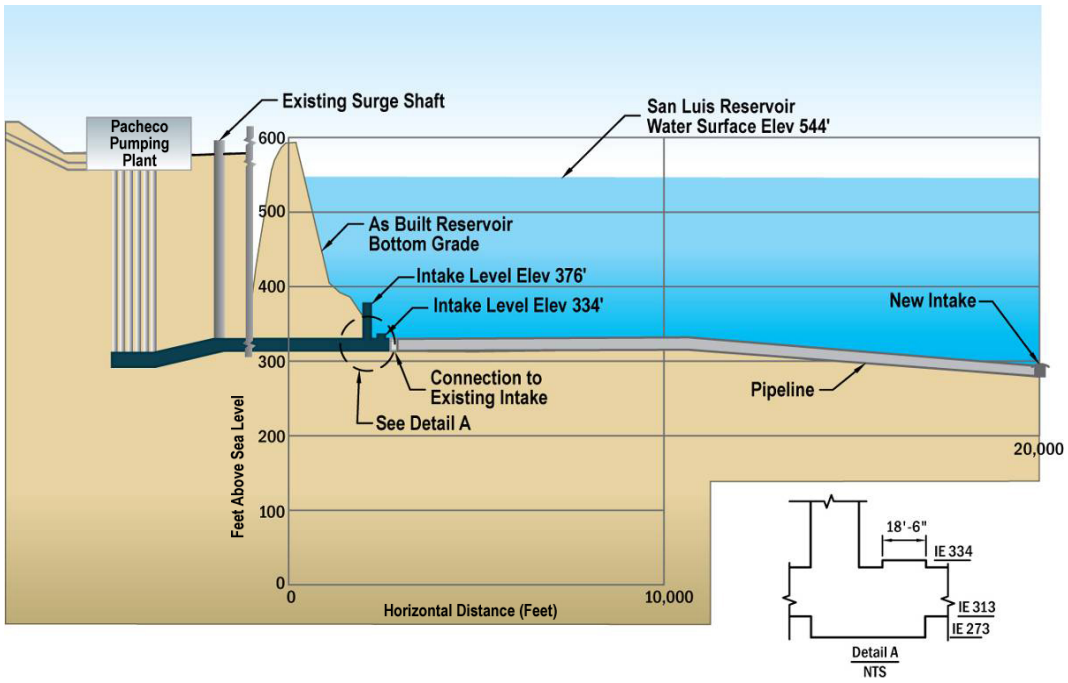


Figure A2-4. Lower San Felipe Intake Alternative Pipeline Profile

A2.1.2.1.3 Connection to Existing Intake

The new intake pipeline or tunnel would connect to the existing intake, either at Gate Shaft Island for the tunnel option, or at the existing lower intake for the pipeline option. Gate Shaft Island is a 4 acre area approximately 2,050 feet from the existing lower intake. The San Felipe Division would likely experience a service interruption during the tie-in work.

Tunnel

The tunnel option would require a new vertical shaft on Gate Shaft Island for the tunneling equipment; this new shaft would connect to the existing intake shaft by a short connection structure constructed between the two shafts. The wall of the existing shaft would need to be penetrated in order to complete the connection. The new vertical shaft on the island would be 35-40 feet in diameter and approximately 330 feet deep.

Pipeline

The pipeline option would require a temporary coffer dam-style structure be constructed to allow for connection of the new pipeline to the existing intake. The coffer dam structure would be approximately 35 feet in diameter.

A2.1.2.1.4 Hypolimnetic Aeration System

During periods of low water levels and warm weather, water within the reservoir can stratify, resulting in a hypolimnion layer at the elevation of the proposed new lower intake. The reduced level of dissolved oxygen in the

hypolimnion could potentially lead to taste and odor issues in the water drawn from this layer. A new aeration system would be constructed to oxygenate the reservoir and prevent stratification. The aeration system would consist of a new facility near Romero Visitor Center (shown on Figure A2-2). A liquid oxygen tank and vaporizers or a compressed air system are being considered for the aeration facility. Either system would be placed in a structure with an approximate footprint of 1,200 square feet. A 3 inch air supply line would connect to approximately 6,000 feet of submerged high-density polyethylene air diffuser piping within the reservoir.

A2.1.2.1.5 Site Access Improvements

Improved road access from State Route (SR) 152 to the Dinosaur Point and Basalt staging areas may be needed to accommodate the high volume of trucks and other heavy equipment anticipated during construction. Road reinforcement would be necessary at the intersections of SR 152 and the access roads to Dinosaur Point and Basalt use areas. Also, temporary paved roads would be constructed for truck transportation of materials between stockpiling areas and the launching area at the reservoir. Existing recreation boat launching ramps may be used for construction activities; however, if the ramps are unsuitable, a temporary ramp would be constructed for moving equipment and materials into the reservoir.

A2.1.2.1.6 Site Utilities

Temporary power facilities would be needed for construction equipment, welding and trailers at the Dinosaur Point boat launch area. Power would be provided by portable generators.

A2.1.2.2 Construction Methods

A2.1.2.2.1 Intake Structure

The new intake structure would be constructed on shore in 10 foot segments. The segments would be transported to the permanent intake location on a barge, and then lowered into the reservoir using a crane. Intake segments would be stacked on top of each other to achieve the full intake height, and welded by divers to join and seal the segments.

Tunnel Option

For the tunnel option, the intake structure would be approximately 46 feet long and 54 feet tall, spanning from the intake elevation of 296 feet to the bottom of the tunnel at 250 feet.

The material volume generated by excavation via barge mounted dredge for the intake structure under would be approximately 49,000 cubic yards. This material would be transported via barge for disposal at Dinosaur Point.

Pipeline Option
The intake structure would be shorter for the underwater pipeline option than the tunnel option since it would only need to span between the intake elevation of 296 feet to the bottom of the reservoir at approximately 280 feet. The final connection to the underwater pipeline would be made by divers.

Dredges would be used to modify the existing intake channel which would serve as a trench for the underwater pipeline. Minimal dredging is expected, since the existing channel is at an approximate elevation of 313 feet. Approximately 9,000 cubic yards of spoils would be generated by the pipeline option. This material would be disposed of by distribution along the bottom of the reservoir.

A2.1.2.2.2 Intake Extension
Tunnel Construction Based on the anticipated alluvial and the potential for Pacheco formation soil materials, and the need to tunnel beneath the groundwater level, the tunnel would be constructed using an Earth Pressure Balance Tunnel Boring Machine (TBM). The TBM would be transported to Gate Shaft Island via a barge and lowered into the access shaft with a crane. Material would be excavated at the front of the TBM and a precast concrete lining would be installed behind the cutting head of the TBM. The lining would function as initial support as well as the permanent liner. This method is known as the one-pass system. No intermediate tunnel access shafts would be possible because work would be conducted below the bottom of the reservoir. Therefore, all TBM repairs and cutter replacement procedures would need to be performed from within the tunnel. Dewatering and blasting during construction would not be necessary. Hazardous materials are not expected to be encountered.

The tunnel option would require that the TBM be removed at the proposed lower intake location within the reservoir. This action would be completed in summer months when seasonal storage at San Luis Reservoir is at its lowest. A temporary coffer dam-style structure would be constructed within the reservoir around the new tunnel outlet to allow for removal of the TBM, and aiding in the tunnel connection to the new intake structure. The temporary coffer dam structure would be larger than the new intake structure, and would isolate the new intake while the tunnel connection is made. Alternatively, the TBM could be stripped of any fuels, oils, and salvageable components and abandoned in place, and the intake structure connection could be made by divers.

Pipeline Construction
Dredges would be used to modify the existing intake channel which would serve as a trench for the underwater pipeline. Minimal dredging is expected, since the existing channel is at an approximate elevation of 313 feet. Pipe segments of 50 foot lengths would be transported by tug boats from the staging area to a barge, then lowered into the reservoir with a crane. Connection of pipe segments would be made by divers. Pipeline installation would occur in water

up to 265 feet deep in some areas, which would require professional divers with specialized technical deep dive certifications and deep water equipment. The availability of qualified divers in the project vicinity may be limited. The use of divers could be reduced if construction occurs during a period where the reservoir is low because of a drought cycle. However, construction would not cause any changes to the CVP or SWP operations in the reservoir. To prevent any pipeline shifting or buoyancy issues, it would be anchored with precast concrete saddles. Spacing and sizing would be determined during future design tasks.

A2.1.2.2.3 Access Shaft and Coffer Dams

Construction of a new permanent access shaft on Gate Shaft Island would only be necessary for the tunnel option. Construction of temporary coffer dam structures is anticipated for both the tunnel and pipeline options in order to complete intake connections within the reservoir.

Tunnel Option

For the tunnel option, a permanent shaft would be assembled at Gate Shaft Island to function as a launch point for the TBM. To control groundwater conditions and improve subsurface working conditions during excavation of the shaft, ground freezing would be utilized during excavation. A temporary coffer dam-style structure would be constructed within the reservoir for removing the TBM, and aiding in the tunnel connection to the new intake structure.

Pipeline Option

For the pipeline option, a temporary coffer dam-style structure would be constructed around the existing lower intake structure to allow for connection of the new intake pipeline. Depending on the reservoir water level, either the upper intake or both intakes would need to be isolated. Steel segments would be used to create the coffer dam to isolate the work area around the existing intake structure. The coffer dam would be removed after the tie-in is complete.

A2.1.2.3 Equipment, Materials, Spoils and Safety

Equipment in the staging areas would include trailers, equipment to be used, and stockpiled materials. Construction staging and stockpile areas would include:

- Dinosaur Point Use Area for both the tunnel and pipeline options. Dinosaur Point Use Area consists of 10 acres.
- Basalt Use Area for the new intake structure construction. Basalt Use Area consists of 10 acres.
- Area south of Gianelli Pumping Plant off of Gonzaga Road, for the transporting materials to the new intake location. The area proposed for use consists of 5 acres.

The main staging area access route would be SR 152 to Dinosaur Point Road. Most of the traffic to the site would come from the east. Construction related traffic would likely begin 1 to 2 months after Notice to Proceed. Approximately 6 to 12 large deliveries per day could be expected, the transport and disposal of approximately 1,200 cubic yards of material to local landfills, along with the regular commuting of construction personnel.

Aside from areas dedicated to construction staging and transportation, all remaining available space at Dinosaur Point and Basalt use areas would be needed for stockpiling materials and recreational use of these areas would be closed for the full construction duration. Dinosaur Point would be used as a staging area of the full duration of construction. This area would be returned to pre-construction condition after the project is completed. Materials stored include precast pipe or concrete tunnel lining segments, and pipeline concrete cap anchors.

The closest concrete batch plants are located in Los Banos, approximately 30 to 40 minutes driving time from reservoir access locations. Materials from local batch plants would be used for road improvement work and construction of the new intake structure. It is assumed that an on-site concrete batch plant would not be needed.

Procurement and delivery of the barges and cranes required is expected to be some of the more difficult aspect of construction mobilization.

Since San Luis Reservoir is a drinking water source and specialized construction methods would be utilized for installation of the new intake and conduit, the following special safety measures would be implemented during construction within the reservoir:

- Use of food grade oil for equipment lubricants,
- Installation of turbidity curtains surrounding existing intakes, if operational,
- Certified professional divers (for the pipeline option).

A2.1.2.3.1 Tunnel Option

Equipment used in the reservoir for the tunnel option would include:

- Tunnel boring machine
- Barge
- 1-2 Boats
- Cranes (2 large, 2 small)
- 2 Large excavators
- 2-3 Chiller plants
- Drill rig

- 1-2 Bulldozers
- 1-2 Loaders
- Scraper
- 2 Dump trucks
- 1-2 Water trucks

Between 163,000 and 184,000 cubic yards of excavated material would be generated by the tunneling option. This quantity accounts for the expansion of excavated materials, and an increase due to soil conditioners used by a TBM. Excavated materials would be disposed of at Dinosaur Point and used to increase the boat ramp area. The material would be spread over 100-115 acres and would result in a 1 foot increase in grade.

A2.1.2.3.2 Pipeline Option

For the pipeline option, anticipated equipment would include:

- Barge
- 3-4 Boats
- Dredging barge or boat
- 2 Small cranes
- Bulldozer
- Loader
- Dump truck
- Water truck

A2.1.2.4 Construction Schedule

Figure A2-5 shows the project schedule for the tunnel and pipeline options. It is assumed for the purpose of this EIS/EIR, that construction would start in 2020. Recreational activities within the reservoir and at the Dinosaur Point and Basalt use areas would be suspended for safety reasons during period of tunnel or pipeline construction. Service would be interrupted temporarily when the new facilities are tied-in to the existing intake and tunnel system.

A2.1.2.4.1 Tunnel Option Schedule

Construction is expected to last approximately 47 months. The construction duration is based on 30-50 total anticipated workers on site, 12 of which would be working within the tunnel. Work would be performed 24 hours per day, 7 days a week.

A2.1.2.4.2 Pipeline Option Schedule

Construction would last 33 months, and would focus on installing as much of the pipeline as possible during low water periods. Twenty workers are estimated to be on site for construction. Work would be performed for 10 hours per day, from 7:00 a.m. to 5:00 p.m., 5 days a week.

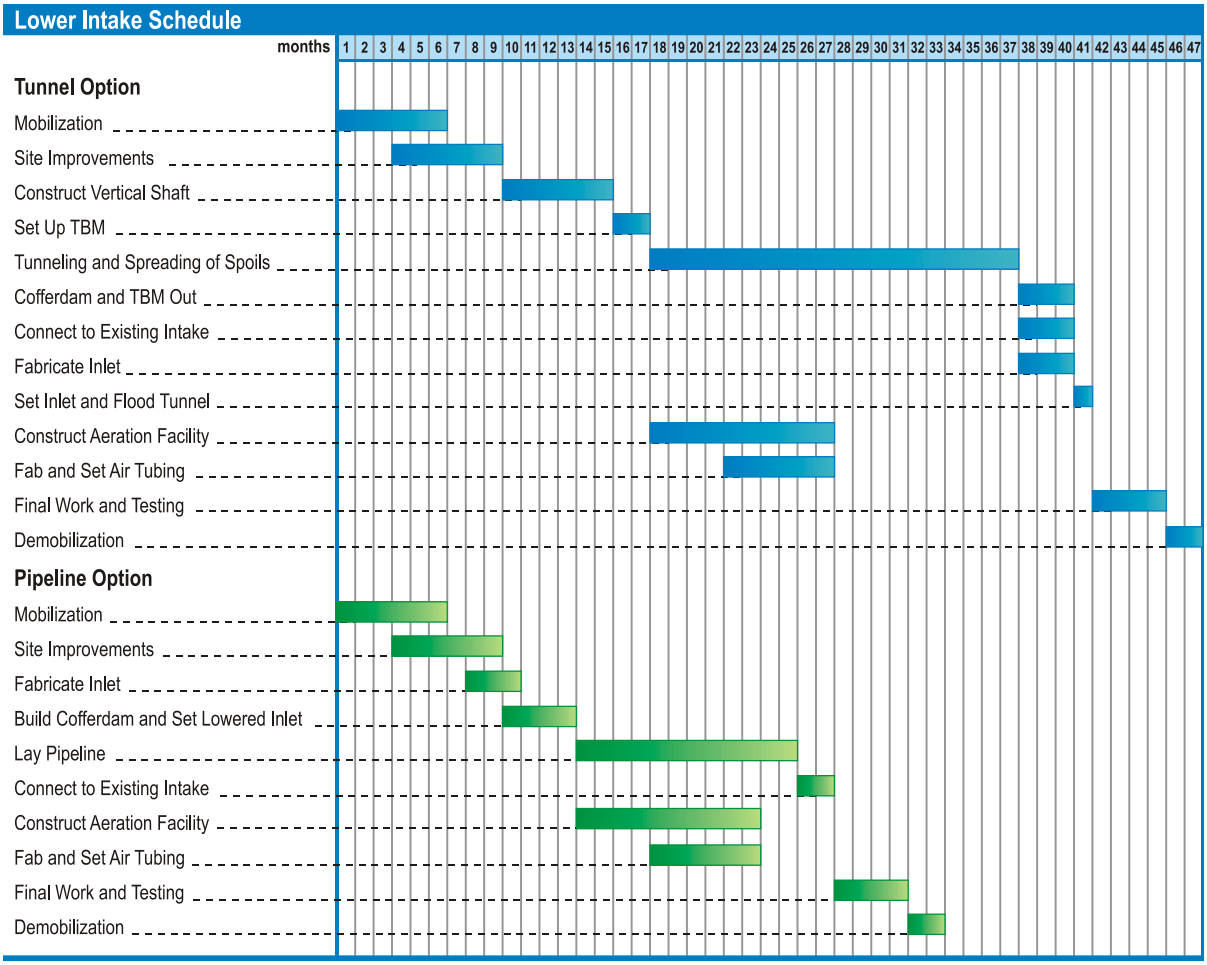


Figure A2-5. Lower Intake Schedule

A2.1.2.5 Operation of the Lower San Felipe Intake Alternative

The Lower San Felipe Intake Alternative would allow the San Felipe Division to draw water from San Luis Reservoir at the same elevation as the Gianelli Intake, which serves other CVP South-of-Delta contractors. This new lower intake would allow reservoir drawdown to its minimum operating level without algae reaching the San Felipe Intake.

Installation of the new lower intake structure at elevation 296 feet, and accounting for the same 35 foot deep algae growth layer at the surface of the reservoir, would allow a new low water elevation for the reservoir of 331 feet.

This elevation also coincides with the maximum potential drawdown elevation currently supported by the pumps at the Pacheco Pumping Plant. The minimum drawdown elevation allowed by the existing vertical pumps and intake shafts (325 feet) plus the anticipated head loss through the new 20,000 foot long intake tunnel or pipeline (anticipated to be approximately 6 feet) also allows a minimum low water elevation of 331 feet.

The Lower Intake Alternative would provide approximately 1,400 acre-feet (AF) of additional south of Delta CVP and SWP Table A supply and on an average annual basis compared to No Action. Figure A2-6 shows how the Lower Intake Alternative addresses SCVWD low point water supply interruptions along with treated water demand shortages in the No Action Alternative. Results show that the Lower Intake Alternative would allow uninterrupted delivery of SCVWD CVP municipal and industrial (M&I) deliveries in all low point years and would be able to fully replace SCVWD's unmet treated water demand in 10 of the 17 low point years. By allowing the delivery of imported CVP supply during low point periods, SCVWD would need to rely less heavily on locally stored surface and groundwater supplies.

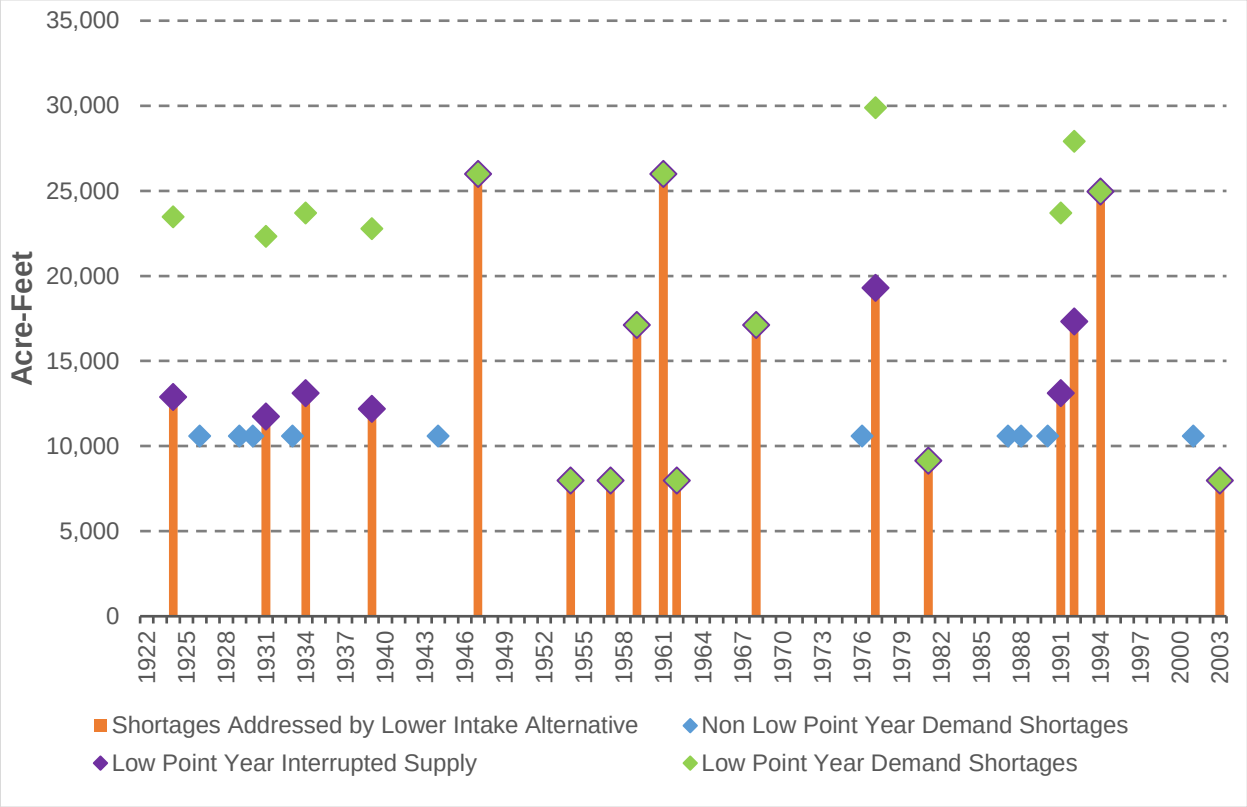


Figure A2-6. Annual Shortages Addressed by the Lower San Felipe Intake Alternative

A2.1.3 Alternative 3 - Treatment Alternative

The SLLPIP Feasibility Report identifies the Treatment Alternative as the Preliminary Proposed Alternative Plan. The Treatment Alternative would develop new technology retrofits at the SCVWD's Santa Teresa WTP. This WTP is supplied with water from San Luis Reservoir, which during low point conditions can contain high concentrations of algae.

The Treatment Alternative would develop new treatment technology at the SCVWD WTP to address some of the negative impacts associated with increased algae during low point events. The proposed improvements evaluated under this alternative would include adding a raw water ozonation process to the Santa Teresa WTP. This would result in the following treatment train (new processes are underlined): raw water ozonation, chemical coagulation, conventional clarification, settled water ozonation, granular media filtration with a granular activated carbon (GAC)/sand media configuration, and disinfection.

A2.1.3.1 Project Facilities

As noted above the Treatment Alternative would install new treatment technology retrofits at the Santa Teresa WTP to improve the WTP's ability to treat water from San Luis Reservoir during low point conditions. This section outlines the existing treatment facilities at the WTP and the new facilities that would be developed under this alternative.

The existing Santa Teresa WTP treatment process includes chemical coagulation, conventional clarification, settled water ozonation, granular media filtration, and disinfection.

Chemical coagulation includes the addition of alum, a cationic polymer, and the ability to add chlorine or chloramines as a pre-oxidant. The conventional clarification process includes pump water injection for rapid mixing, 3-stage tapered mixing for flocculation, and rectangular basins for gravity sedimentation. The sedimentation basins utilize chain and flight mechanisms to remove settled solids. Ozonation includes liquid oxygen, ozone generators and 8-cell ozone contactor structures to provide a maximum ozone dose of 2 milligrams per liter (mg/L). Hydrogen peroxide can be dosed at concentrations up to 1.5 mg/L to improve oxidation of taste and odor causing compounds. Filtration includes 12 granular media filters with 48 inches of GAC over 10 inches of sand. The filters operate at loading rates of 6.0 to 7.2 gallons per minute/square foot and are cleaned using both an air and water backwash. Disinfection includes free chlorine contact time and chloramine formation for disinfectant residual.

Solids handling facilities include washwater recovery basins and sludge drying beds. The recovered washwater is returned to the headworks of the plant. The recovered decant water from the sludge drying beds is returned to the washwater recovery basins, and the dried sludge is disposed of in a landfill.

The Treatment Alternative would add a raw water ozonation process to the treatment train at the Santa Teresa WTP. A site plan of the Santa Teresa WTP with the raw water ozonation process is shown in Figure A2-7. Raw water ozonation is described in further detail in the section below.

A2.1.3.1.1 Raw Water Ozonation

In a raw water ozonation process, ozone is added to the raw water entering the treatment plant before the water is treated by any other processes. Ozone oxidizes taste and odor causing compounds and other dissolved organic material released by algae. Ozone also improves clarification and filtration processes when used as a pre-oxidant. Implementation of a raw water ozonation process at the Santa Teresa WTP would require installation of a new ozone contactor, new ozone generation equipment housed in a new building, and new liquid oxygen storage facilities. The proposed location of these facilities are shown in Figure A2-7. New chemical storage and dosing facilities may be required to support the raw water ozonation process.

A2.1.3.2 Construction Methods

Construction of the Treatment Alternative retrofits at the SCVWD WTP would be completed in compliance with existing SCVWD design standards.

Replacement of the ozone generation equipment at the Santa Teresa WTP would require a plant shutdown. According to SCVWD staff, the plant can be shut down for up to 4 months. So, this work would need to be completed in a 4-month period. A plant shutdown would also be required for relocation of the existing duct bank. It is estimated that this work can be completed in a 1-month period.

All other structures, equipment, and piping can be installed with the plant in operation. However, tie-in of all new piping, electrical feeders, and instrumentation and control system feeders would need to take place during the 4-month shutdown period described previously. Installation of the new equipment adjacent to existing facilities in operation would need to be closely coordinated with plant operations for safety purposes.

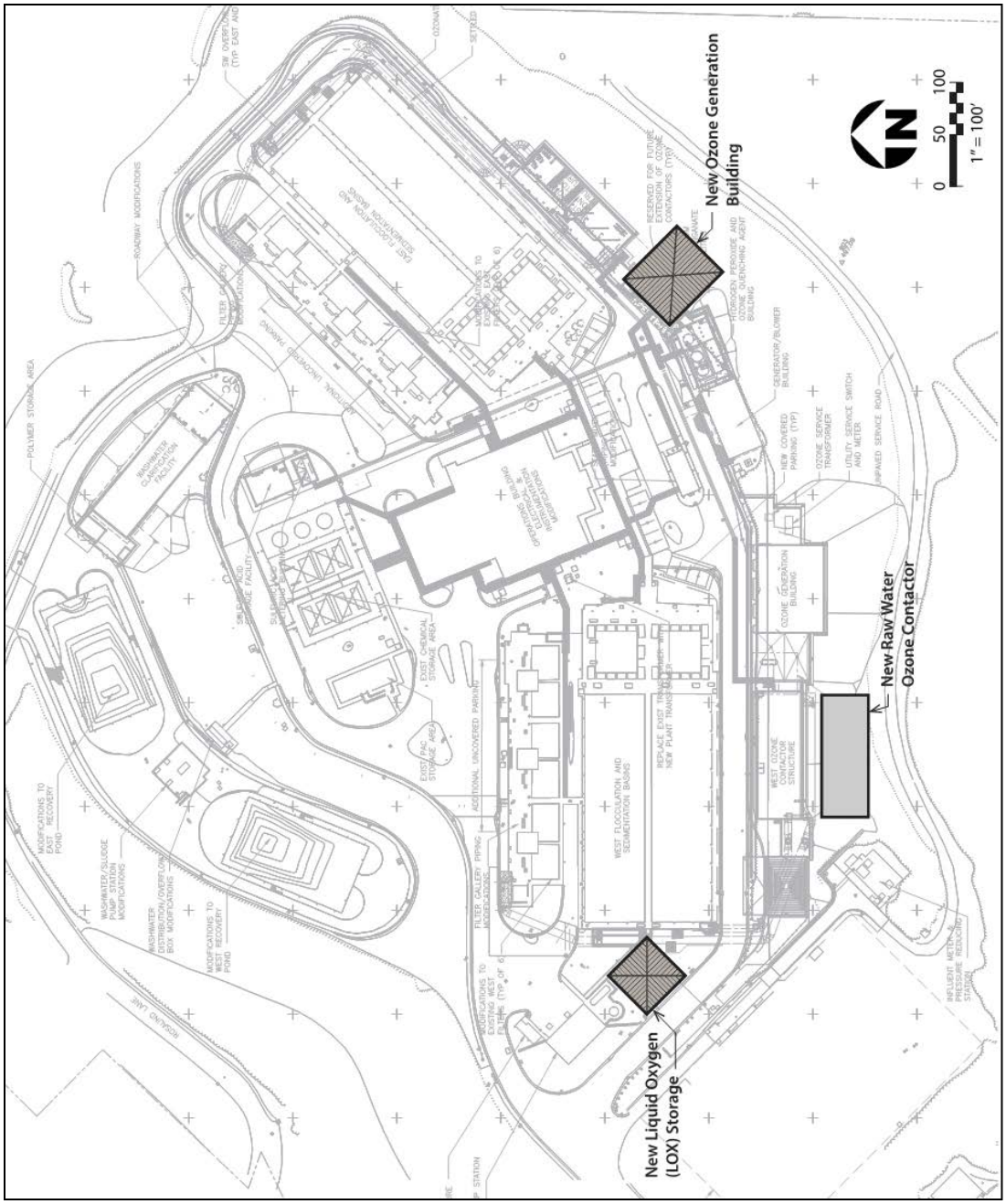


Figure A2-7. Santa Teresa WTP Conceptual Site Plan – Raw Water Ozonation

A2.1.3.3 Equipment and Staging

Equipment in the staging areas would include trailers and equipment to be used. Construction staging areas would be set up during the period of construction. It is anticipated that construction staging areas would be established at the WTP. The staging areas would be located on site and would not encroach on neighboring parcels. Construction equipment would include cranes, excavators, bulldozers, loaders, backhoes, ready mix concrete trucks, concrete pumpers, dump trucks, water trucks, flatbed trucks, and gravel, air compressors, concrete saw cutters, demolition equipment, and portable diesel generators. The Treatment Alternative would also require the transport and disposal of approximately 7,000 cubic yards of material at local landfills.

A2.1.3.4 Treatment Alternative Construction Schedule

Construction work would be performed for 10 hours per day from 7:00 a.m. to 5:00 p.m., 5 days a week. The construction, testing and startup of the Treatment Alternative is anticipated to be approximately 3 years. It is assumed for the purpose of this EIS/EIR, that construction would start in 2020.

A2.1.3.5 Operation of the Treatment Alternative

The Treatment Alternative would leave current SCVWD operations largely unchanged with the exception of periods with low point conditions in San Luis Reservoir (typically August and September) when SCVWD operators would be able to continue to take delivery of water supply from the reservoir while maintaining WTP performance.

The Treatment Alternative would provide additional water supply to meet SCVWD treated water demands when compared to the No Action Alternative by avoiding low point generated water supply interruptions. The additional water supply provided under the Treatment Alternative would be the same as the Lower Intake Alternative as both alternatives allow SCVWD to receive its full allocation of water stored in San Luis Reservoir. Figure A2-8 shows how the Treatment Alternative addresses SCVWD low point water supply interruptions along with treated water demand shortages in the No Action Alternative. Results show that the Treatment Alternative would allow uninterrupted delivery of SCVWD CVP M&I deliveries in all low point years and fully replace unmet treated water demand in 10 of the 17 low point years. By allowing the delivery of imported CVP supply during these low point periods, SCVWD would need to rely less heavily on locally stored surface and groundwater supplies. By allowing the delivery of imported CVP supply during low point periods, SCVWD would need to rely less heavily on locally stored surface and groundwater supplies.

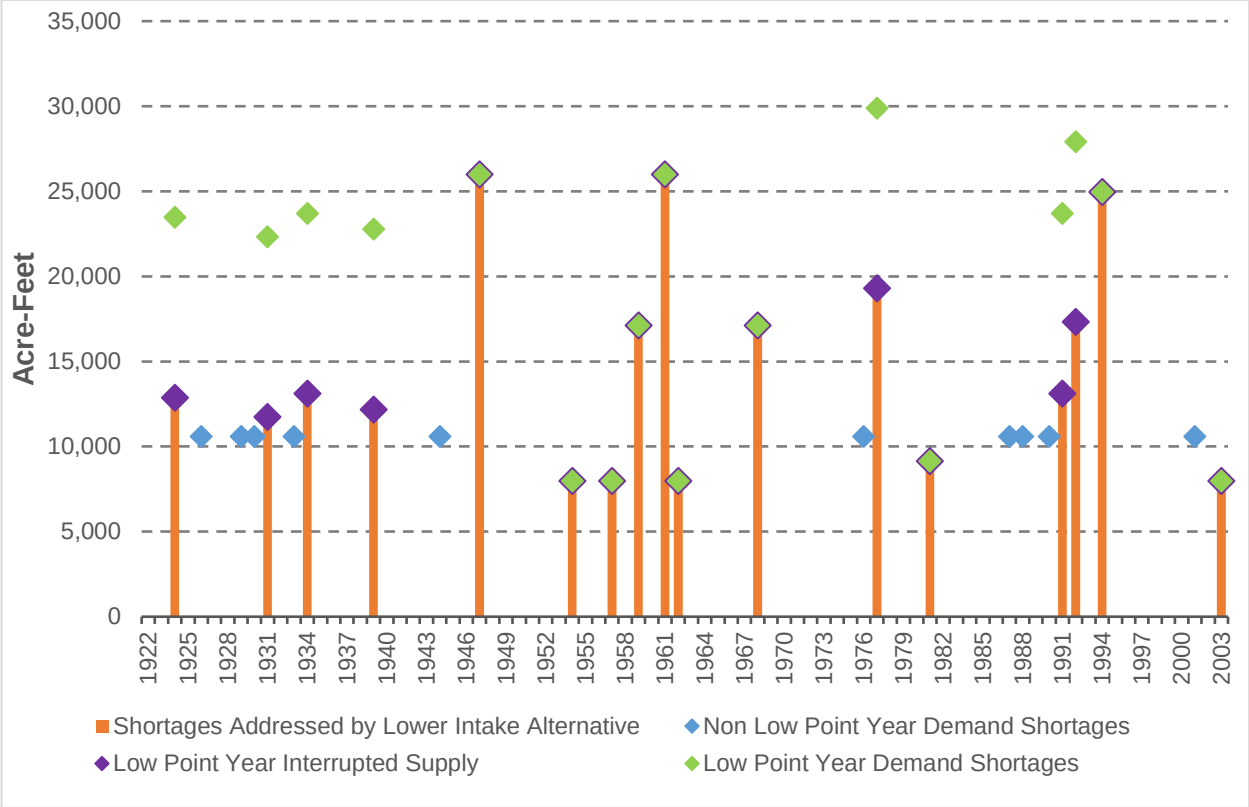


Figure A2-8. Annual Shortages addressed by the Treatment Alternative

A2.1.4 Alternative 4 - San Luis Reservoir Expansion Alternative

The San Luis Reservoir Expansion Alternative would be completed by placing additional fill material on the dam embankment to raise the dam crest to increase storage capacity. The alternative would build upon the dam embankment expansion and foundation modifications to address the seismic concerns that are currently in final design. The seismic modifications to B.F. Sisk Dam currently under Reclamation's Safety of Dams (SOD) Act, as amended, that the San Luis Reservoir Expansion Alternative would build on are included in this alternative as connected actions as defined under NEPA. The San Luis Reservoir Expansion Alternative would allocate the increased capacity to the CVP only. This expanded capacity would be operated in the same way as the current CVP portion of San Luis Reservoir, with the reservoir used for seasonal storage.

Increasing storage capacity in San Luis Reservoir would potentially increase the yield of the CVP in years that surplus supplies in excess of the reservoir's existing storage capacity are available. This increased yield could increase SCVWD's capacity to access their CVP supply prior to the reservoir being drawn below the 300 TAF level and allow the District to avoid the potential for a water supply interruption from low point conditions.

As part of this alternative, the dam crest would be raised by adding additional embankment material (see Figure A2-9 and Figure A2-10), and downstream stability berms and crack filters would be installed. Construction of foundation shear keys at slopewash sections in the abutments and the north valley section (NVS), and a filter around the downstream portion of the existing spillway conduit are also included in this alternative. The existing saddle dike located north of the main embankment would be modified by adding a downstream filter. In addition to these modifications, development of a foundation shear key at the south valley section (SVS) is under consideration as an optional additional feature of this alternative. With increased reservoir surface elevations, modifications would also be made at multiple locations along SR 152 to prevent inundation of the roadway when the enlarged reservoir is filled to capacity, and modifications to the Dinosaur Point Boat Launch and the Goosehead Point Boat Launch would be made to increase the ramps operating elevation by 10 feet. The existing berm developed during construction of the Pacheco Pumping Plant would be reconstruction with a higher crest elevation to protect the plant at high storage levels (see Figure A2-11).

A2.1.4.1 San Luis Expansion Project Facilities

As noted above the San Luis Reservoir Expansion Alternative would expand storage in San Luis Reservoir to increase the yield of the CVP and the SWP, by supporting in some years when conditions permit, increases in south of Delta exports. This section outlines the physical modifications that would that would be developed under this alternative.

A2.1.4.1.1 B.F. Sisk Dam

B.F. Sisk Dam is a zoned earthfill structure with a maximum structural height of 382 feet, a crest length of 18,600 feet, a crest width of 30 feet, and a crest elevation of 556 feet. The dam embankment was constructed of five materials in seven zones, with the central zone consisting primarily of low-plasticity clays (see Figure A2-10). The downstream face of the dam is covered by a 2-foot-thick cobble blanket, and the upstream face is covered by a 3-foot-thick layer of riprap. Both thickness measurements are normal to the dam slope. A saddle dike, known as the East Dike, is present along the north rim of the reservoir, approximately 1,300 feet from the dam.

The foundation that the dam is built on can be divided into sections: the right abutment, the left abutment, the NVS, and the SVS (See Figures A2-9 and A2-12). The NVS and SVS are the alluvial channels of San Luis Creek and Cottonwood Creek that B.F. Sisk Dam impounds and consist of deposits of sands and gravels with clayey or silty fines. The abutments are primarily founded on bedrock (sandstone, shale, and conglomerate), which is covered by clayey slopewash in some locations. In addition, the East Dike is also partially founded on slopewash.

Studies completed during the Corrective Action Study (CAS) have identified the potential for significant deformation (crest settlement) of the dam in the

sections built on the alluvium and clayey slopewash during a seismic event (Reclamation 2013). The SOD seismic modification will address this deformation potential with the placement of downstream stability berms anchored to bedrock and placement of additional embankment materials on the downstream slope of the dam to increase the crest elevation 10 feet, increasing the distance between the water surface and the dam crest (freeboard) to prevent reservoir overtopping and failure in the event of earthquake-induced deformations (Reclamation 2013).

In addition to dam crest deformation, seismic shaking can cause cracks in the dam embankment susceptible to erosion that can lead to dam failure. Downstream crack filters restrict the migration of soil materials through these cracks mitigating the potential for post seismic cracks to induce internal erosion within the dam embankment. The SOD modification will address this seismic crack induced erosion risk by installing downstream filters along the upper portion of the embankment across the entire length of the dam.

Evaluation of the seismic shaking potential at B.F. Sisk Dam has identified the potential need for additional modification to the foundation soils beneath the SVS berm. The development of a foundation shear key is being evaluated as an optional modification in the San Luis Expansion Project Alternative. A foundation shear key is developed by removing the weak overburden foundation soils found beneath the berm footprint and replacing them with material with a higher shear strength.

The San Luis Reservoir Expansion Alternative would build on the physical SOD modifications currently under final design and raise the dam crest an additional 10 feet to a new crest elevation of 576 feet. This additional 10 feet in embankment height would support a new water surface elevation of 554 feet and an additional 120 TAF in storage capacity. In addition to the new embankment height added by the reservoir enlargement the existing outlet works intake towers, access bridge, and spillway intake would need to be raised by 10 feet.

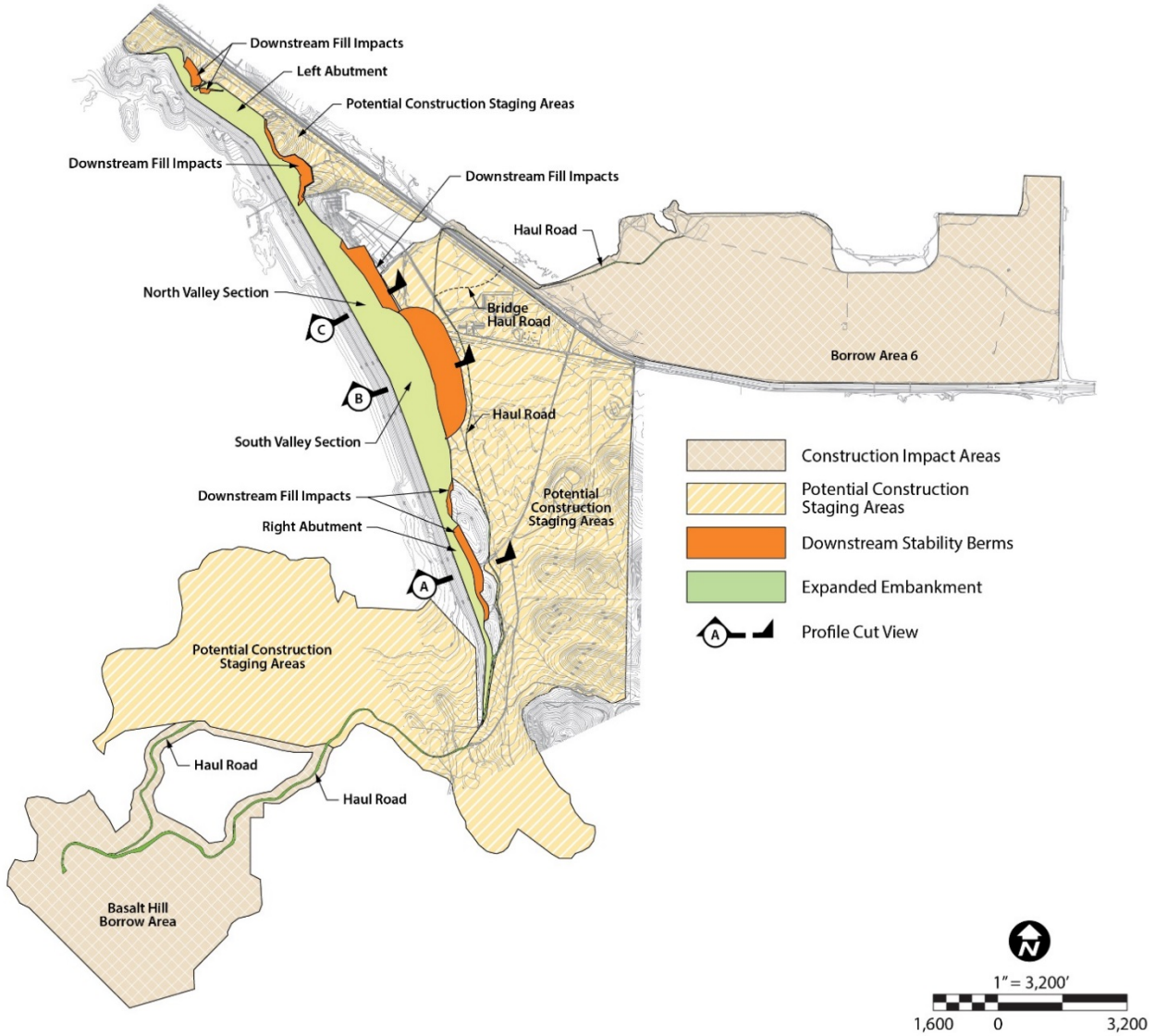


Figure A2-9. Construction and Staging Areas

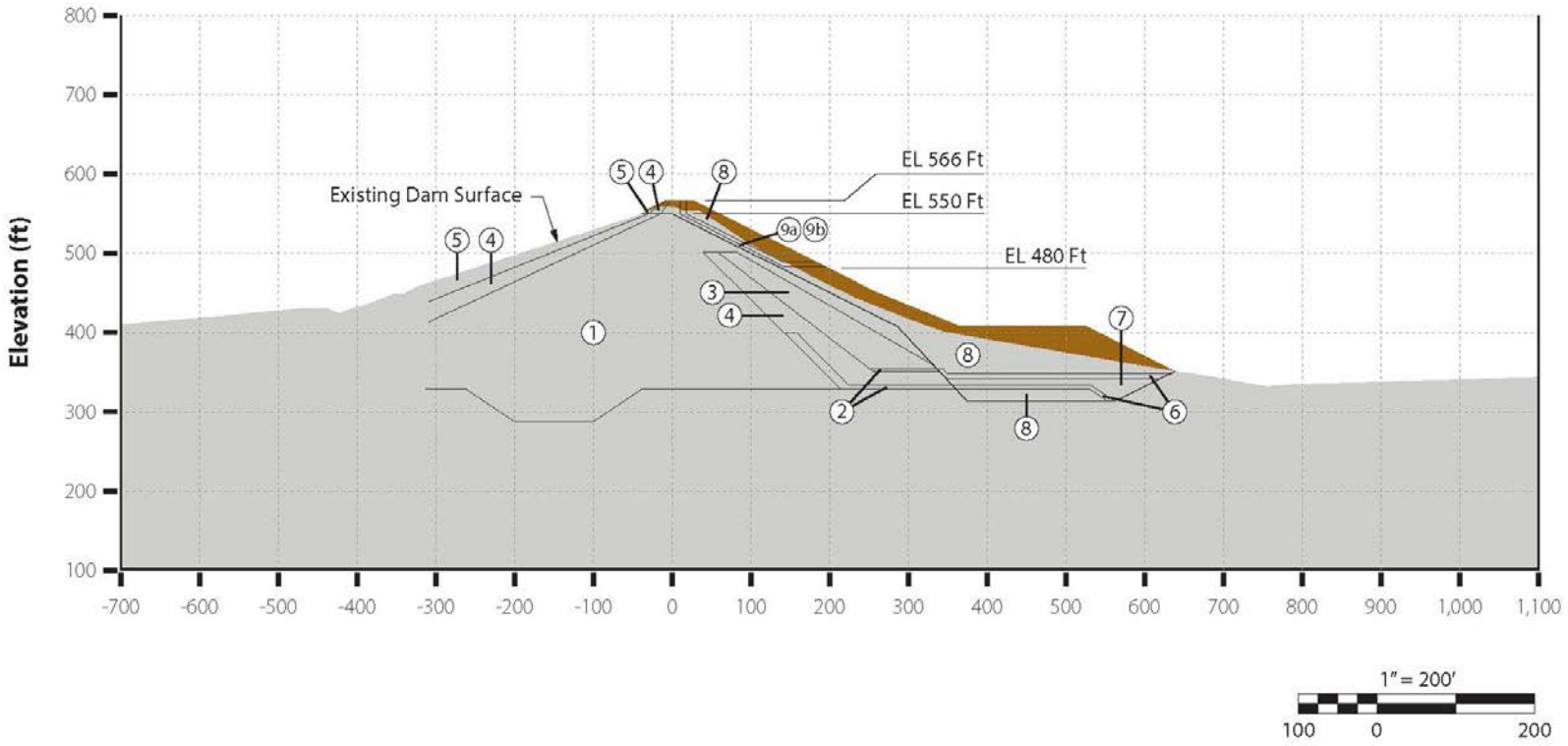


Figure A2-10. Typical Cross-Section View and Embankment Materials

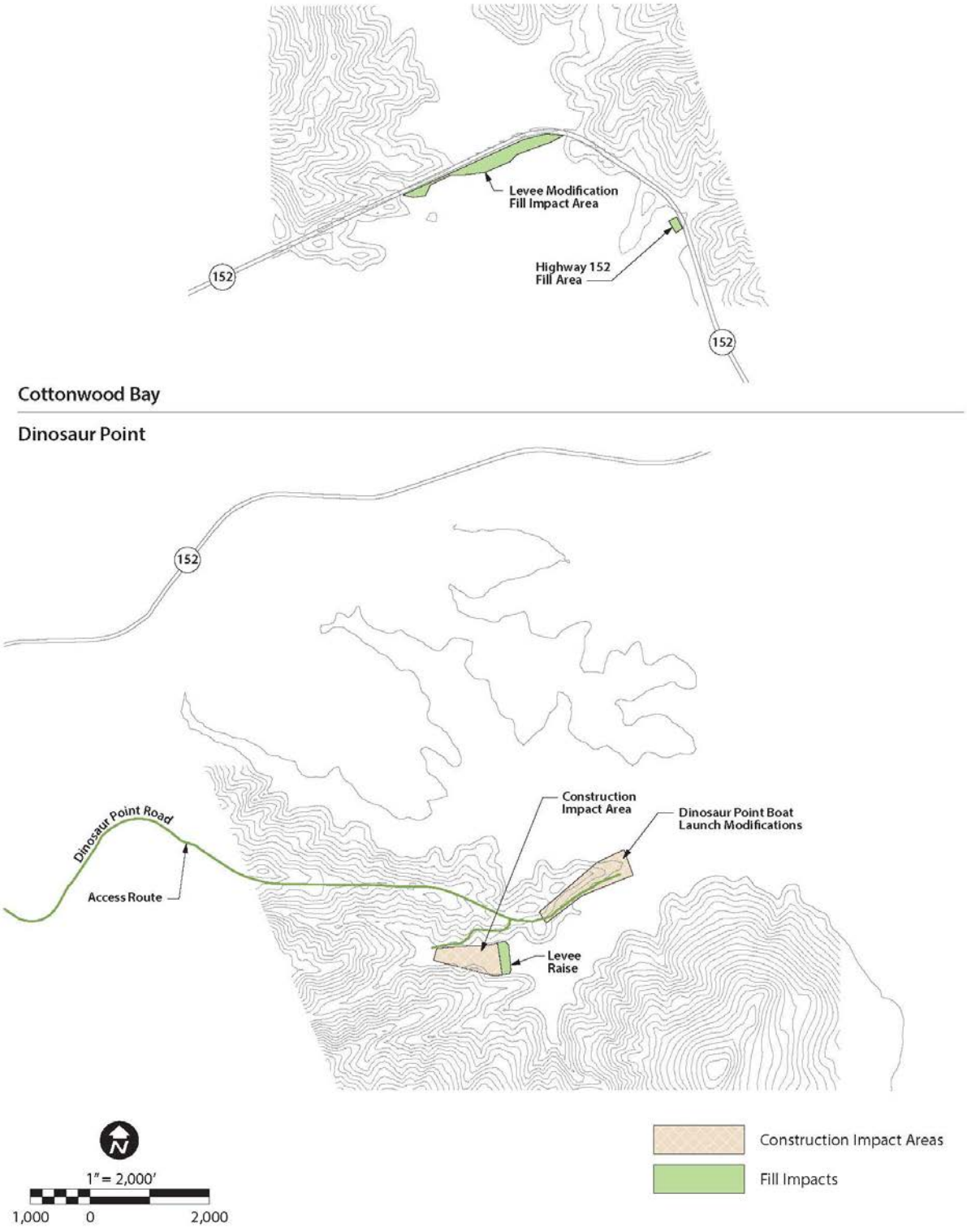


Figure A2-11. Reservoir Expansion Actions along State Route 152 and at Pacheco Pumping Plant

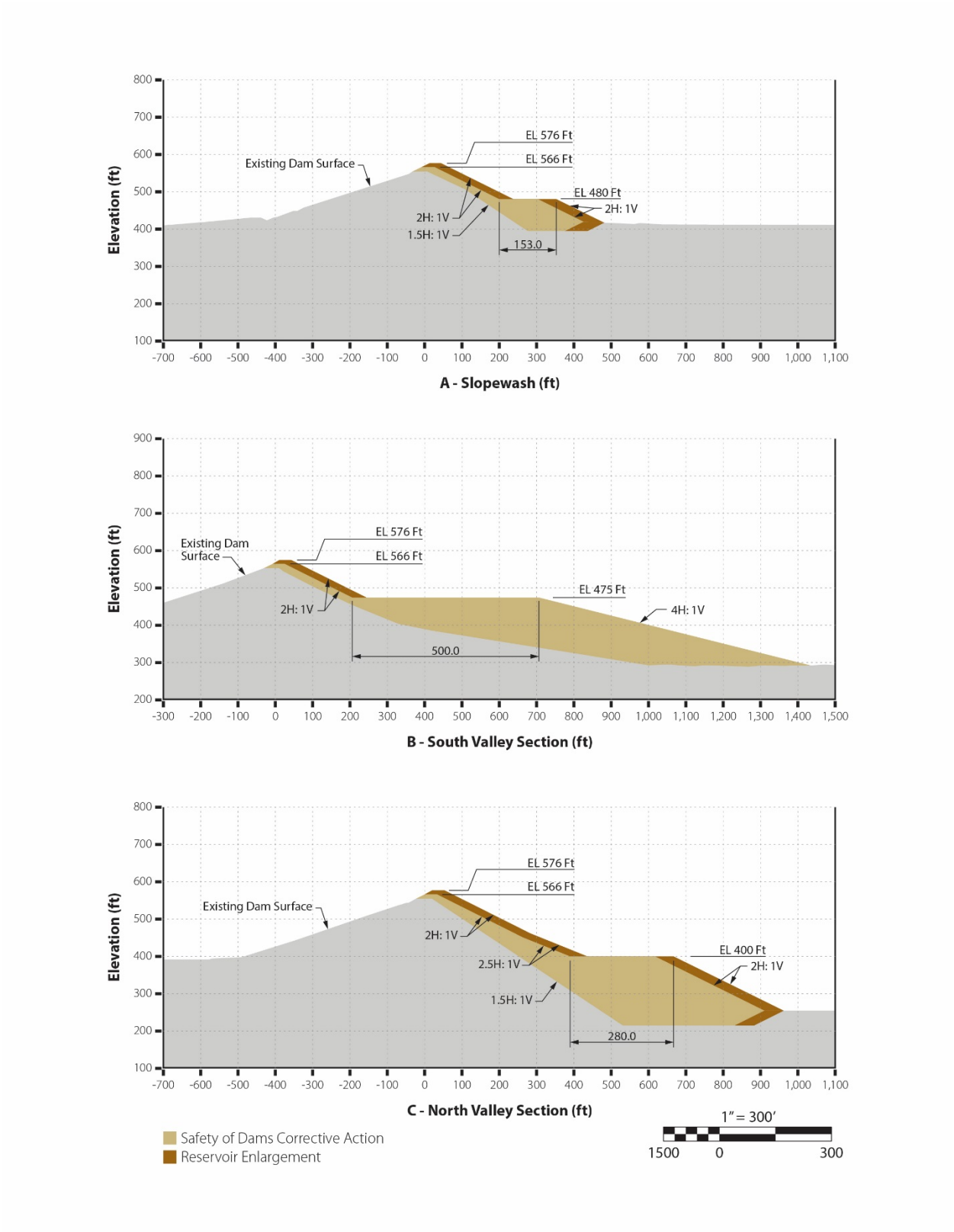


Figure A2-12. Dam Expansion Profiles

San Luis Reservoir seasonally operates in most years with an approximately 6-month period that CVP and SWP supplies are pumped into the reservoir followed by an approximately 6-month period where the reservoir is drawn down as those stored supplies are delivered to water users. Any work that would reduce the reservoir embankment strength, such as foundation or embankment excavation, would be timed seasonally and would occur during periods of the year when the reservoir is drawn down to lower elevations. As the reservoir is drawn down as a part of regular operations, construction would start after the reservoir is drawn below an elevation sufficient to ensure slope stability during any work that would impact embankment strength. This work would also be scheduled for completion each year prior to the refill of San Luis Reservoir back above safe level to protect embankment stability. Scheduling work during regular periods of drawdown would allow for uninterrupted water supply deliveries. Delays to refill could potentially occur if the construction schedule is delayed, but the division of specific modification actions scheduled to occur in one drawdown season would be structured to minimize this risk. In addition, contract requirements would require use of the second construction shift on this particular component of the overall project in the event that work becomes delayed.

Implementation of the optional SVS shear key action would require limits on the maximum surface elevation in San Luis Reservoir for two fill and drawdown seasons, during the period that the berm foundation would be excavated. This reduction in surface elevation would reduce storage capacity in the reservoir and could limit CVP and SWP deliveries during this construction period. If implemented, the shear key reservoir restriction would consist of a 55-foot reduction in the maximum water surface elevation of San Luis Reservoir from the current elevation of 544 feet to 489 feet. Excavation activities for the shear key would initiate when the reservoir is drawn down to 489 feet as a part of regular reservoir operations and would continue through two refill periods during which the reservoir would not be allowed to refill above that level. Reclamation and SCVWD would also target initiation of the shear key modification if possible, in a year where initial water supply forecasts are projecting dry or critically dry conditions to lessen the magnitude of this reservoir restriction’s impact in at least the first year of its two-year implementation window.

A2.1.4.1.2 Cottonwood Bay/State Route 152

Sections of SR 152 near and at Cottonwood Bay could potentially be impacted by the 10 foot increase in water surface elevation, and would be protected by the development of berms separating the reservoir from the roadway in periods when storage in the enlarged reservoir is full (see Figure A2-10).

A2.1.4.1.3 Pacheco Pumping Plant West Dike

The Pacheco Pumping Plant is located on the western side of San Luis Reservoir. The pumping plant is separated from San Luis Reservoir by an approximately 500-foot wide dike east of the pumping plant (see Figure A2-10).

This dike would be replaced with a new dike 20 feet taller than the existing structure to protect the pumping plant from the enlarged reservoir.

A2.1.4.1.4 Dinosaur Point Boat Launch

The Dinosaur Point Boat Launch is located on the western side of San Luis Reservoir close to the Pacheco Pumping Plant. The boat ramp and portions of the parking lot at Dinosaur Point would be inundated with the 10-foot increase in surface elevation requiring modifications to the facility to maintain launching functions during periods when the enlarged reservoir is at capacity (see Figure A2-10).

A2.1.4.1.5 Goosehead Point Boat Launch

The Goosehead Point Boat Launch is located on the southern side of San Luis Reservoir close to Basalt Hill. The boat ramp and parking lot at Goosehead Point would be inundated with the 10-foot increase in reservoir surface elevation requiring modifications to the facility to maintain launching functions during periods when the enlarged reservoir is at capacity.

A2.1.4.2 Construction Methods

The shear keys and downstream stability berms would be constructed by first excavating the existing liquefiable and soft foundation soils down to bedrock up to a depth of 80 feet in the NVS alluvium and up to a depth of 50 feet in the sections of the abutments developed on the clayey slopewash. The maximum depth of excavation would be approximately 160 feet in the SVS, if the shear key option is implemented. During these shear key excavations, dewatering and unwatering measures would be employed to remove ground water from the excavation and maintain a dry excavation. The rock blanket or slope protection would also be removed to the top elevation of the embankment and stockpiled downstream of the toe. Next, the existing toe drain would be removed by excavation. These two operations would expose the existing blanket drain and surrounding filter materials in the downstream face of the dam. Above the blanket drain, the existing Zone 3 shell would be exposed.

After completion of the excavations, the existing filters/drains located at the downstream toe would be re-established and a new toe drain seepage collection system would be installed, similar to the one currently in place. Stronger material would then be placed as backfill and compacted. Placement of shell material (Zone 8) and the rock blanket would continue up the downstream side of the embankment until it reaches an elevation of 480 feet. At 480 feet, construction of the two-stage downstream crack filter begins and the filter material along with shell material (Zone 8) continues up to the new dam crest elevation. Above an elevation of 550 feet, the raised crest is developed by simultaneously placing riprap and bedding (Zones 5 and 4), core (Zone 1), a two-stage chimney filter (Zones 9A and 9B) and the downstream shell (Zone 8), as shown in Figure A2-12. Materials used would be stockpiled downstream of

the toe and in Borrow Area 6. After fill placement is completed, road base and paving of the dam crest complete the overlay raise.

The dam raise action would elevate the B.F. Sisk Dam embankment to an elevation of 576 feet from approximate dam station 30+00 to the left abutment with a transition back to the existing crest elevation at the right abutment. The raise would be constructed by initially excavating approximately 8 feet from the top of the dam. This excavation would remove portions of existing Zones 1, 4, and 5. Removing this portion of the dam exposes an approximately 40 to 50-foot-wide surface of the existing low-plasticity clay core (Zone 1) material and provides a working surface for connecting the new zones of the dam overlay to the existing embankment. The 2-foot thick rock blanket on the downstream slope of the dam would be removed in all areas to be covered by the overlay. For sections of the embankment not also receiving a stability berm, no further excavation would be needed.

Fill materials for the new enlarged dam embankment would be sourced from two borrow sites - Basalt Hill and Borrow Area 6 (See Figure A2-9). The Basalt Hill Borrow area was used to support construction of the original B.F. Sisk Dam and would again be used to supply rock materials including gravel, riprap and cobble slope protection. These materials would be produced on site from source material present at Basalt Hill. Borrow Area 6 was used to support construction of embankment modifications made in the 1980s and would be again used to supply material for the expansion of the Zone 1 core along with the materials for downstream berms. The only fill materials that would be imported from offsite are the filter sands needed for Zone 9a.

The preferred method to transport materials to and from the construction site and Borrow Area 6 would be either a conveyor belt system or low-profile trucks passing below SR 152 under the existing bridge that crosses O'Neill Forebay. A temporary platform or roadbed would be developed below the bridge by placing clean riprap and rockfill-sized cobbles and boulders in the water between the second bridge column and the south abutment (approximately 60 feet) and topped with clean gravel to construct a clean (no fine materials) roadway underneath the bridge. This temporary construction road would be used to allow for transportation of materials without impacting traffic on SR 152. The riprap and rockfill-sized cobbles and boulders would be removed and the area would be returned to pre-construction conditions upon completion of the work.

As an alternative to the preferred route below the SR 152 bridge over O'Neill Forebay, construction material could be transported to and from the construction site and Borrow Area 6 through a tunnel under SR 152. Under this configuration a tunnel would be bored under SR 152 to allow for installation of 15 foot high by 30 foot wide concrete box culverts. The culverts would allow for conveyor system equipment to be installed through the culverts and allow the transportation of materials without impacting traffic. The location of this tunnel corresponds to the potential route of another routing option to develop

either a temporary construction bridge over SR 152 or use of an at grade road crossing with signalized traffic control.

The last routing option for any materials developed in the construction site that require temporary stockpiling in Borrow Area 6 would utilize Gonzaga Road and the Santa Nella Boulevard underpass to access Borrow Area 6. Haul and access roads would be constructed consistent with the 2009 Reclamation Safety and Health Standards, as amended. New roads would be cleared and existing roads would be improved and would be either paved or treated to prevent dust. Roads would be approximately 30 feet wide with approximately 100 feet of clearance.

Other material imports to the site would include pipe for new toe drains that would be installed beneath new berms, asphalt pavement for road replacement at the top of the new dam crest, and steel and other materials needed for construction of new transmission towers adjacent to Gianelli Pumping-Generating Plant. Offsite material disposal at area landfills and regional hazardous waste landfills would include steel and other materials from the removed transmission towers, and asbestos wrapped corrugated metal pipe (CMP) where existing toe drains are removed.

Construction actions that would impact dam strength like embankment excavation would be scheduled for completion during times in the water year that San Luis Reservoir is typically drawn down to lower levels to avoid any adverse impact on storage capacity and water supply. This would be accomplished by not initiating any excavation actions until the reservoir is drawn below safe levels and scheduling construction to complete prior to the annual reservoir refill cycle bringing storage levels above safe levels. Development of the optional SVS shear key foundation modification would however require significant foundation excavation at the downstream toe of the embankment that would limit storage capacity in San Luis Reservoir for two seasons to reduce risk of slope instability during construction. Temporary in-reservoir construction roads would be constructed on the upstream side of the embankment when the reservoir is lowered during normal operations and then removed prior to reservoir filling the following year.

A2.1.4.3 Equipment and Staging

Equipment in the staging areas would include trailers, equipment to be used, and stockpiled materials. Construction staging and stockpile areas would include:

- Area south of Gianelli Pumping Plant off of Basalt Road, for the staging of construction equipment, fill materials transported from the borrow sites, embankment materials excavated and stored for later use and materials transported from offsite. The area proposed for use consists of approximately 1,000 acres.

- Area north of Gianelli Pumping Plant off of Gonzaga Road for the staging of construction equipment, fill materials transported from the borrow sites, embankment materials excavated and stored for later use and materials transported form offsite. The area proposed for use consists of approximately 120 acres.

- Dinosaur Point for the staging of construction equipment for both the Pacheco Pumping Plant West Dike replacement and Dinosaur Point Boat Launch modifications. The area proposed for use consists of approximately 28 acres.

The access route to the two main staging areas would be SR 152 to Basalt Road. Most of the traffic to the site would come from the east. Construction related traffic would likely begin one to two months after Notice to Proceed. Temporary traffic signals would be installed at the current left turn crossing on SR 152 at Basalt Road and at the access road to Romero Visitor Center for the duration of the project. Up to 240 large deliveries or waste material transports offsite per day could be expected, the transport and disposal of material to local landfills, along with the regular commuting of construction personnel.

Aside from areas dedicated to construction staging and transportation, all remaining available space at the areas next to B.F. Sisk Dam would be needed for stockpiling materials. These areas around the dam would be used as a staging area of the full duration of construction. These areas would be returned to pre-construction condition after the project is completed.

Equipment used to construct the alternative would include:

- 3 Excavators
- 4 Bulldozers
- 5 Cranes/Lifts
- 5 Compactors
- 2 Graders
- 2 Scrapers
- 5 Loaders (2 small, 3 large)
- 13 Dump trucks
- 5 Water trucks
- 1 Barge

A2.1.4.4 Construction Schedule

Recreational activities would be suspended for safety reasons during the entire construction schedule at Basalt Use Area and Medeiros Use Area, and during active construction at Dinosaur Point Use Area (approximately 1 year). Recreational use for boating would be suspended for the full year that both the

Basalt and Dinosaur Point use areas are closed and would be limited to areas away from B.F. Sisk Dam for the full construction schedule. The closed Basalt Campground would be utilized as a temporary camping area for construction workers.

Final design of the dam raise would include the development of a construction schedule that times the completion work in the direct path of potential flood flows or on infrastructure specifically designed to direct flood flows to occur in periods of the year when rain is unlikely and reservoir levels are lower. In addition, the contractor would be required to develop a health and safety plan that includes a response plan to flood forecasts that would require the suspension of construction activities and the movement of construction equipment to higher ground.

Construction is expected to last approximately 8 to 10 years. With the addition of the SVS shear key option, construction is expected to last approximately 10 to 12 years. Both with and without the SVS shear key option, construction duration is based on 130 anticipated workers on site during the day shift and 87 workers on site during the night shift. Work would be performed 24 hours per day, seven days per week, 12 months per year. The 24 hour work day would consist of two 10 hour work shifts, with a half hour for lunch each shift, plus a 3 hour maintenance period. Blasting operations at Basalt Hill would be limited to the hours between 6:00 a.m. to 6:00 p.m. It is assumed for the purpose of this EIS/EIR, that construction would start in 2020.

This 8 to 12 year construction schedule is based on the assumption of no funding constraints and is used to analyze the impacts in this EIS/EIR. However, with potential funding constraints, the construction schedule could extend up to 20 years. Impacts under an extended 20 year schedule would result in impacts equal to or potentially smaller in a single year of construction that cumulatively over the full 20 year schedule would be the same in total magnitude as the unconstrained schedule. An extended schedule would not change the impact determination of any of the resources analyzed in this EIS/EIR.

A2.1.4.5 Operation of the Reservoir Expansion Alternative

The San Luis Reservoir Expansion Alternative would provide approximately 9,600 AF of additional south of Delta CVP water supply on an average annual basis compared to No Action. Figure A2-13 shows how the San Luis Reservoir Expansion Alternative addresses SCVWD low point water supply interruptions along with treated water demand shortages in the No Action Alternative. Results show that the San Luis Reservoir Expansion Alternative would not fully replace interrupted water supply but would provide some additional water in 8 of the 17 low point years.

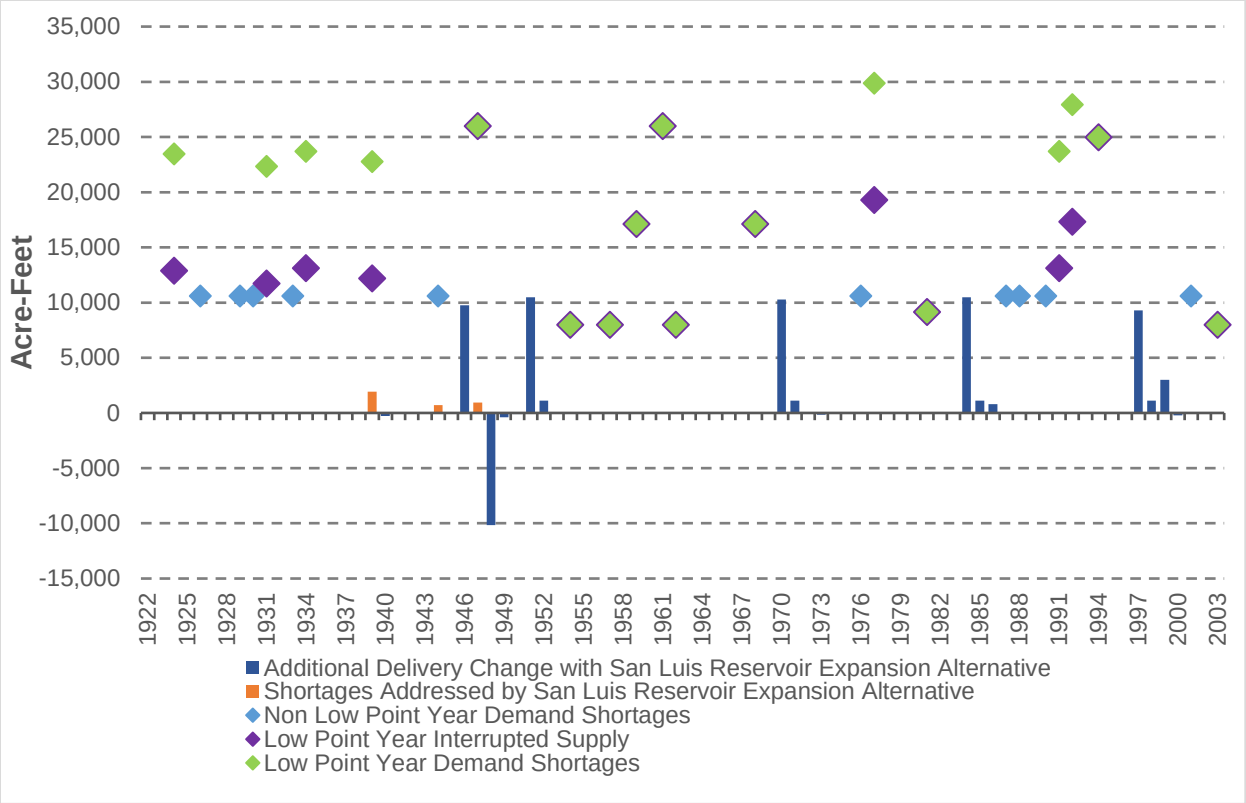


Figure A2-13. Annual Shortages Addressed by San Luis Reservoir Expansion Alternative

A2.1.5 Alternative 5 - Pacheco Reservoir Expansion Alternative

The Pacheco Reservoir Expansion Alternative includes construction and operation of a new dam and reservoir, pump station, conveyance facilities, and related miscellaneous infrastructure. The new dam and reservoir would be constructed on the North Fork of Pacheco Creek 0.5 mile upstream from the existing North Fork Dam and would inundate most of the existing Pacheco Reservoir. The proposed total storage for the new reservoir is 141,600 AF, with an active storage of 140,800 AF. The full pool elevation would be 694 feet and would inundate an additional 1,245 acres, for a total of 1,385 total acres inundated. Water would be collected in the new reservoir during the winter months from runoff from the local watershed area, and diversion of CVP supplies from Pacheco Pipeline. Figures associated with the Pacheco Reservoir Expansion Alternative are included in Attachment A and show proposed project component layouts, borrow areas, and construction access and staging areas from SCVWD's application for funding under the Water Storage Investment Program (WISP).

A2.1.5.1 Pacheco Reservoir Expansion Project Facilities

The Pacheco Reservoir Expansion Alternative would include the removal of the existing dam, development of a new earthen dam and spillway, expansion of the existing reservoir, new pipelines and tunnels, a new pump station, and associated channel modifications, a new regulating tank at Pacheco Pumping Plant, and access improvements.

A2.1.5.1.1 Dam and Spillway

The new embankment dam would be a zoned earthfill structure consisting of an impervious core, flanked by an outer shell of random fill. A system of filters and drains would be provided to control seepage through the dam and foundation. A downstream sand chimney filter would protect the impervious core. A gravel chimney drain located downstream of the chimney filter would convey drainage to a gravel blanket beneath the downstream random fill zone. The gravel blanket drain would convey seepage from the impervious core and overlie form the foundation beneath the downstream random fill zone to the downstream toe of the dam. Sand filter zones would be placed above and beneath the gravel blanket drain to protect the gravel drain from contamination of the overlying random fill and underlying foundation materials. The upstream slope of dam would be protected from reservoir wave action by a 3-foot thick riprap layer.

An uncontrolled side channel spillway with a trapezoidal cross section would be located adjacent to the right (west) abutment of the proposed dam. Due to the relatively steep topography at the dam site, a side channel spillway would reduce the amount of excavation required in order to accommodate the spillway control weir. The spillway features include an approach channel, discharge chute and stilling basin, all of reinforced concrete and founded on bedrock. The side channel spillway entrance would include an ogee weir. A flip bucket located at the end of the stilling basin would dissipate the remaining energy in the basin during high discharge events. After leaving the deflector bucket, spillway discharges would be conveyed through a riprap lined outlet channel into the restored Pacheco Creek channel (see below description).

A2.1.5.1.2 Inlet/Outlet Facilities

The inlet/outlet facilities would consist of a sloping intake/outlet structure and a low-level inlet/outlet designed to provide deliveries to the reservoir from Pacheco Conduit and withdrawals from the reservoir to the conduit and the north Fork of Pacheco Creek. However, these facilities would not be operated to facilitate these flows at the same time. For withdrawals from the reservoir, under normal operating conditions, this inlet/outlet facility would need to simultaneously convey up 490 cubic feet per second (cfs) to Pacheco Conduit and release up to 35 cfs to Pacheco Creek. The inlet/outlet conveyance facilities have been sized to accommodate up to 1,350 cfs under emergency drawdown conditions. During emergency conditions, the outlet works would serve as an evacuation outlet for reservoir draw down.

A sloping intake structure would be located north of the left (east) abutment and would consist of a single 132-inch diameter reinforced-concrete structure, with approximately 10 ports located at various elevations for drawing from the reservoir. A low-level reservoir inlet would also be constructed, with an inlet elevation of 450 feet, for reservoir drainage. A hydraulically operated gate valve structure would be located upstream of the reinforced-concrete sloping intake to allow for switching between reservoir delivery (through the tunnel) and withdrawal operations (through the outlet structure).

A 2,300-foot long conveyance tunnel would be constructed under the dam abutment to connect the intake structures and the pump station. The conveyance tunnel would be excavated through the bedrock on the left abutment of the dam. The control gatehouse structure would be used to regulate outlet flows from the reservoir to the pump station, for normal releases, and the discharge channel for stream augmentation and emergency releases.

To connect the new outlet works to Pacheco Creek, the historical Pacheco Creek channel would be restored between the new dam and the existing dam through the existing Pacheco Reservoir. Restoration of the channel would include excavating a new 1,500-feet long, 1.7-feet deep, one-foot wide, low-flow channel, and a 6-feet deep, 20-feet wide overbank channel to facilitate riparian restoration. The channel would be designed to reduce streambank erosion (e.g., using bank stabilizing materials), and riparian vegetation would be planted to initiate growth of a new riparian forest along the restored channel.

A2.1.5.1.3 Pacheco Reservoir Pump Station

The Pacheco Reservoir Pump Station would serve as a two-way pump station that both delivers water to and withdraws water from the Pacheco Reservoir. The water surface elevation of the new reservoir would have an operating range of 450 feet to 694 feet; however, at the connection point to the Pacheco Conduit the total hydraulic head would be 610 feet. This requires a “two-way” system operating both by gravity and through a booster pump station.

The conveyance system would contain 10 feet of dynamic head loss that is included in the scenarios above. Isolation valves would enable the pump station to deliver water to, or pump water from, the reservoir. Pressure-reducing sleeve valves were identified as necessary to reduce excess pressure head under certain gravity-flow conditions. These valves would be used only when needed and bypassed at all other times. Additionally, pressure relief valves and discharge structures would be required to prevent over-pressurization of the existing Pacheco Conduit.

The pump station would be below the new dam. To provide security and minimize noise levels in the surrounding area, the pumps would be housed in a building. Space has been identified for other facilities on site, including intake, access, parking, surge tanks, power substation, yard piping, and construction staging.

The new pump station would need to meet a wide range of lift (0 to 160 feet static plus 10 feet dynamic) and high flow (490 cfs). A single pump station with multiple pump ranges has been proposed to meet these requirements—while preventing pump station horsepower (hp) duplication—limiting the amount of head burned by pump control valves and minimizing cost. A total of 11 pumps (10 duty plus 1 standby) are planned, however the pump configuration may be refined during future design studies. The pump motors would be sized for the first operating range (higher lift) at 1,250 hp each (13,750 total hp).

The 14 megavolt amp (MVA) substation for the new reservoir pump station is located in the Pacific Gas and Electric Company (PG&E) service area, with no other nearby service sources. PG&E has a 70 kilovolt (kV) transmission line that cannot support the additional 14 MVA connected load, and it would need to be upgraded to support the increased load. The existing 70 kV transmission line would be upgraded to two circuits, for use by the double-ended substation arrangement for this alternative.

A2.1.5.1.4 Conveyance from Pacheco Reservoir Pump Station to Pacheco Conduit

A pipeline would be constructed to connect the new pump station located immediately downstream of the new dam and the existing Pacheco Conduit. The proposed pipeline would be 9 feet in diameter and about 4,700 feet long, with a pipeline design capacity of 490 cfs. This pipeline would allow for delivery of imported water from the Pacheco Conduit to the proposed reservoir for future release and would also provide for reservoir releases to the Pacheco Conduit.

Construction would be by conventional excavation, open trench, and backfill—except for the length of pipe located under SR 152. The length of pipe that would be located under SR 152 and Pacheco Creek would be installed using bore and jack techniques (i.e., tunneling techniques), to minimize impacts during construction. Construction spoils would be used on site for backfill as necessary, haul road development, and to support the dam crest raise. The tunnel, when completed, would be a 132-inch casing containing a 108-inch carrier pipe. There would also be permanent structures for appurtenances, such as air/vacuum valves, vaults, drains and blowoffs for the conveyance line.

The connection of the pipeline to the existing Pacheco Conduit would be southeast of the existing North Fork Dam. The connection would be with a tee in the Pacheco Conduit, with an isolation valve for the turnout (inlet and outlet) for the new reservoir.

A2.1.5.1.5 New Regulating Tank at Existing Pacheco Pumping Plant

Controls to turn pumps on or off remotely would be based on the water level within Pacheco Reservoir and regulating tanks at the existing Pacheco Pumping Plant site near San Luis Reservoir. A second regulating tank at the existing Pacheco Pumping Plant site would be added adjacent to the existing regulating

tank to provide additional control buffer and surge control for the new Pacheco Reservoir Pump Station. The new regulating tank would match the elevation, diameter, and materials of the existing tank. This would add a second 10 AF, 150-feet diameter reservoir. Additional piping, valving, and controls would be required.

A2.1.5.2 Project Construction

The environmental compliance, design, permitting, land acquisition, and financial and institutional arrangements are anticipated to be completed in 2023. Major construction is anticipated to take approximately five years from 2024 to 2028 with commissioning of system completed in late 2028. Miscellaneous improvements, such as road repairs, would continue through 2029.

A2.1.5.2.1 Borrow Areas

Preparation of borrow areas would include the reservoir borrow areas, the spillway area, and the existing dam site prior to its removal. Preparation would include logging, stripping and disposal of topsoil, and implementation of any associated work access or material processing areas. It is assumed that the material processing areas could include a crushing and screening plant at the filter and drain borrow area and a concrete batch plant near the spillway excavation.

The area for impervious borrow materials would be located upstream of Turkey Flat, with material in this area classified as low-plasticity silt or clay. The potential random fill borrow area is just above Turkey Flat, and the material consists of a mix of silt, sand, gravel, and boulders. The proposed rock borrow area is along Pacheco Creek, just above Turkey Flat.

Approximately 5.75 miles of 25 feet-wide haul road would be required to access the reservoir borrow areas upstream of the embankment location. The haul road would follow an existing access road along Pacheco Creek that would need to be improved. Construction access roads totaling 4 miles and 25 feet wide would need to be constructed across the stream, downstream of the embankment, to access the spillway area. One and a half miles of these construction roads would improve existing access roads, providing permanent access to the site post-construction. An existing bridge over the stream would need to be improved.

A2.1.5.2.2 Inlet/Outlet Construction

Construction of the tunnel and pipe between the inlet/outlet structure and pump station area would be accomplished as a site preparation activity; either by open-cut excavation, tunneling, or a combination of excavation and tunneling. The low-level intake would also be completed to allow diversion of the stream through the outlet structure for the duration of the following embankment construction. Construction of the outlet tunnel could include excavation for, and construction of, the pump station lower level, that would act as the energy

dissipation and discharge pipeline and channel to return flow to the stream below the dam.

Construction methods are anticipated to consist of clearing, grubbing, stripping, and disposal of topsoil; and grading consisting of excavation of soil and rock, filling, and compacting. Blasting of hard, fractured rock may be used to expedite excavation, but it is anticipated to be very limited during site preparation. Site preparation activities would include diversion of surface water, implementation of erosion and sediment controls, and establishment of a construction management area, including placement of temporary construction trailers. Site preparation activities may also include stabilization of potential or active landslide areas.

A2.1.5.2.3 Dam Construction

Construction activities for the new dam and reservoir would include removing the existing North Fork Dam, and constructing a temporary cofferdam, new embankment dam, and spillway. Construction methods for dam removal and the cofferdam would consist of clearing, grubbing, stripping, and disposal of topsoil, and grading consisting of excavation of soil and rock, filling, and compacting. Construction methods for the new embankment and spillway include excavation and processing of borrow materials; hauling, placing and compacting fill and backfill; and forming and placing concrete.

Dam Removal

The North Fork Dam is currently being operated under the terms of a DWR Division of Safety of Dams order requiring that the upstream and downstream outlet controls be maintained in the fully open position to maximize releases and maintain the lowest possible surface elevation in Pacheco Reservoir given the current condition of its spillway (DWR 2018). Construction of the Pacheco Reservoir Expansion Alternative would initiate with demolition of the existing North Fork Dam. Removal of the existing dam would proceed from the top down to prevent steep slopes and to minimize the potential for slope failure. Material excavated from the dam, deemed suitable for earth fill, would need to be directly hauled to the temporary cofferdam site for placement and compaction. Unsuitable material would be stockpiled for disposal off-site. Sand, gravel, cobbles, and rock may be segregated from the excavated material and used for site restoration. Bank stabilization and channel reconfiguration would be performed once the dam is removed, and any planned riparian and aquatic habitat enhancements would be implemented, such as creating pools, adding boulders, installing logs, and enhancing irregular edges.

Cofferdam

The temporary cofferdam would be constructed at the upstream toe of the new dam footprint, following or concurrent with completion of the outlet construction, preferably during the dry season when flows in Pacheco Creek are low. The cofferdam crest elevation is 500 feet and was sized to ensure that

flows in Pacheco Creek are maintained during construction while accommodating at least a 20-year flood event and would accommodate the 50-year flood event. Foundation preparation for the cofferdam would be similar to that for the main embankment, and would consist of over-excavation of alluvium from the valley bottom and surficial soils along the abutments. The foundation and embankment of the cofferdam would be incorporated into the dam. Material used to construct the cofferdam would be imported from the random fill borrow sources, spillway excavation, and removal of the North Fork Dam.

Embankment Construction
Initial preparation of the dam footprint would consist of clearing and grubbing of vegetation, removal of soft sediments and other deleterious materials, and shaping of the abutment side slopes. Form of slope protection may be needed to mitigate the potential for landslides and shallow-slope failures during construction. Dam foundation construction would include excavation of existing-channel alluvial materials to competent bedrock; loading and hauling excavated materials in the foundation footprint to stockpiles; cleaning of the foundation in the core and earth fill zones; surface treatment of the impervious-core foundation by excavating shear zones and backfilling with dental concrete/grout; and set-up, mix, and installation of a cutoff wall beneath the cores (grout curtain). Materials excavated from the foundation area could be stockpiled and reused in the earth fill areas of the embankment.

Embankment construction activities would include processing, excavating, loading, hauling, placing, and compacting of impervious core, adding earth fill, and draining and filtering of materials from borrow areas. Processing materials at the borrow sites would likely include, at a minimum, moisture conditioning. Drain and filter materials are anticipated to be sourced from local commercial vendors or facilities. Additional moisture conditioning may be required at the dam site as the materials are placed and compacted. It is anticipated that up to four concurrent material placement and compaction operations could be occurring at the same time as the embankment elevation is raised.

Spillway Construction
Spillway construction would consist of completing excavation to final grades; formwork and placement of concrete for the base and walls of the entrance channel; chute and energy dissipation and stilling basin; and backfilling of walls, and final grading and erosion protection for the excavation slopes.

A2.1.5.2.4 Pump Station and Conveyance to Pacheco Conduit Construction Methods

Construction methods for the pump station, surge tanks, and electrical substation would consist of excavation for basements, foundations, and building pads; preparing formwork and pouring concrete; installation of pumps and equipment; and final finishing of the interior. Construction of the conveyance pipeline to the Pacheco Conduit would generally consist of conventional trench

excavation and backfill. However, the section of the pipeline passing beneath SR 152 would be constructed using jack and bore trenchless methods.

Excavations to competent bearing material would need to be performed to construct the proposed pump station and appurtenant structures. The pump station and surge tanks are anticipated to be reinforced-concrete structures, and the electrical substation an open-graveled area with concrete mat and pedestal foundations for the electrical gear and towers. Security fencing would be required around all above-grade facilities.

A temporary and permanent construction easement would be required for the conveyance pipeline to the existing Pacheco Conduit. A potential corridor for the high-capacity electric transmission lines to the pump station could be located adjacent to the permanent easement from the pipeline. The pipeline would be constructed in an open-trench excavation and backfilled with imported bedding material and native backfill to existing grade. A series of permanent structures for appurtenances (i.e., air/vacuum valves, vaults, drains, and blowoffs) would be placed along the pipeline right-of-way. These structures would generally be below-grade and positioned directly over, or adjacent to, the conveyance pipeline.

Site access for the tunnel would include constructing new haul and access roads in conjunction with making improvements to existing roadways. Wherever possible, the alignment of these roads would follow the existing unimproved roads or four-wheel-drive trails. The access road from SR 152 to the dam site would be about 2.74 miles long. It is anticipated that the road would eventually be completed as an approximately 40-feet wide, asphalt-paved, two-lane road. Preparing a temporary construction road with this width would allow two-way traffic during construction.

A2.1.5.3 Operation of the Pacheco Reservoir Expansion Alternative

The expanded Pacheco Reservoir would be primarily filled using natural inflows from the North and East Forks of Pacheco Creek. These inflows are typically realized from December through March. Supplemental flows to the expanded reservoir would arrive from SCVWD's share of contracted CVP pumped water from San Luis Reservoir. This would include allocated CVP water supplies that otherwise could not be delivered to or stored by SCVWD. This CVP water supply would be pumped from the Pacheco Conduit up to the expanded Pacheco Reservoir earlier in the year prior to the summer months when the San Luis Reservoir is typically drawn down to the 300 TAF level. The rate at which these transfers are made between San Luis Reservoir and Pacheco Reservoir would depend upon water rights, supply allocations, water demands, availability of other water supplies, and conveyance limitations of Pacheco Conduit. Conveyance and storage of these CVP supplies is anticipated to occur primarily in wet years. CVP water stored in Pacheco Reservoir could then be

released through the summer while supplies from San Luis Reservoir would be inaccessible to SCVWD.

Alternative 5 would be operated by SCVWD to improve habitat conditions for steelhead in Pacheco Creek, improve SCVWD water supply reliability, including during drought periods and emergencies, and meet the groundwater recharge objectives of Pacheco Pass Water District (PPWD). Average monthly target flows ranging from 10 to 30 cfs in Pacheco Creek would support the biological needs of South-Central California Coast (SCCC) steelhead, which are listed as threatened under the Federal Endangered Species Act (ESA), for higher flows for outmigration. The average monthly release targets are shown in Table A2-2. During heavy precipitation events, releases from the expanded reservoir would be reduced to minimize flooding risks along Pacheco Creek and the Pajaro River. Winter releases of stored supply would be discontinued when it is estimated that there will be sufficient inflow passed through the reservoir downstream onto Pacheco Creek to provide for aquatic habitat going forward into the spring. The thresholds for discontinuing these winter releases are shown in Table A2-2. Operation of the expanded Pacheco Reservoir would not change the existing operations of the CVP.

To ensure that flows and water temperatures in Pacheco Creek are maintained in consecutive dry years, releases to Pacheco Conduit—to meet SCVWD water demands—would be discontinued in the event that reservoir storage volumes fall below 55,000 AF. This flow regime may however be altered in the event of an emergency declaration by SCVWD for health and safety purposes. These habitat flows would be secured by operations requirements expected in the biological opinion(s) that would be developed for the expanded Pacheco Reservoir, as well as the contract between DWR and SCVWD for the provision of grant funding through the WSIP, and in the contract between and DWR and SCVWD for the provision of grant funding through the WSIP, and in the multi-agency operations agreement between Reclamation and SCVWD for Pacheco Reservoir that would be developed during the pre-construction design phase for this alternative if it is selected for implementation.

Table A2-2. Average Monthly Release Targets to Pacheco Creek from Expanded Pacheco Reservoir

Month	Average Monthly Release Targets to Pacheco Creek (cfs)[1]	Inflow into Pacheco Reservoir Needed to Discontinue Winter Releases (cfs)
January	10	11.2
February	10	11.2
March	20	22.4
April	20	22.4
May	12	13.4
June	13	NA
July	14	NA
August	14	NA
September	14	NA
October	14	NA
November	10	11.2
December	10	11.2

Notes: [1] Releases from Pacheco Reservoir are reduced during high flows in the south fork of Pacheco Creek.
Key: CFS = cubic feet per second

In addition, SCVWD would transfer 2,000 AF of its CVP water contract allocation (in below normal water years), directly or through transfer and exchanges, in perpetuity to Reclamation and U.S. Fish and Wildlife Services' Refuge Water Supply Program (RWSP), for use in the Incremental Level 4 water supply pool for wildlife refuges. This long-term voluntary reallocation of CVP yield by SCVWD would be secured by an agreement between the U.S. Fish and Wildlife Service (USFWS) and SCVWD detailing the mechanisms and timing for delivery of this supply, a contract between DWR and SCVWD for the provision of grant funding through the WSIP specific to this refuge water supply that would require the provision of these supplies in perpetuity, and an multi-agency operations agreement between Reclamation and SCVWD for Pacheco Reservoir to deliver and store SCVWD's CVP supply in this new facility that would also include the requirements for this transfer.

While Reclamation sets priorities for Incremental Level 4 distribution, SCVWD has expressed its desire that the transferred water be designated to refuges supported by Grassland Resources Conservation District (GRCD). The water would be used to flood wetlands, directly benefiting wetland-dependent wildlife populations. The delivery schedule of this water would be flexible, but could be delivered as early as March or April. This water could be stored in San Luis Reservoir, providing the RWSP greater flexibility in making late season deliveries to refuges. For deliveries to GRCD, deliveries would be made to Los Banos through the Delta-Mendota Canal.

SCVWD would use Pacheco Reservoir Expansion Alternative for operational storage within their system as well as for emergency supply. SCVWD accesses its CVP water through the Pacheco Conduit. Pacheco Reservoir Expansion

Alternative includes construction of an inlet/outlet facility connecting to then the conduit that takes water from Pacheco Conduit to the expanded Pacheco Reservoir as well as from the expanded Pacheco Reservoir to Pacheco Conduit. During years when SCVWD water supplies exceed the water demands in the SCVWD service areas and excess storage capacity is available in the expanded reservoir, SCVWD would convey CVP supplies from San Luis Reservoir through Pacheco Conduit and into the expanded Pacheco Reservoir. Conveyance and storage of these CVP supplies is anticipated to occur primarily in wet years. The rate at which these transfers are made between San Luis Reservoir and Pacheco Reservoir would depend on supply allocations, water demands, and availability of other water supplies.

Under this alternative, modeling results have predicted that there would be 17 years (out of the 82 modeled years) where the reservoir would be drawn below 300 TAF of storage i.e. low point years. Figure A2-14 shows how the Pacheco Reservoir Expansion Alternative addresses SCVWD low point water supply interruptions along with treated water demand shortages in the No Action Alternative. Results show that the Pacheco Reservoir Expansion Alternative would allow uninterrupted delivery of SCVWD CVP M&I deliveries 14 out of the 17 low point years when compared to the No Action/No Project Alternative, partially reducing SCVWD unmet demand during low point events.

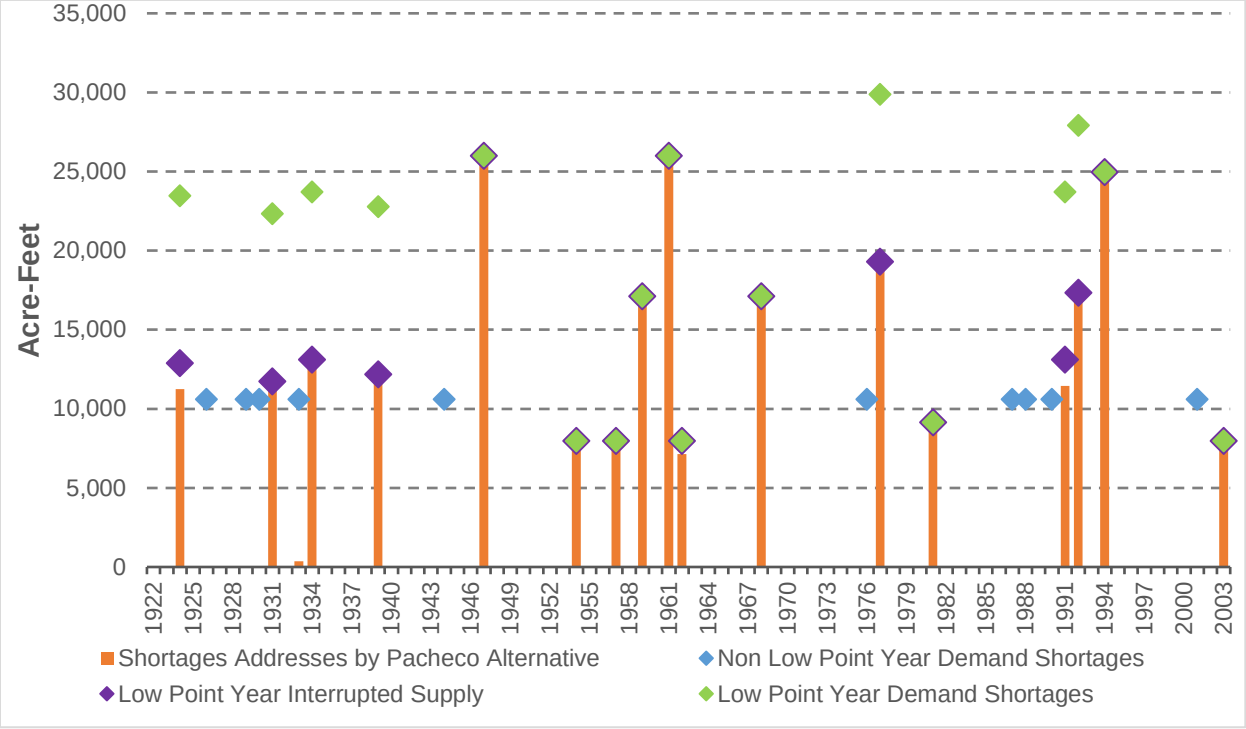


Figure A2-14. Annual Shortages Addressed by Pacheco Reservoir Expansion Alternative

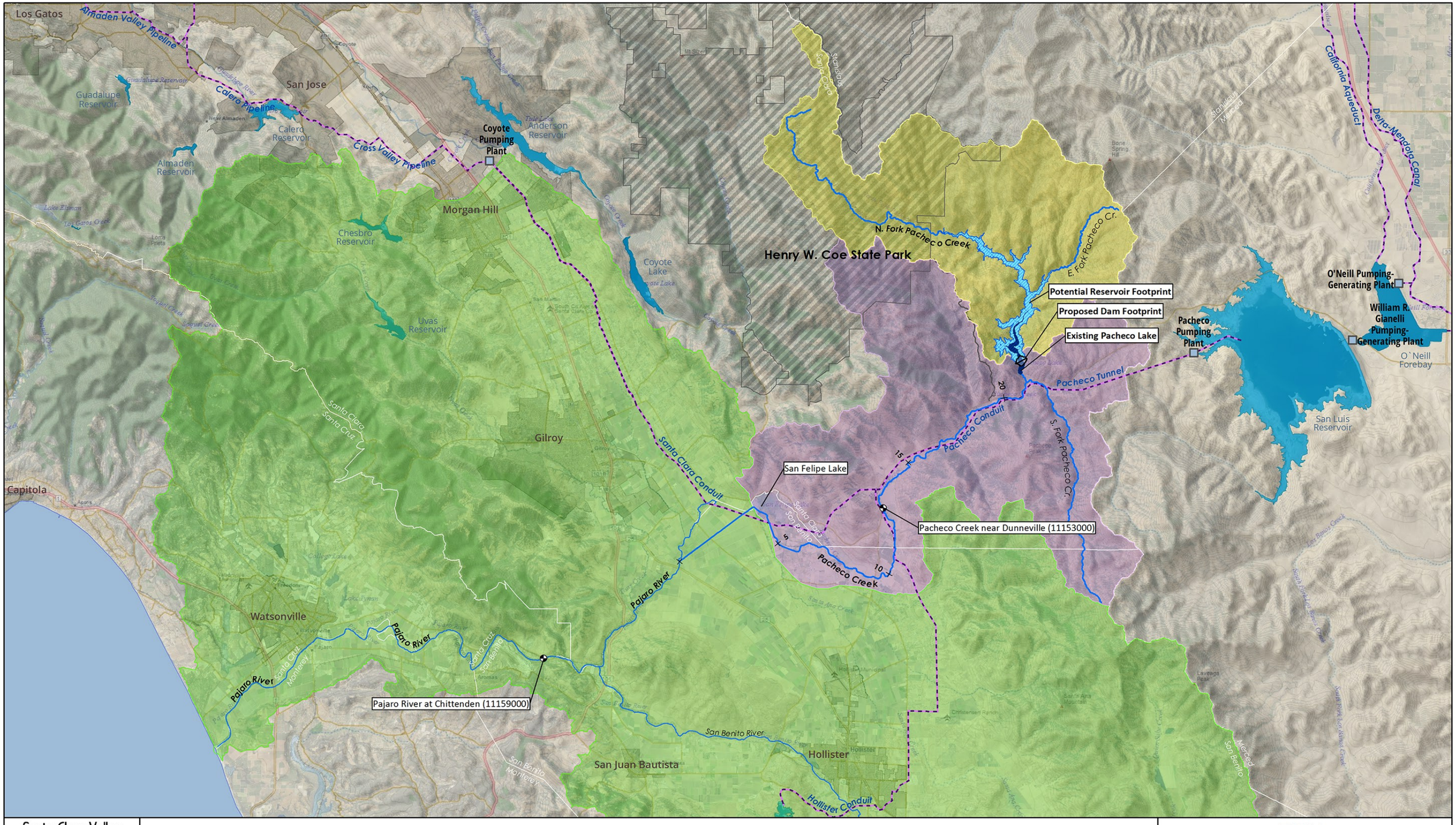
A2.2 References

California Department of Water Resources (DWR). 2018. *Second Notice Regarding Necessary Repairs*. Letter from Sharon Tapia, Chief Division of Safety of Dams to Frank O'Connell, President Pacheco Pass Water District. April 6, 2018.

United States Department of the Interior, Bureau of Reclamation (Reclamation). 2013. San Luis Reservoir Expansion Draft Appraisal Report. December 2013. Accessed on 09/12/2016. Available at: https://www.usbr.gov/mp/sllpp/docs/2013_11_19_DRAFT_San_Luis_Expansion_Appraisal_Report.pdf.

Attachment A: Project Description Support
Pacheco Reservoir Expansion Project Facilities

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Santa Clara Valley Water District

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- Selected USGS Gage Station
- Existing Pump Station
- Existing Tunnel/Pipeline

Affected Watersheds

- Pajaro River below Pacheco Creek *(Includes San Benito River Shed - not shown in its entirety)*
- Pacheco Creek below Proposed Dam
- North Fork Pacheco Creek above Proposed Dam

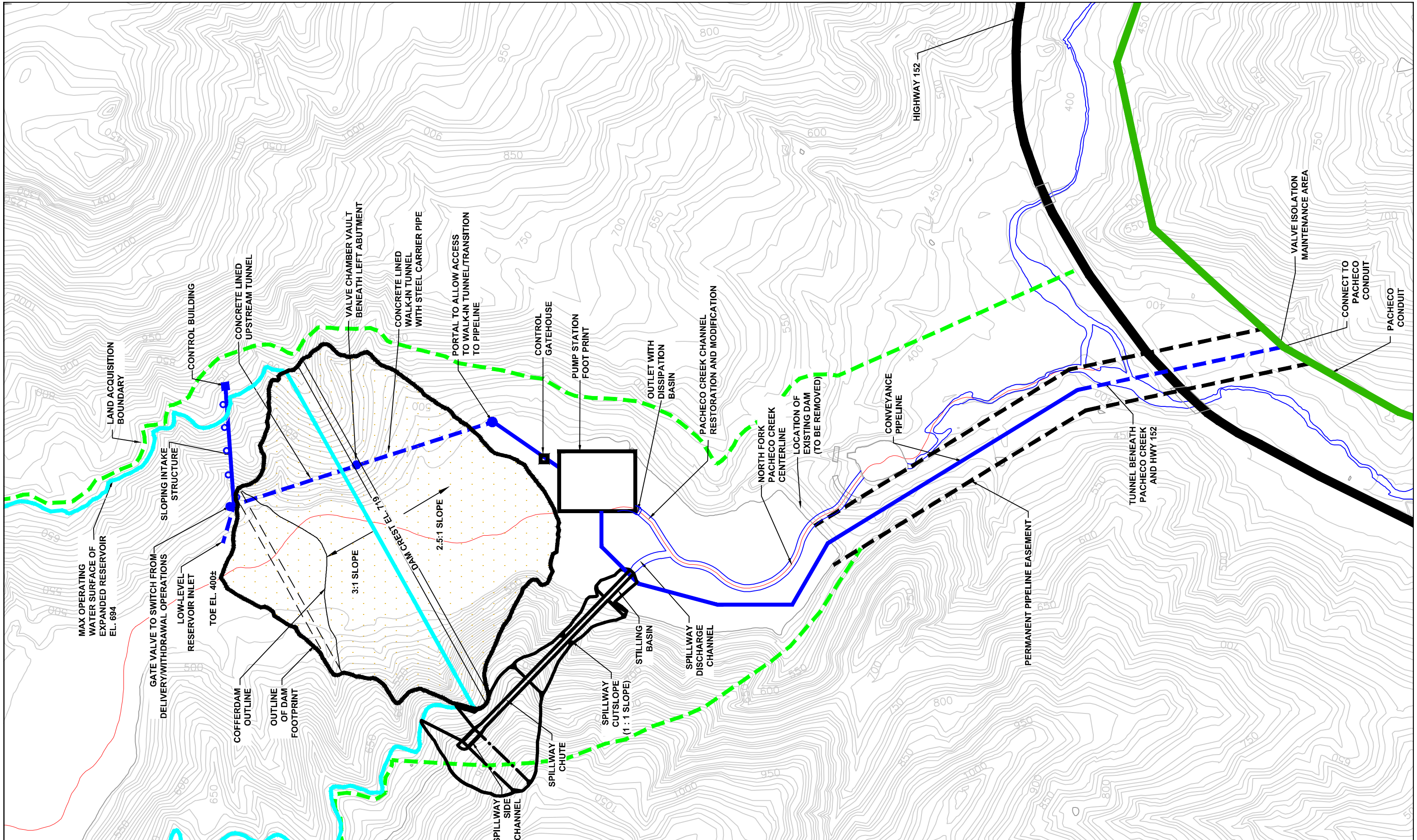
N 0 1.5 3 6 Miles

Prepared: July, 2017
Projection: CA SP III NAD83
Background: DeLorme (Copyright © 2015)
G:\SCVWD_MXDs_Reports\Prop1\Project_Overview_20170725.mxd

Exhibit 1

PROJECT LOCATION AND VICINITY

PACHECO RESERVOIR EXPANSION PROJECT
AUGUST 2017



Stantec

N

SCALE:
1"=500'
0 500

Santa Clara Valley Water District

MAX. WATER SURFACE ELEVATION OF 694 FT
LAND ACQUISITION BOUNDARY
PERMANENT PIPELINE EASEMENT BOUNDARY
EXISTING PACHECO CONDUIT
PACHECO AND NORTH FORK PACHECO CREEK
PACHECO AND NORTH FORK PACHECO CREEK

Exhibit 2

PROJECT SITE FEATURES
PACHECO RESERVOIR EXPANSION PROJECT
AUGUST 2017

Henry W. Coe State Park

Canada de los Osos Ecological Reserve

Cottonwood Creek Wildlife Area

San Luis Reservoir Wildlife Area

Pacheco State Park

Private

Proposed Dam Site

Pump Station

Dam Spillway

Area of Existing Reservoir to be Drained

Lower Pacheco Dam Site *(Existing North Fork Dam)*

Conveyance Pipeline

Connect to Pacheco Conduit

Pacheco Tunnel

Pacheco Conduit

Henry Coe State Park Rd

Red Mountain Rd

Fitzgerald Rd

Dinosaur Point Rd

Whiskey Flat Rd

El Toro

CALIFORNIA 152

Santa Clara Valley Water District

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Existing Tunnel/Pipeline

Proposed Tunnel/Pipeline

Proposed Dam Footprint

Potential Reservoir Footprint

Proposed Dam Contributing Watershed

Private Parcel

State Lands

- State Park
- Canada de los Osos Ecological Reserve
- Cottonwood Creek Wildlife Area
- San Luis Reservoir Wildlife Area

N

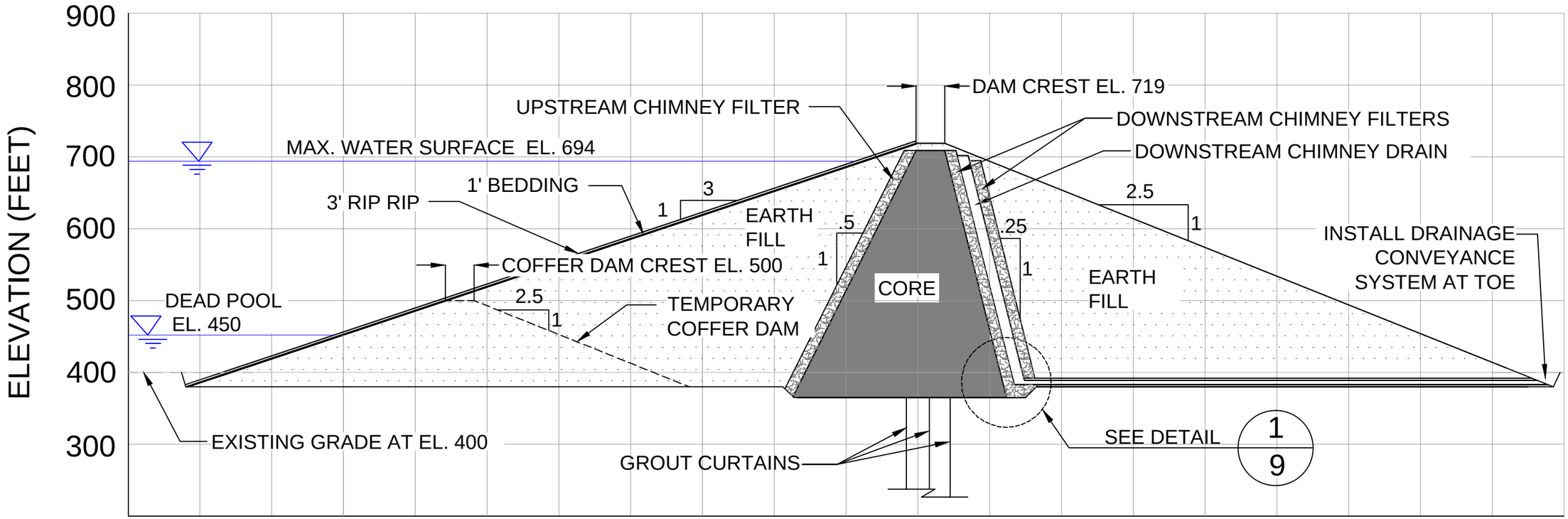
0 2,000 4,000 6,000 Feet

Prepared: July, 2017
Projection: UTM Zone 10 NAD83
Parcel Data: Santa Clara Co. Assessor (2014)
Cons. Easement: TNC (2017)
State Lands: CaSIL (2016)
Background: NAIP (2016)
G:\SCVWD_MXDs_Reports\Prop1\ReservoirArea_AltA_20170725.mxd

Exhibit 3

EXPANDED RESERVOIR FOOTPRINT

PACHECO RESERVOIR EXPANSION PROJECT
AUGUST 2017



0

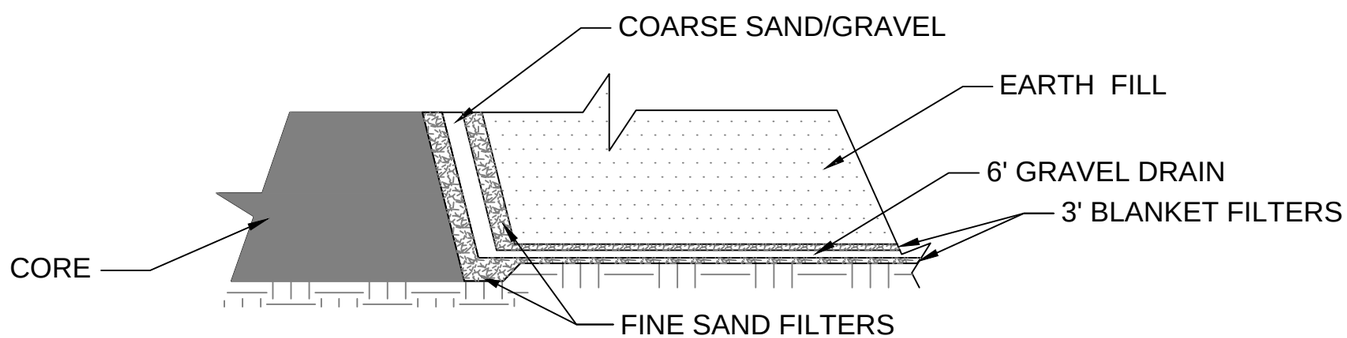
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0 75 150

1,000
HORIZONTAL DISTANCE (FEET)

2,000

CROSS SECTION OF ZONED DAM EMBANKMENT



DETAIL 1/9

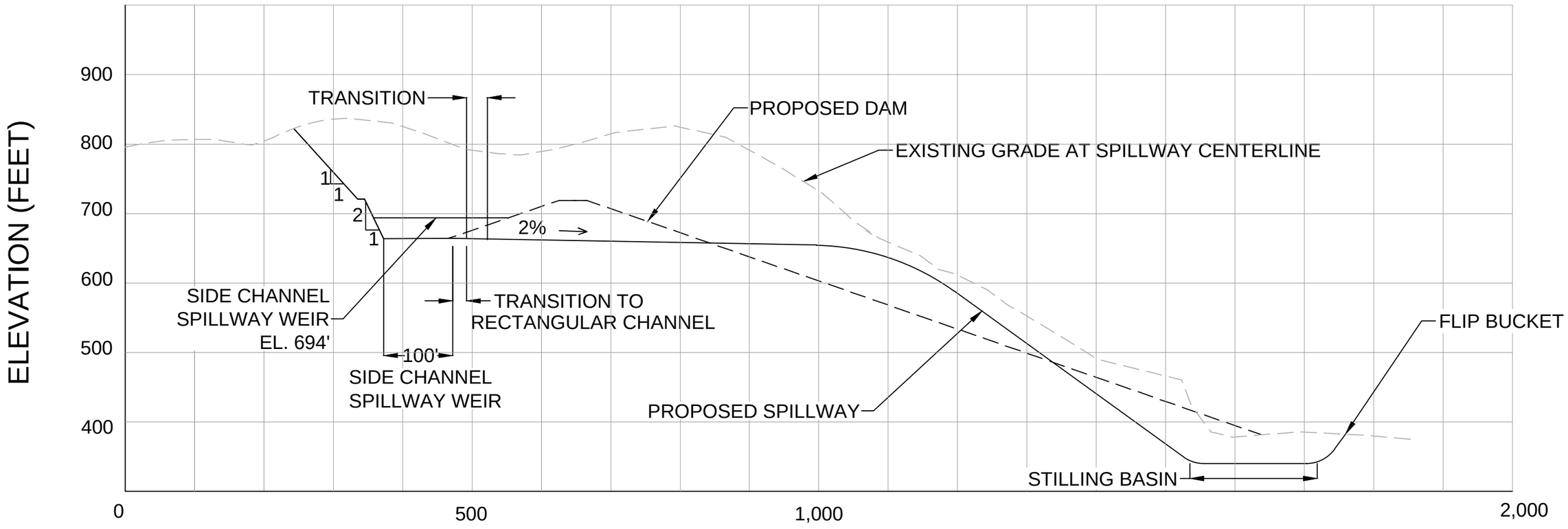
NTS

Stantec

Santa Clara Valley Water District

Exhibit 4

CROSS SECTION OF DAM EMBANKMENT
PACHECO RESERVOIR EXPANSION PROJECT
AUGUST 2017



HORIZONTAL DISTANCE (FEET)

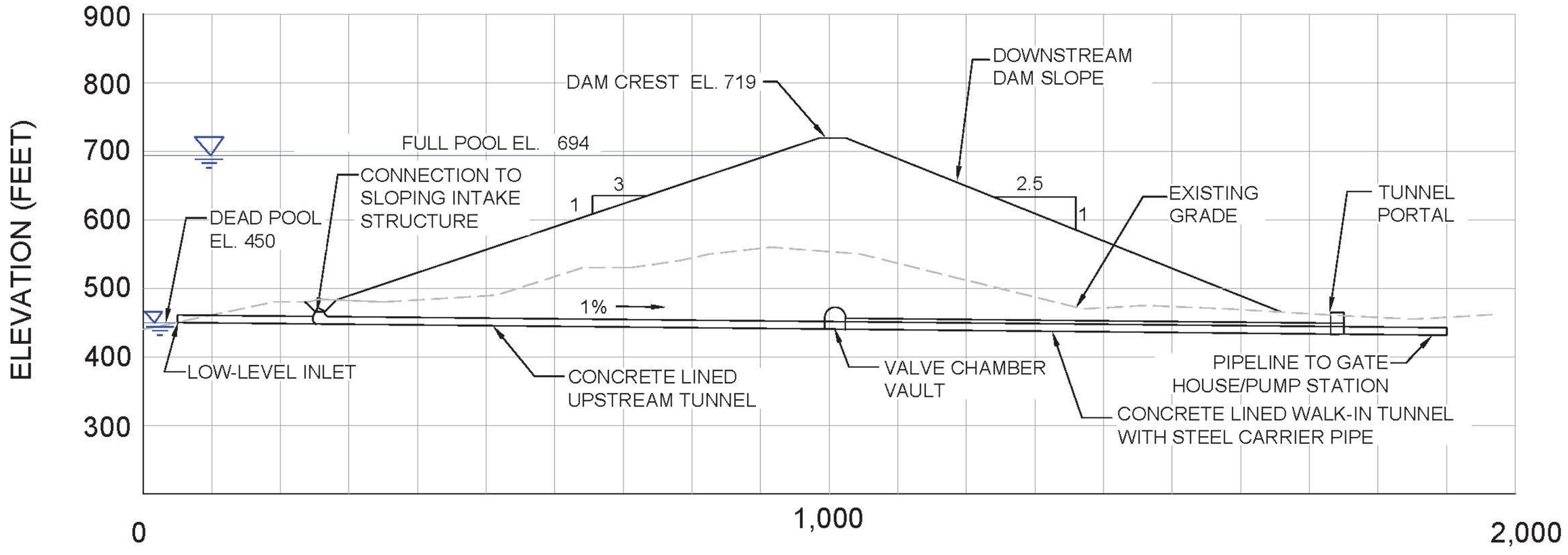
Stantec

SCALE:
1"=150'
0 75 150

Santa Clara Valley Water District

Exhibit 5

SPILLWAY PROFILE
PACHECO RESERVOIR EXPANSION PROJECT
AUGUST 2017



PROFILE - OUTLET TUNNEL

Stantec

SCALE:
1"=150'
0 75 150

Santa Clara Valley Water District

Exhibit 6

OUTLET TUNNEL PROFILE
PACHECO RESERVOIR EXPANSION PROJECT
AUGUST 2017

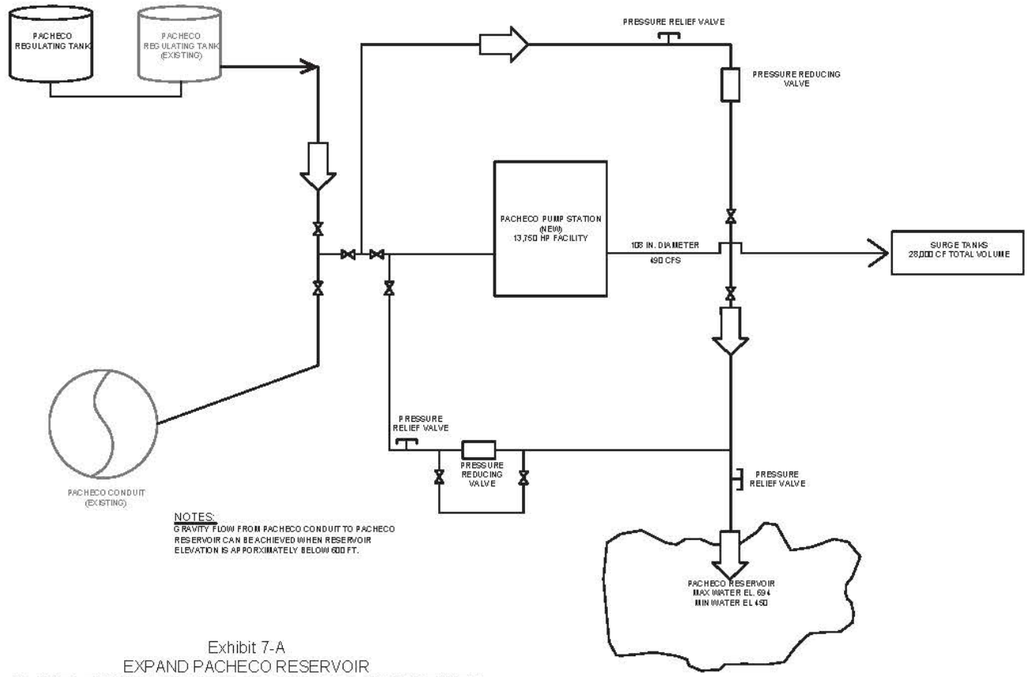


Exhibit 7-A
EXPAND PACHECO RESERVOIR
GRAVITY FLOW TO PACHECO RESERVOIR FLOW SCHEMATIC

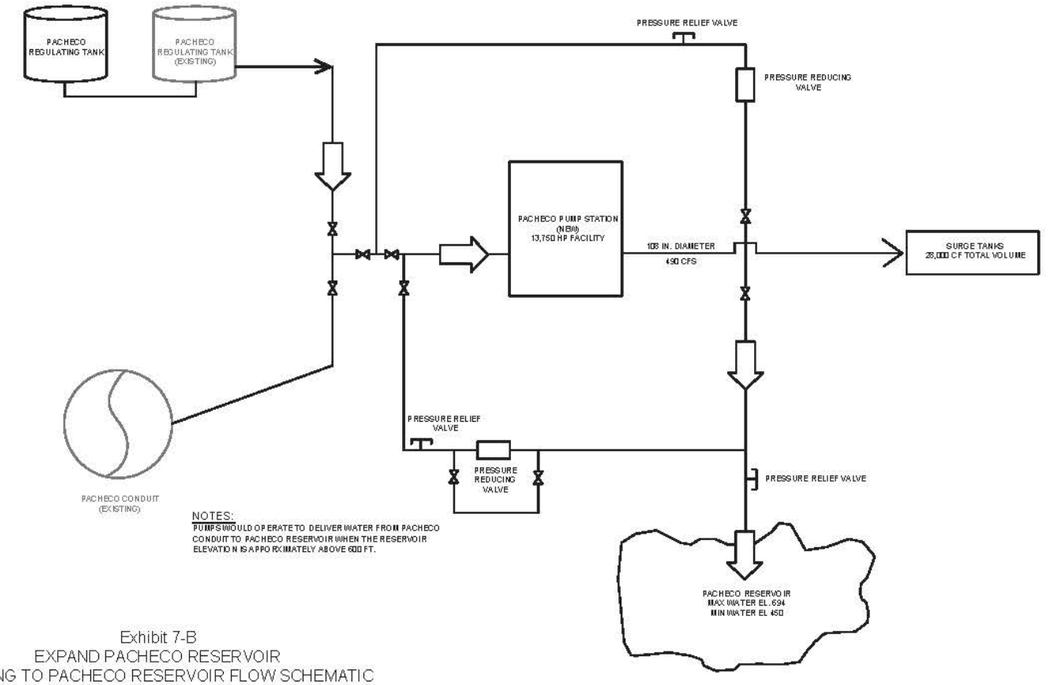


Exhibit 7-B
EXPAND PACHECO RESERVOIR
PUMPING TO PACHECO RESERVOIR FLOW SCHEMATIC

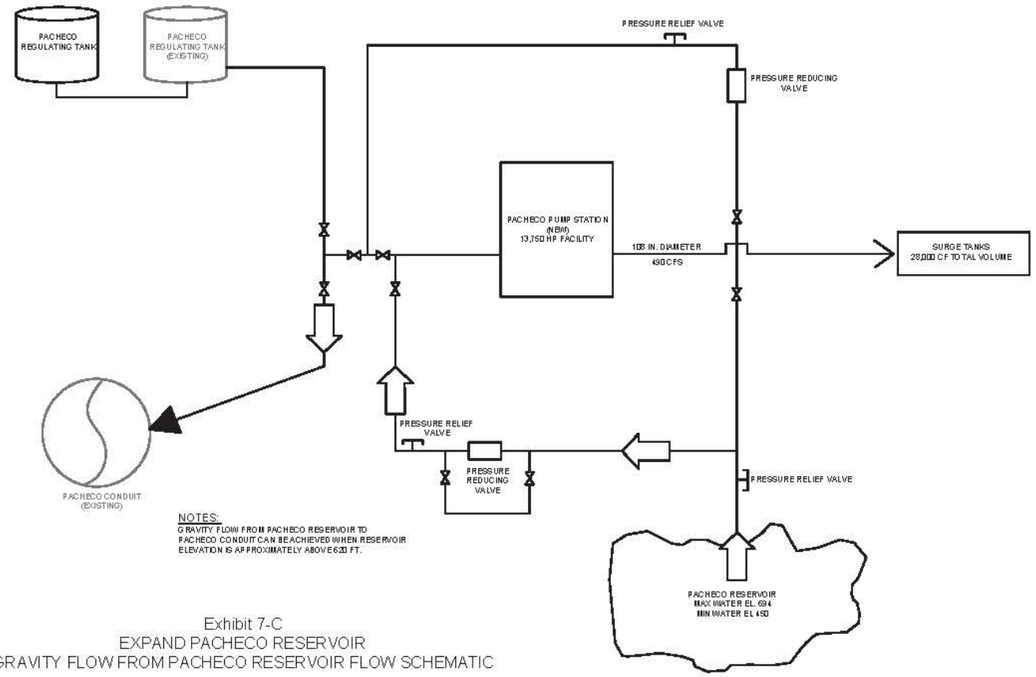


Exhibit 7-C
EXPAND PACHECO RESERVOIR
GRAVITY FLOW FROM PACHECO RESERVOIR FLOW SCHEMATIC

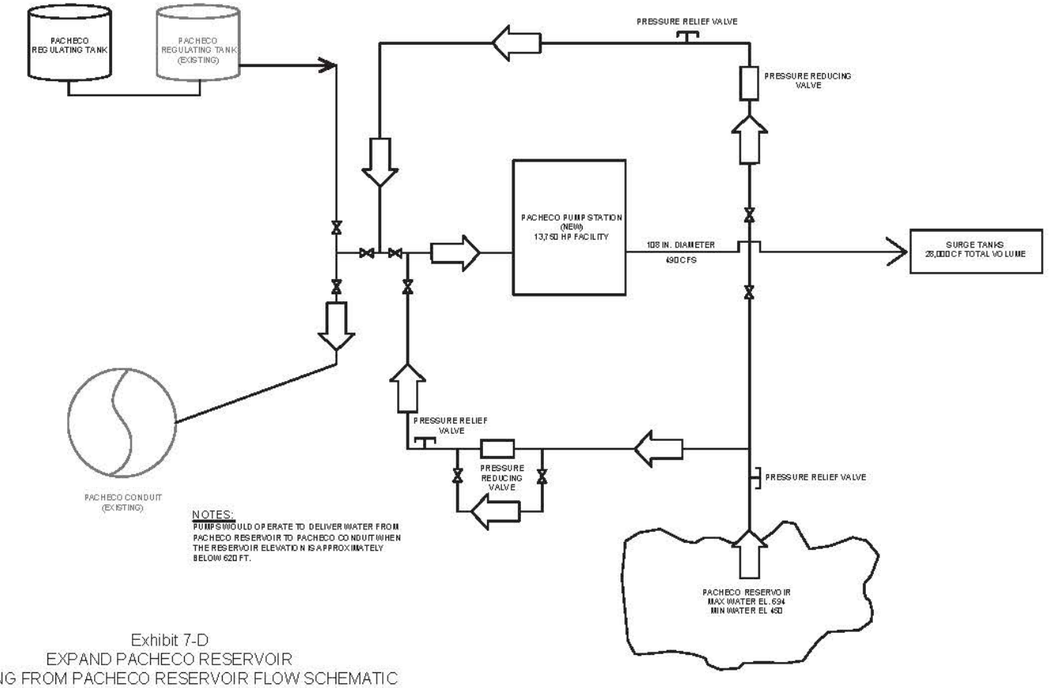


Exhibit 7-D
EXPAND PACHECO RESERVOIR
PUMPING FROM PACHECO RESERVOIR FLOW SCHEMATIC

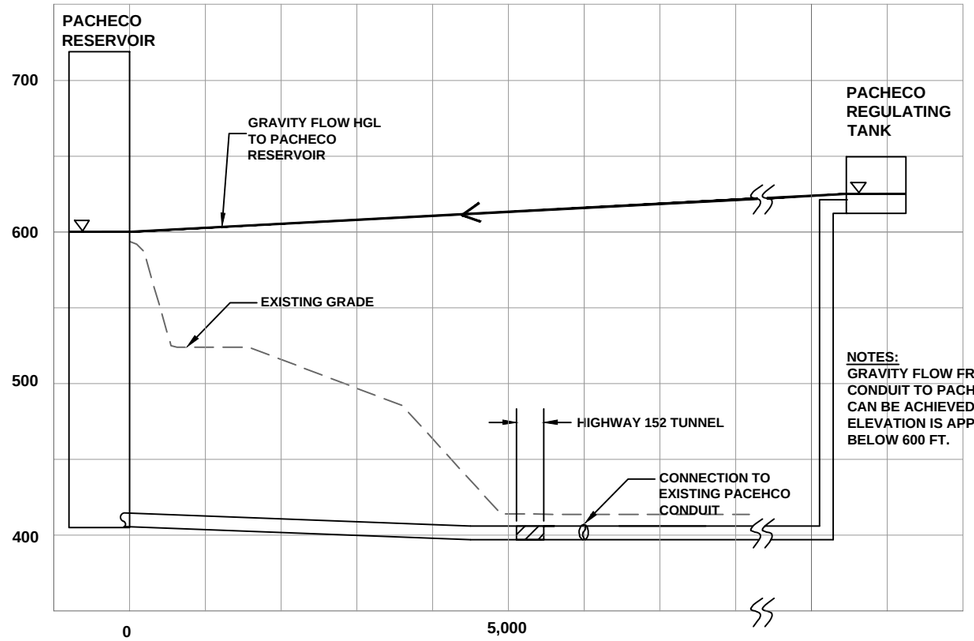
Stantec

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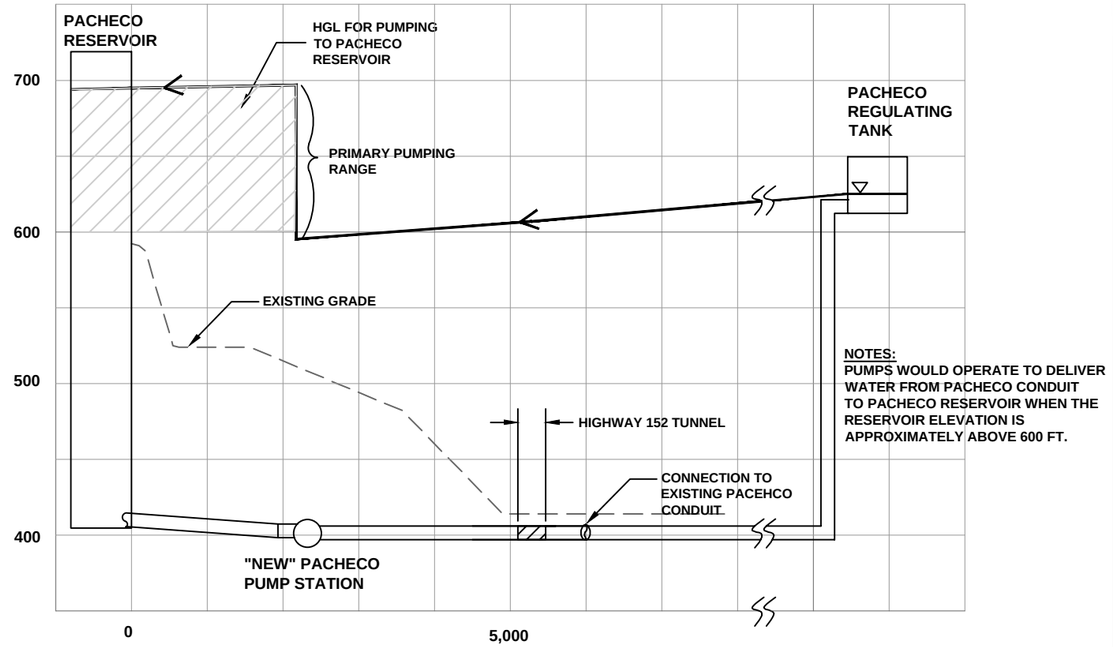
Santa Clara Valley Water District

Exhibit 7

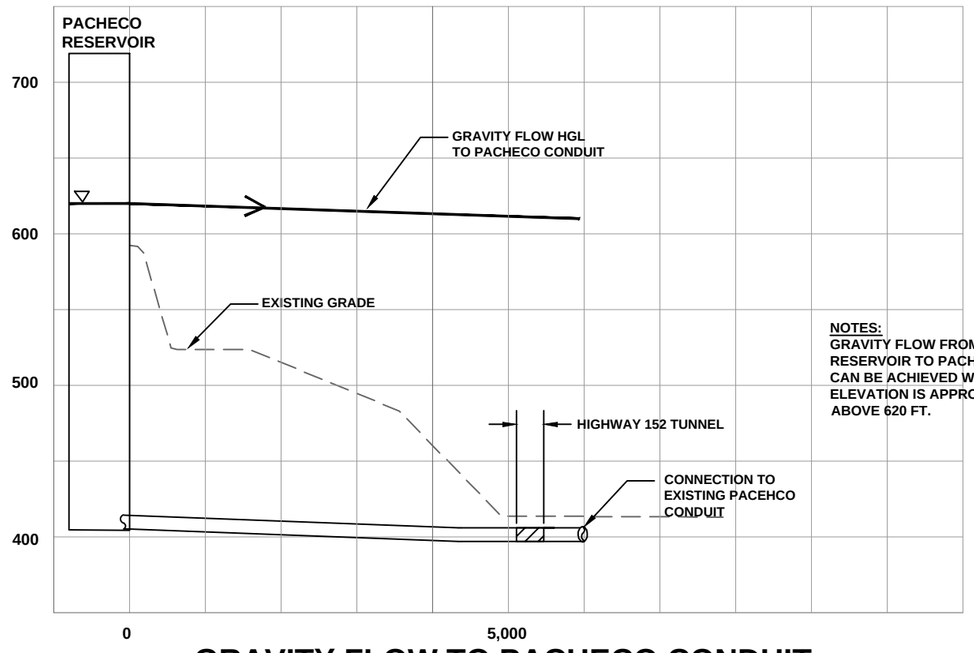
Pump/Gravity Flow Diagram
PACHECO RESERVOIR EXPANSION PROJECT
AUGUST 2017



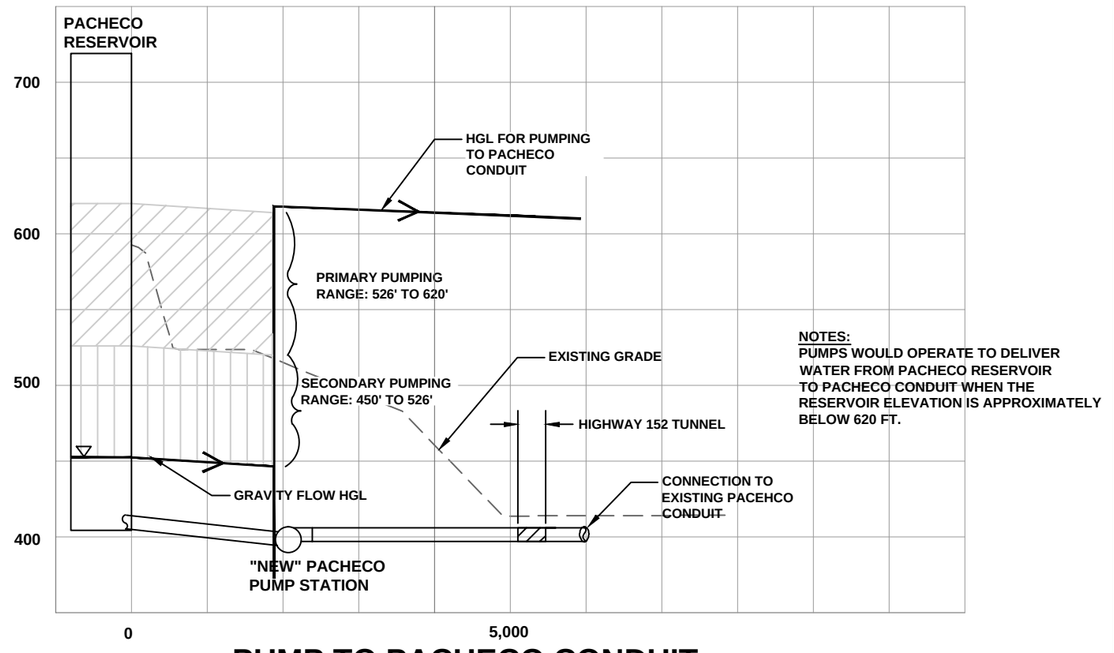
GRAVITY FLOW TO PACHECO RESERVOIR



PUMP TO PACHECO RESERVOIR



GRAVITY FLOW TO PACHECO CONDUIT



PUMP TO PACHECO CONDUIT

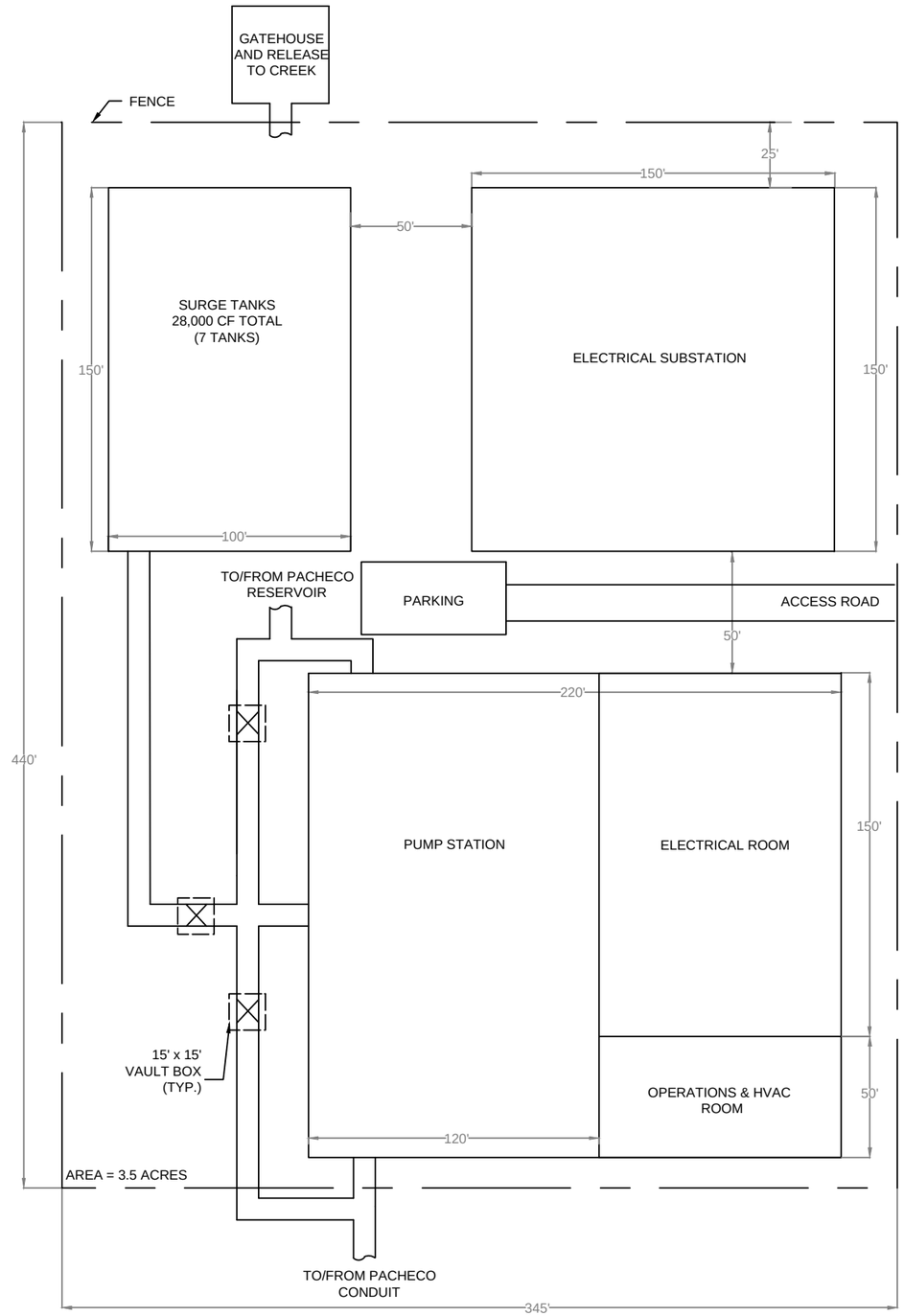
Stantec

SCALE
HOR: 1" = 2,000'
VERT: 1" = 100'

Santa Clara Valley Water District

Exhibit 8

PUMP/GRAVITY HYDRAULIC PROFILE
PACHECO RESERVOIR EXPANSION PROJECT
AUGUST 2017



NOTES:
1) SURGE ANALYSIS WILL BE PERFORMED TO DETERMINE THE SIZE AND NUMBER OF SURGE TANKS REQUIRED, DURING SUBSEQUENT STUDIES

Stantec

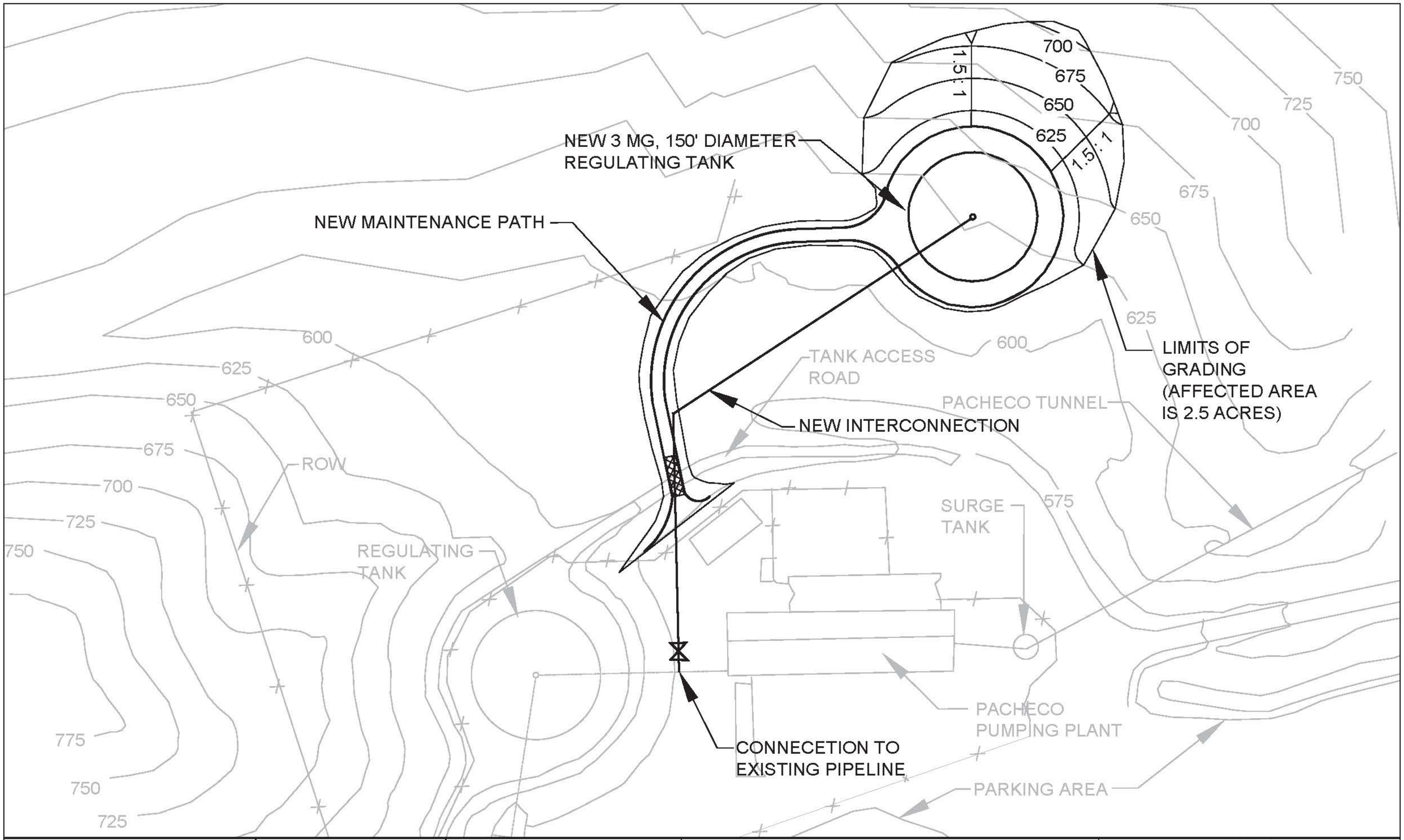
N

SCALE
1" = 60'
0 30 60

Santa Clara Valley Water District

Exhibit 9

PUMP STATION LAYOUT
PACHECO RESERVOIR EXPANSION PROJECT
AUGUST 2017



Stantec

N

SCALE
1" = 100'
0 100

Santa Clara Valley Water District

LEGEND

EXISTING FEATURES
NEW REGULATING TANK & MAINTENANCE PATH
NEW CONTOURS

Exhibit 10

REGULATING TANK at Pacheco Pumping Plant
PACHECO RESERVOIR EXPANSION PROJECT
AUGUST 2017

Henry W. Coe State Park

Temporary Haul Road

Proposed Dam Site

Pump Station

Conveyance Pipeline

Pacheco Tunnel

Pacheco Conduit

Santa Clara Valley Water District

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- Existing Tunnel/Pipeline
- Proposed Tunnel/Pipeline
- Temporary Haul Road
- Proposed Dam Footprint
- Potential Reservoir Footprint
- Existing Pacheco Lake above Proposed Dam
- Contributing Watershed
- Henry W. Coe State Park

Borrow Areas

- Potential Impervious Zone Source *(Landslides and Franciscan Melange)*
- Potential Random Zone Source
- Potential Rock Source

N

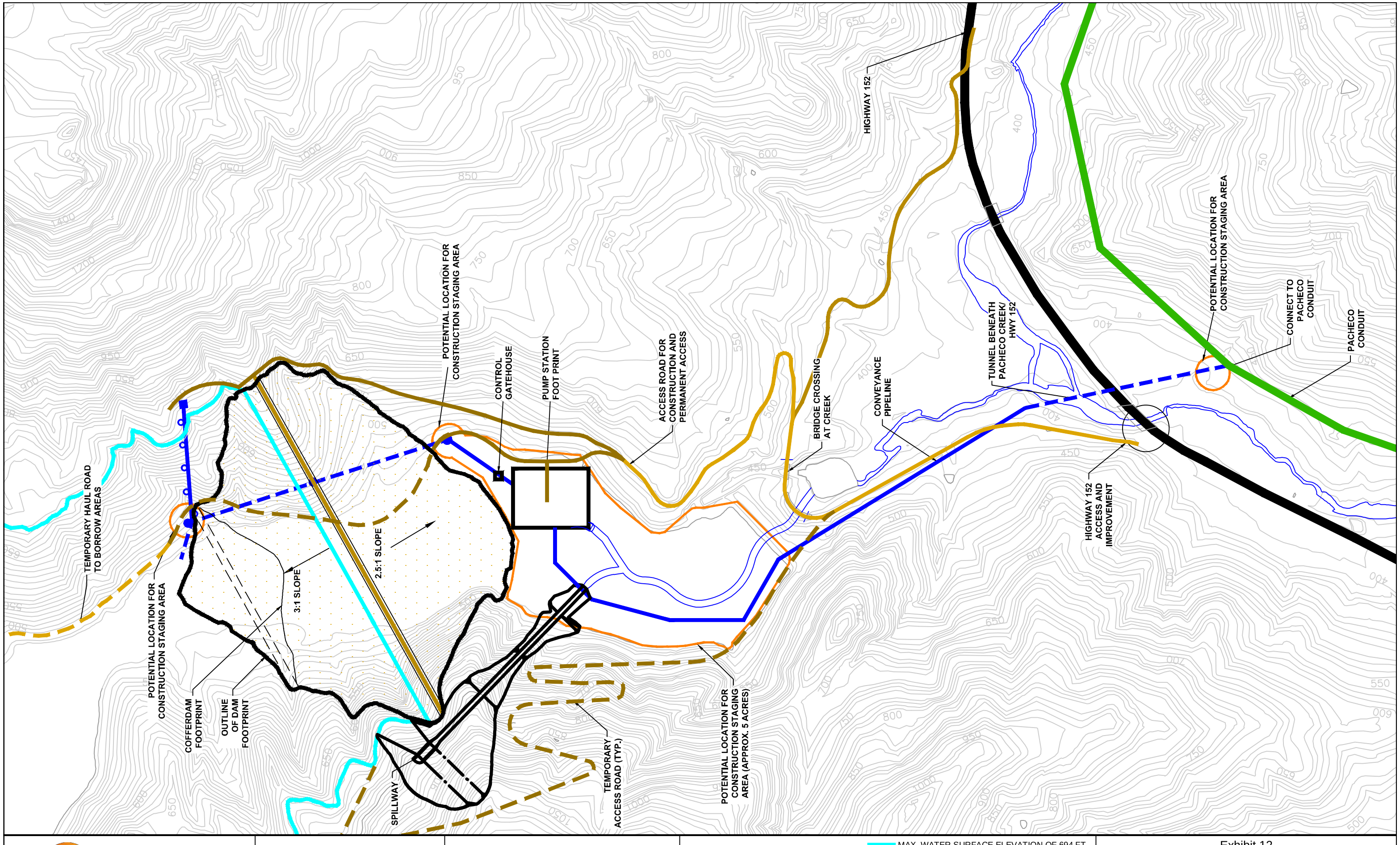
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Prepared: July, 2017
Projection: CA SP III NAD83
Lanslide Data: Cotton (1972)
Borrow Areas: Wahler (1993)
Background: USGS 7.5' Topo
G:\SCVWD_MXDs_Reports\Prop1\ReservoirBorrowAreas_AltA_20170725.mxd

Exhibit 11

BORROW AREAS

PACHECO RESERVOIR EXPANSION PROJECT
AUGUST 2017



Stantec

N

SCALE:
1"=500'
0 500

Santa Clara Valley Water District

- EXISTING PACHECO CONDUIT
- IMPROVEMENT OF EXISTING ACCESS ROAD (TEMPORARY)
- NEW ACCESS ROAD (TEMPORARY)
- MAX. WATER SURFACE ELEVATION OF 694 FT
- IMPROVEMENT OF EXISTING ACCESS ROAD (PERMANENT)
- NEW ACCESS ROAD (PERMANENT)
- POTENTIAL STAGING AREAS

Exhibit 12

CONSTRUCTION ACCESS AND STAGING AREAS
PACHECO RESERVOIR EXPANSION PROJECT
AUGUST 2017

San Luis Low Point Improvement Project Planning Study Report

Appendix B Hydrologic Modeling Technical Report

Prepared for Reclamation by MBK Engineers and CDM Smith under Contract No. R10PC20537

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Attachments

Attachment A. CalSim II Assumptions for Future No Action Conditions
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Chapter 1
Background and Project Description

The purpose of the San Luis Low Point Improvement Project (SLLPIP) is to address the delivery schedule uncertainty and water supply reliability problems with San Luis Reservoir when reservoir storage drops below a certain threshold and low point issues may develop. Low point issues occur when conditions in San Luis Reservoir promote the growth of reservoir-wide algae. Algae blooms generally reach diversion facilities when reservoir storage is at or below 300,000 acre-feet (AF), corresponding to a lake elevation of approximately 370 feet. The first diversion facilities to be affected by algae blooms are intakes for the Pacheco Pumping Plant serving the San Felipe Division of the Central Valley Project (CVP). Water quality within algae blooms is not suitable for municipal and industrial water users and existing water treatment facilities in Santa Clara County, and may not be suitable for agricultural water users with drip irrigation systems in San Benito County. The SLLPIP investigated alternatives to remedy these potential issues and avoid supply interruptions to San Felipe Division contractors due to algae blooms in San Luis Reservoir.

This technical appendix to the Planning Study Report and environmental documentation describes modeling tools and assumptions used in analysis of SLLPIP alternatives. The Planning Study evaluated several alternatives for the ability to satisfy SLLPIP objectives. Each alternative was simulated in a model of the CVP and State Water Project (SWP) to determine effects on water supply for the San Felipe Division, Santa Clara Valley Water District (SCVWD), and effects in other areas of the CVP/SWP[1]. CalSim II model results for each alternative were compared to results of a No Action Alternative to quantify changes in water deliveries, reservoir storage levels, river flows, and CVP/SWP operations in the Sacramento-San Joaquin River Delta (Delta). Simulated water deliveries were used in the economic analysis of each alternative, conducted as part of the Planning Study. Simulated reservoir storage, river flow, Delta outflow and Delta exports were used to evaluate environmental effects during preparation of the Environmental Impact Statement/Environmental Impact Report (EIS/EIR). Key model results are summarized and presented in this report for each alternative. Model results for each alternative were subsequently input to the water supply model used by SCVWD to simulate the local effects of each alternative on the operation and performance of the SCVWD system. Water Evaluation and Planning (WEAP) model results for each alternative were compared to a No Action Alternative to quantify the effects of each alternative

[1] The Treatment Alternative would provide SCVWD uninterrupted access to storage in San Luis Reservoir similar to the access that would be provided by implementation of the Lower San Felipe Intake. As a result, the modeling results presented in this appendix for the Lower San Felipe Intake are utilized in the EIS/EIR and Planning Study Report to evaluate anticipated water supply impacts and benefits for both alternatives.

to local water treatment plant (WTP) deliveries, and local surface and groundwater storage that contribute to SCVWD emergency water supply.

Chapter 2
Water Operations Modeling

Water operations modeling is a key step in the analysis of SLLPIP alternatives. Water operations model results frequently serve as the basis of subsequent economic and environmental analyses. This section provides brief descriptions of the models used to analyze alternatives. Descriptions include model assumptions and modifications made to baseline model files provided by Department of Interior, Bureau of Reclamation (Reclamation). Model limitations for analysis of SLLPIP alternatives are also described.

2.1 Operations Models

Two models were used to analyze effects of SLLPIP alternatives. CalSim II was used to simulate CVP/SWP operations, including San Luis Reservoir and San Felipe Division deliveries. Subsequent analysis includes input of Calsim II CVP and SWP allocation and delivery results for each alternative to a WEAP model of the SCVWD system to simulate the local effects on the operation and performance of the SCVWD system.

2.1.1 CalSim II

Water operations modeling of the CVP/SWP system was performed using CalSim II. CalSim II is a planning model designed to simulate operations of CVP and SWP reservoirs and water delivery systems. CalSim II simulates flood control operating criteria, water delivery policies, in-stream flow, and Delta outflow requirements. CalSim II is the best available tool for modeling CVP and SWP operations and is the primary system-wide hydrologic model used by California Department of Water Resources (DWR) and Reclamation to conduct planning and impact analyses of potential projects.

CalSim II is a simulation by optimization model. The model simulates operations by solving a mixed-integer linear program to maximize an objective function for each month of the simulation. CalSim II was developed by Reclamation and DWR to simulate operation of the CVP and SWP for defined physical conditions and a set of regulatory requirements. The model simulates these conditions using 82 years of historical hydrology from water year 1922 through 2003.

CalSim II modeling conducted for the SLLPIP was developed from a baseline model provided by Reclamation to the project team. A baseline CalSim II simulation at a future level of development (LOD) was developed by Reclamation in January 2015. Baseline studies include actions in the reasonable

and prudent alternatives from National Marine Fishery Service's (NMFS') 2009 Biological Opinion (BO) for Chinook salmon and United States Fish and Wildlife Service's (USFWS') 2008 BO for delta smelt. Additional key assumptions governing CVP/SWP operations in CalSim II are described in Attachment A to this Appendix.

2.1.2 CalSim II Representation of San Felipe Division

Water service contractors supplied through the Pacheco Pumping Plant make up the San Felipe Division of the CVP and include SCVWD, San Benito County Water District (SBCWD), and Pajaro Valley Water Management Agency. Table 2-1 summarizes agricultural and municipal and industrial (M&I) water service contracts, in thousands of AFAF per year, represented in CalSim II for each agency in the San Felipe Division.

Table 2-1. CVP San Felipe Division Annual Contract Quantities (1,000 AFAF)

Agency	Ag Contract	M&I Contract	Agency Total
Santa Clara Valley Water District	33.1	119.4	152.5
San Benito County Water District	35.6	8.3	43.9
Pajaro Valley Water Management Agency	6.3	0.0	6.3
Total by Contract Type	75	127.7	202.7

Calsim II simulates delivery of this contract water through the Pacheco Pumping Plant. CalSim II simulates Reclamation's annual allocation process for agricultural and M&I water service contracts in various divisions of the CVP. CalSim II uses a monthly demand pattern that varies from one month to the next but is the same each year to simulate delivery of CVP contract supplies. Monthly deliveries are subject to model allocations, annual contract amounts, and availability of water to meet contract demands.

2.1.3 Modifications to Reclamation CalSim II Baselines

Baseline models provided by Reclamation required modifications for use in evaluating operations under SLLPIP alternatives, including the Future No Action (FNA). The following sections describe key changes.

2.1.3.1 Refined Export Estimates and San Luis Reservoir Operations

The most significant modification to the baseline model provided by Reclamation was the improvement of Delta export estimates, simulated CVP and SWP allocations, and the operations of San Luis Reservoir. These modifications to CalSim II were made by MBK Engineers in 2015 under a separate contract with Reclamation intended to improve simulated operations of San Luis Reservoir. Additional detail on the specific model changes and the associated effects to CalSim II simulated operations are provided in a technical memorandum from July 2015 (Attachment C).

Model improvements addressed three long-standing issues in CalSim II simulated operations and resulted in a significantly improved operation of San Luis Reservoir. The first improvement involved replacing static input tables of estimated Delta export capacity used in allocation logic. These tables were replaced with an iterative process that uses prior simulations to develop more reliable, and more realistic, Delta export estimate forecasts.

The second improvement was to address instances where simulated CVP allocations to south-of-Delta water service contractors (SOD allocations) were low, yet a significant volume of water remained in the CVP portion of San Luis Reservoir. Under these conditions, Reclamation is likely to increase SOD allocations to deliver the water that is already in storage. This model improvement tends to increase allocations and further draw down storage in the CVP portion of San Luis Reservoir in dry periods, particularly during the 1932 through 1934 period.

The third improvement with implications to the operation of San Luis Reservoir and the SLLPIP were modifications to the San Luis target storage levels, or "rulecurve", in CalSim II. The purpose of rulecurve is to prioritize balance between storage in north-of-Delta (NOD) reservoirs and San Luis Reservoir for both the CVP and SWP. Rulecurve controls release from NOD reservoirs for export when there is a choice between storing water in NOD reservoirs and releasing water for export and storing it in San Luis Reservoir. Rulecurve was improved to better simulate the scheduling of releases and Delta exports to balance storage in CVP and SWP reservoirs.

Each of these three model improvements affect the simulated operation of San Luis Reservoir in CalSim II and improved a previous deficiency in model operations for the SLLPIP.

2.1.3.2 San Felipe Division M&I Delivery Interruptions

CalSim II was modified to simulate San Felipe Division M&I water service delivery interruptions that may occur due to low point issues. Simulated deliveries to M&I water service contractors were interrupted when previous end-of-month combined CVP and SWP storage in San Luis Reservoir was less than 300,000 AFAF. Interrupted San Felipe Division M&I water service contract deliveries were not rescheduled or delivered in later months. This water was simulated as remaining in San Luis Reservoir and available for allocation in future years. San Felipe Division agricultural water service deliveries were simulated to occur as long as storage in CVP San Luis Reservoir was above dead pool.

2.1.4 Level of Development

CalSim II simulations at a projected LOD are used to depict how the modeled water system might operate with an assumed physical and institutional configuration imposed on a long-term hydrologic sequence. A future LOD study is needed to explore how the system may perform under an assumed

future set of physical and institutional conditions. This future setting is developed by assuming year 2030 land use, facilities, and operational objectives and is used for the FNA Condition for the National Environmental Policy Act (NEPA) analysis.

A FNA CalSim II simulation depicts how the Delta, its major tributaries, and the CVP/SWP may operate in the future without the Project. Areas tributary to the Delta have experienced numerous physical and institutional changes over the years, and are continuing to experience change. Projecting the availability of facilities, institutional, and regulatory requirements, and the practices that will affect the management of future water supplies and demands is a daunting task. Nevertheless, reasonable assumptions must be made regarding these items to estimate future conditions. These assumptions include actions in the reasonable and prudent alternatives from NMFS' 2009 BO for Chinook salmon and USFWS' 2008 BO for delta smelt.

2.1.5 CalSim II Limitations

There are limitations to the use of CalSim II for most projects. A key limitation for the SLLPIP analysis is the ability to adequately simulate San Luis Reservoir operations. CalSim II is the only available model that adequately simulates the integrated operations of the CVP and SWP both north and south of the Delta; therefore, it must be relied upon as the foundation of most studies that affect CVP/SWP operations. However, CalSim II was developed primarily to simulate reservoir operations upstream of the Delta, Delta conditions and exports. CalSim II does not consider several variables that affect San Luis Reservoir storage. An understanding of the limitations of CalSim II for the analysis of SLLPIP alternatives is necessary to properly characterize results.

One method for evaluating model adequacy is to compare model results with observed data. Unfortunately, this method is no longer appropriate for CalSim II and San Luis Reservoir storage. CalSim II assumptions for the Future No Action Alternative include actions in the reasonable and prudent alternatives from USFWS' 2008 BO for delta smelt and NMFS' 2009 BO for Chinook salmon. These two operational constraints were added to the system in 2008 and 2009, respectively. Requirements contained in the BOs result in significant operational changes including changes in upstream reservoir release, the ability to move water through the Delta, and the operation of both the CVP and SWP portions of San Luis Reservoir. CVP/SWP operators have operated to these requirements since 2009 providing only a few years of observed data under the BOs. The CalSim II simulation period does not include the historical hydrology for this period. Therefore, there is no common period between the model and observed data under a similar regulatory condition. A comparison of historical San Luis Reservoir storage and simulated storage under the BOs illustrates the change in regulatory requirements, but is not useful for understanding model limitations.

2.1.6 Santa Clara Valley Water District's WEAP Model

SCVWD uses the WEAP system model developed by the Stockholm Environment Institute's U.S. Center. WEAP is a software tool for water resources planning. WEAP uses a database to maintain water demand and supply information and drive the mass balance on a link-node architecture. In addition, the model evaluates a full range of water development and management options, and takes account of multiple and competing uses. The following model description was adapted from a document provided by SCVWD staff.

2.1.6.1 General Model Description

The SCVWD WEAP model is designed primarily to simulate SCVWD's local water system of facilities that recharge Santa Clara County's groundwater basins, operation of its reservoirs and creeks, existing and proposed treatment and distribution facilities, and raw water conveyance system of imported water. WEAP also accounts for non-District sources and distribution of water in Santa Clara County , including: imported water from the Hetch-Hetchy System, recycled water, and local water developed by other agencies. WEAP was formulated to simulate the total management of current and future water resources within Santa Clara County.

WEAP operates on a monthly time-step, and can simulate any defined set of hydrologic years with either fixed demands or any sequence of yearly demands. For this analysis, WEAP used an 82-year hydrologic record consistent with CalSim II.

WEAP is primarily a surface water supply simulation model. However, WEAP does track groundwater basin storage as a mass balance of inputs and outputs. The central focus of WEAP results is typically operation of the County's groundwater basins; the artificial recharge of sufficient water such that total natural and artificial recharge balances demands on the basins within the bounds of operational basin storage capacity. WEAP can also pass pumping demand data and recharge data to SCVWD's groundwater models to ensure basin storage results are in-line with groundwater model determinations.

2.1.6.2 Major Components of WEAP

WEAP has a data structure composed of five major systems: water demands, groundwater, local surface water, treated water, and raw water conveyance. Each major system is described in further detail below.

2.1.6.2.a Water Demands System

The water demands system is designed around a long-standing division of the County into water service areas that are closely associated with water retailer areas. Areas that are not served by a retail water agency are delineated using geographic and/or hydrologic boundaries. Water demand data have been developed using another model that uses census data and growth projections to generate annual service area water demands. These water demands are then

reconciled with each retailer's Urban Water Management Plan for growth projections.

Water is delivered to meet demands according to availability, and priority. Commonly, the lowest priority source of supply (or last to be used to meet service area demands) is groundwater. Therefore, service area groundwater pumping is calculated as the supply necessary to meet service area water needs after taking into account conservation, treated water, and other available alternate supplies for a specific service area.

2.1.6.2.b Groundwater System

The groundwater system comprises the County's three groundwater subbasins and is currently depicted in WEAP with each basin having specific recharge, pumping, and subsurface inflows and outflows. Recharge occurs through streams and existing or planned recharge ponds that are located over the groundwater basins. Groundwater pumping is simulated to occur in water service areas associated with each basin.

The most northern basin is called the Santa Clara Valley basin. The central basin is called the Coyote basin. The southern basin is called the Llagas basin. One of the primary objectives of WEAP's Groundwater System is to determine if the basins all stay within their respective operational storage capacities and subsidence does not occur.

2.1.6.2.c Local Surface Water System

The local surface water system contains the major watersheds and their respective streams. The major streams, as used in WEAP, are those that are either: (1) controlled by a storage reservoir; (2) receive imported water; or (3) directly affect flow of a stream that is controlled by a reservoir or receives imported water. Each major stream that is processed by WEAP is defined as either regulated (controlled by reservoir releases) or unregulated (not controlled by a reservoir).

Regulated stream flow data are defined in WEAP as monthly unimpaired flows at the various reservoirs sites and downstream accretions between the reservoir and the basin boundary. Unregulated stream flows are defined in WEAP as monthly stream flows of the unregulated streams at the upstream basin boundary.

Recharge ponds are another part of the local surface water system. Recharge ponds can be connected to streams and/or raw water pipeline turnouts and can provide a source of recharge for associated groundwater basins.

Each major stream and recharge pond are defined within this system with a monthly recharge rate based on observed historical rates. Each stream has a variety of methods for connecting to other streams, reservoirs, ponds and raw water piping node recharge turnouts.

2.1.6.2.d Treated Water System

The treated water system, as depicted in WEAP, is comprised of a number of subsystems which simulate operation of SCVWD's distribution systems and three treatment plants: Rinconada, Penitencia, and Santa Teresa.

2.1.6.2.e Raw Water Conveyance System

The raw water conveyance system comprises the pipelines, canals, conduits, pumping plants, and other related facilities used to convey both imported and local raw water to recharge facilities, treatment plants, reservoirs, and other miscellaneous raw water turnouts.

Two imported water supplies are simulated in WEAP. One is from the South Bay Aqueduct (SBA) of the SWP and the other is from the San Felipe Division of the CVP. Raw water supplies available from the SWP/CVP are provided through contracts with the State and Federal governments. SCVWD's SWP maximum contract is for 100,000 AF annually of Table A water. SCVWD's CVP maximum contract is for 152,500 AF annually. WEAP relies on CalSim II's representation of CVP/SWP operations and deliveries through the SBA and Pacheco Pumping Plant, by using CalSim II output for CVP and SWP allocations and deliveries as input.

SCVWD participates in a water banking and exchange program with the Semitropic Water Storage District in Kern County. In wetter years, SCVWD is able to store excess Delta-conveyed water in the Semitropic groundwater bank for later use, particularly in dry years. This operation is defined in WEAP.

A banking arrangement with agencies from outside of Santa Clara County is also defined in WEAP to store excess imported supplies in wet years and draw upon these banked supplies in drought years.

2.1.6.2.f System Water Needs

WEAP's first major step in the analysis process is establishment of system water needs. Annual projected total water needs, expected water conservation savings, and expected sources of supply for each water service area are defined by the user. Sources of annual supplies are:

(1) Treated water from Rinconada, Penitencia, and Santa Teresa

(2) Other sources not managed by SCVWD (e.g. Hetch-Hetchy System)

(3) Raw surface water deliveries from SCVWD's raw water pipelines

(4) Recycled water from existing or proposed facilities

(5) Groundwater

(6) Water conservation

All or any combination of the above sources of water may be available to a service area. Groundwater pumping is computed by WEAP as the difference between a service area's total annual demands and its other annual sources of supplies.

2.1.6.2.g Operation of Local Facilities

WEAP then simulates reservoir operations using the defined storage rule curve for each reservoir. Rule curves define how much water can be released from the reservoir to meet remaining recharge capacity in ponds and streams connected to the regulated outlet stream. Reservoirs can also be connected to raw water pipelines and release water to meet these demands. When the reservoir is simulated to spill water, some of this excess can be moved to a pipeline if conveyance and demand allow. In times of excess imported CVP/SWP supply, reservoirs connected to a pipeline can store excess imported supply if conveyance and storage capacity allow. Monthly reservoir inflow is defined for each reservoir, and reservoir evaporation is calculated based on observed historical rates.

2.1.6.2.h Operation of Raw Water System

The raw water system serves as the nucleus of WEAP, determining how much and where imported water will be delivered through pipelines to WTPs and recharge turnouts. For the distribution of imported water, WEAP can draw its first priority supplies from either the SBA or the San Felipe Division. When needed, releases from any defined water banks and reservoirs connected to pipelines will be initiated.

Priorities are also defined by the user to determine the order of where the imported water is distributed. When there is not enough water to meet all facility needs, or conveyance of all water is not possible, reductions are made by WEAP according to the following priorities:

(1) Excess raw water to reservoirs connected to pipelines, and banking facilities outside of the County

(2) Raw water delivered to recharge facilities

(3) Raw water surface deliveries

(4) Raw water delivered to meet the needs of SCVWD's various treatment plants

WEAP was used to simulate SCVWD's water operations for each alternative, including the no action alternative, at a future LOD. CalSim II output for CVP and SWP allocations and deliveries were provided to SCVWD staff for each alternative to run WEAP and summarize results. WEAP results include local reservoir operations, flows at key locations, groundwater banking operations,

and SCVWD's ability to meet service area demands. WEAP output for treated water deliveries was a key input to the economic evaluation.

2.2 Supplemental Support for Modeling Results

As discussed in the previous sections, CalSim II is the only tool available that includes the majority of the system components and inputs that affect storage conditions in San Luis Reservoir. An accurate simulation of San Luis Reservoir is extremely difficult to achieve because myriad factors and human decisions affect it. CalSim II's simulation of a future condition represents only one of many possible future conditions. Additional understanding of the potential range of future conditions may be gained from review of historical hydrology and system conditions.

An understanding of the historical hydrology and CVP SOD operations were combined to provide supplemental information to accompany CalSim II modeling results. A review of the hydrology identified conditions and factors that contribute to, or help prevent the occurrence of low point issues. The frequency of occurrence for those contributing and preventing factors can help identify years when low point issues are more and less likely. The frequency of occurrence of factors or combinations of factors can define a minimum and maximum number of years when low point issues are more likely to occur. This information provides a model-independent estimate of the range of potential low point occurrences and helps support CalSim II model results.

CVP operators currently target drawing down the CVP portion of San Luis Reservoir to minimum pool each year when making allocations. Reasons why CVP storage stays above or dips below minimum pool can be characterized as either supply or demand factors. Supply factors include reservoir inflows north and south of the Delta, the availability of local supplies or surplus flows south of the Delta, and unforeseen increases or reductions in Delta exports. Demand factors include meteorological conditions such as temperature, wind, and precipitation that drive evapotranspiration from crops and changes in cropping patterns that influence the timing of demand for water from San Luis Reservoir.

Reclamation currently uses conservative forecasts for both supply (90% exceedance for reservoir inflows) and demand. The use of conservative forecasts reduces the number of times actual inflow is less than forecasted inflow or actual demands exceed forecasts. Low point issues are more likely to occur when actual demands are at or above forecasted demands and/or supplies are at or below forecasted supplies. A review of the historical hydrology and data was made to estimate how frequently the actual factors that influence supply and demand are more likely to be significantly different from forecasted values. Supply factors include reservoir inflows, water year types, water supply forecasts, and spills into Mendota Pool. Demand factors include temperature, precipitation, and evapotranspiration data. Data for most of these factors was

previously collected and analyzed to determine the feasibility of predicting potential low point issues. The same data were analyzed to determine the frequency of occurrence for factors that contribute to or help prevent low point issues. The frequency of occurrence for these factors can define a minimum and maximum number of years wherein low point issues are more likely to occur. This analysis attempts to determine the likely range or number of years when low point issues are more likely to occur. A worst case scenario would result in a low point condition occurring every year, whereas low point conditions would never occur in a best case scenario.

Sacramento and San Joaquin Valley Water Year indices can be used as one metric for evaluating factors that may tend to increase or decrease San Luis Reservoir storage conditions.

The Sacramento River is the largest river flowing into the Delta and carries water released from upstream CVP and SWP reservoirs. Water stored in San Luis Reservoir is exported from the Delta. The Sacramento Valley Index is one metric to define overall water supply conditions in the Sacramento Valley and is one supply factor for determining conditions that may increase or decrease the likelihood of low point conditions.

The San Joaquin Valley Water Year Index (SJR Index) is an indicator of hydrologic conditions in much of the area supplied by San Luis Reservoir. Conditions on the San Joaquin River can be an indicator of conditions on other rivers and creeks that serve as local supplies to areas also served from San Luis Reservoir. For example, the SJR Index can be an indicator of flow from the Kings River through James Bypass to Mendota Pool and spills from Friant Dam down the San Joaquin River to Mendota Pool. Spills into Mendota Pool during the April through September irrigation season reduce deliveries from San Luis Reservoir and decrease the likelihood of low point issues. Figure 2-1shows the frequency of such spills and the SJR Index in years when spills occur.

Figure 2-1 shows that historically there have been large volumes of water spilled into Mendota Pool from both the San Joaquin and Kings rivers when the SJR Index is wet. San Joaquin River spills are expected to decrease with implementation of San Joaquin River Restoration, but Kings River spills are likely to continue. While there can be differences between conditions in the northern and southern San Joaquin Valley, or the east and west sides of the San Joaquin River, the SJR Index generally indicates the availability of local water supplies. When the SJR Index is wet or above normal, there is typically more local supply available and less demand for water from San Luis Reservoir and vice versa. In this way, the SJR Index can be an indicator of demand for water from San Luis Reservoir.

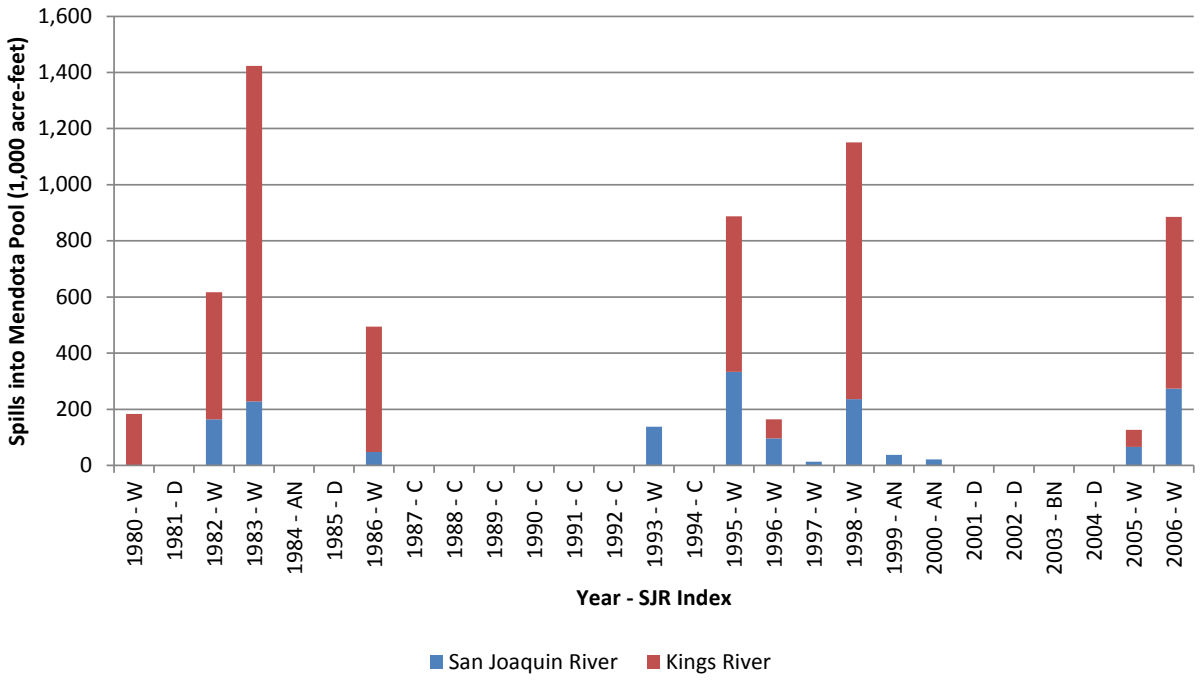


Figure 2-1. Total April through September Spills into Mendota Pool

Another indicator of demand may be obtained through analysis of historical temperature data. While numerous factors contribute to crop evapotranspiration and thereby water requirements, temperature is one of the main components and long-term data records of temperature are readily available. Daily temperature records for five locations throughout the San Joaquin Valley were reviewed and analyzed to determine years that were consistently above or below long-term average temperatures from April through September. The period of analysis was the 82-year period of historical hydrology simulated in CalSim II. Stations included in the analysis include Coalinga, Bakersfield, Hanford, Los Banos, and Visalia. Long-term average monthly temperatures were calculated for each station based on the available record. The difference between recorded daily temperature and average monthly temperature were summed for the April 1 through September 30 period each year. These degree-day differences for each station were analyzed to determine years when the stations were consistently above or below the average monthly temperature for the entire season. Data were not available for all years at all stations, but results reflect data for at least three stations for any year identified as consistently above or consistently below average. These results are summarized by SJR Index in the following figure.

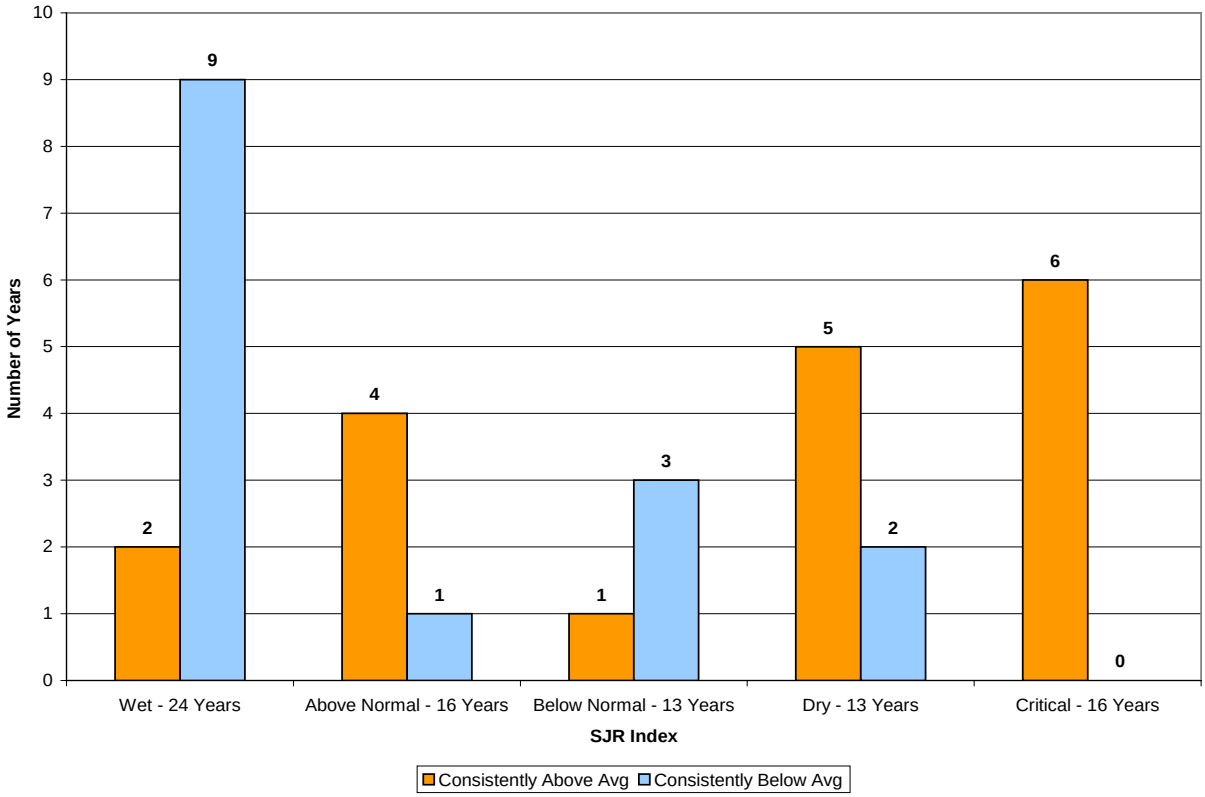


Figure 2-2. Years with Temperatures Consistently Different from Long-Term Averages throughout the CVP SOD Service Area

Figure 2-2 illustrates that out of the 82 years analyzed, in 18 years the majority of the stations analyzed show consistently above average temperatures with 11 of those years being classified as dry or critical (5 dry years and 6 critical years) according to the SJR Index on a calendar year basis. Conversely, 15 years show consistently below average temperatures with 10 of those years being classified as wet or above normal (9 wet years and 1 above normal year) according to the SJR Index. The combination of dry conditions and higher temperatures increase demand for water from San Luis Reservoir, and are more likely to result in low point conditions.

Storage levels at low point are also highly dependent on human decision-making including allocations made by CVP operators and water user's response to storage conditions in San Luis Reservoir. Low point conditions will tend to occur when water supplies are less than runoff forecasts, and/or demands exceed forecasted demands used for seasonal operations plans and allocations. Low point conditions may occur outside of dry or critical years, and may not occur in every dry or critical year. However, the combination of dry and critical years with consistently higher temperatures, and therefore demands, are more

likely to lead to low point conditions than wet years when demands are lower than forecasted.

Based on Figure 2-1 and Figure 2-2, it is possible to estimate the number of years when low point conditions are more and less likely. Table 2-2 is a summary of this analysis.

Table 2-2. Number of Calendar Years in Period of Analysis when Low Point Issues are More and Less Likely

Water Year Index	Sacramento Valley Index Years	SJR Index Years	Above Average Temperature	Below Average Temperature	Low Point More Likely[1]	Low Point Less Likely[2]
Wet	26	24	2	9	-	9
Above Normal	12	16	4	1	4	1
Below Normal	14	13	1	3	1	-
Dry	18	13	5	2	5	-
Critical	12	16	6	0	6	-
Total	82	82	18	15	16	10

[1] Assuming spills into Mendota Pool decrease the likelihood of low point issues in all wet years and above average temperatures in any other year increase the likelihood of low point issues.

[2] Assuming spills into Mendota Pool combined with below average temperatures in wet and above normal years decrease the likelihood of low point issues.

Table 2-2 shows that in the 82 (calendar) years analyzed, there are 16 years when low point conditions are more likely and 10 years when low point years are less likely to occur. These values, combined with the 82-year period of analysis, can be viewed as potential bookend values for how often low point issues may occur. The maximum number of years when low point issues may occur is 72, 82 minus 10 years when low point is less likely. The minimum number of years when low point may occur is 16, assuming low point issues occur in every year defined as more likely in Table 2-2. The FNA Alternative used for the economic analysis provides one scenario when low point issues occur in 17 years (on a calendar year basis). The distribution of low point years by Sacramento Valley and San Joaquin Valley Index are provided in Table 2-3.

Table 2-3. Number of Low Point Years by Sacramento Valley and San Joaquin Valley Index for FNA

Index Year Type for the Future No Action Alternative	Low Point Years: Sacramento Valley Index	Low Point Years: San Joaquin Valley Index
Wet	0	0
Above Normal	3	0
Below Normal	3	4
Dry	4	5
Critical	7	8
All Years	17	17

Based on the analysis of historical hydrology and temperature, these CalSim II results are within the range of a model independent analysis of potential low point occurrence.

Chapter 3
Future No Action Alternative

The following section describes the SLLPIP Future No Action Alternative and summarizes key model results for the alternative.

3.1 Future No Action Conditions: CalSim II

Results from the FNA Alternative simulation are used to depict operation of the CVP and SWP without SLLPIP alternatives at a future LOD. FNA results are used in a comparative sense with results from SLLPIP alternatives to quantify changes in CVP/SWP operations. Operation of San Luis Reservoir and any San Felipe Division M&I water service contract delivery interruptions are key results for the FNA simulation. These results are summarized in the following figures and tables.

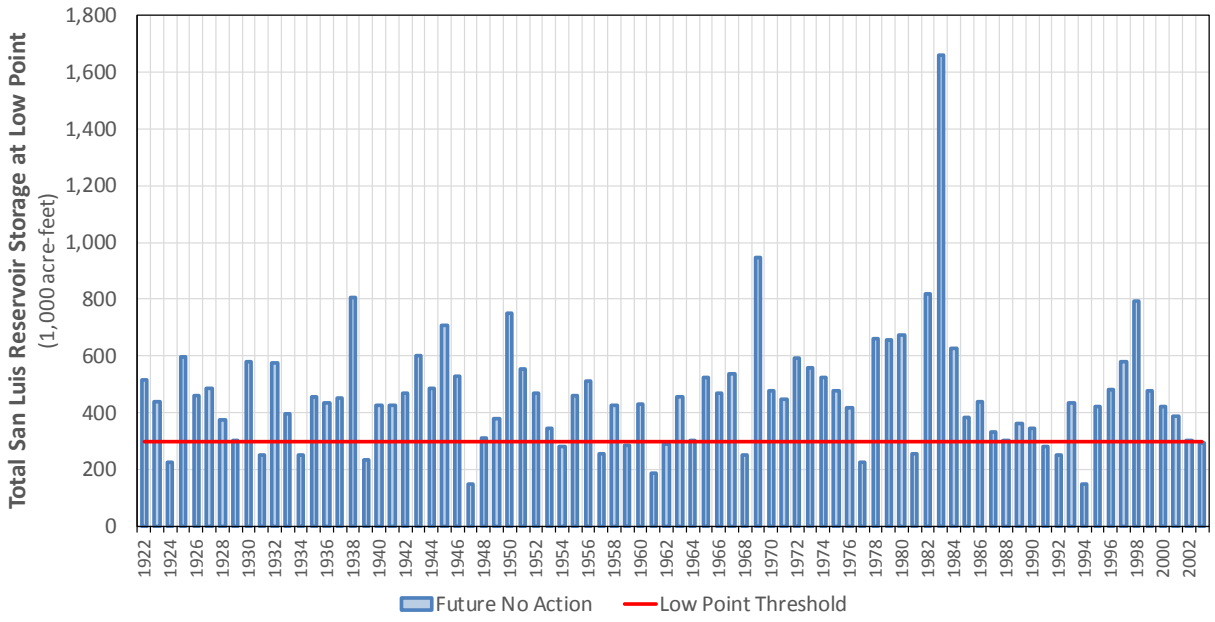


Figure 3-1. Annual Total San Luis Reservoir Storage at Low-Point

Figure 3-1 illustrates annual San Luis Reservoir storage at low-point for each year of the FNA simulation. A low point threshold of 300,000 AFAF is shown on the figure to illustrate years when low-point issues may develop. A low point of less than 300,000 AFAF occurs in 17 of the 82 years simulated.

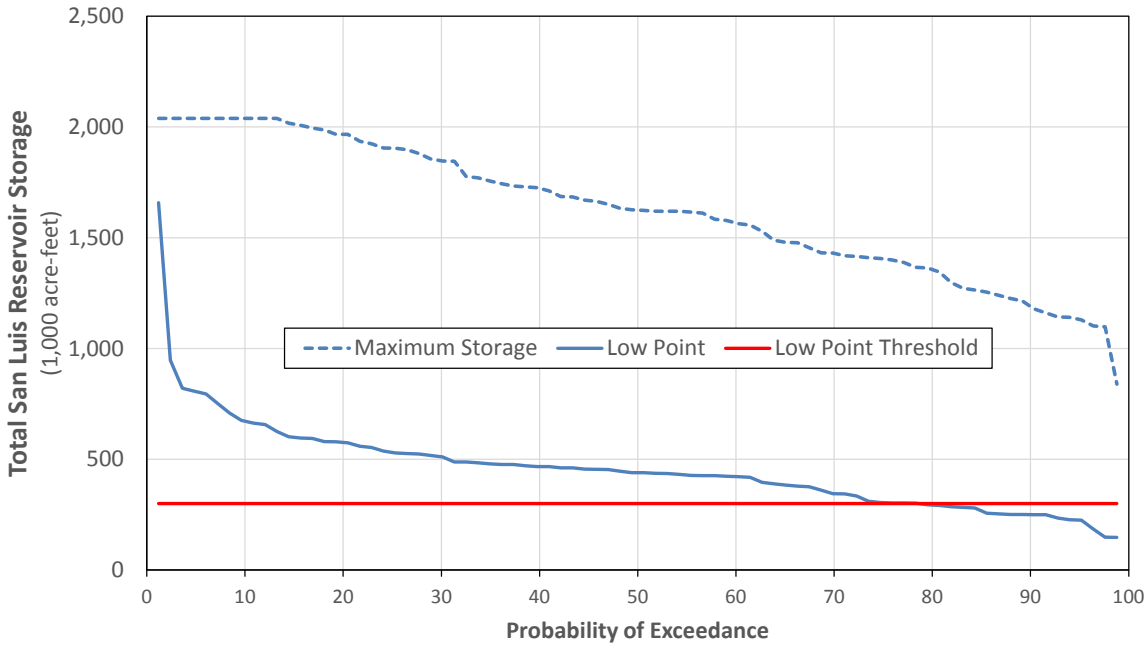


Figure 3-2. Probability of Total San Luis Reservoir Maximum and Low Point Storage

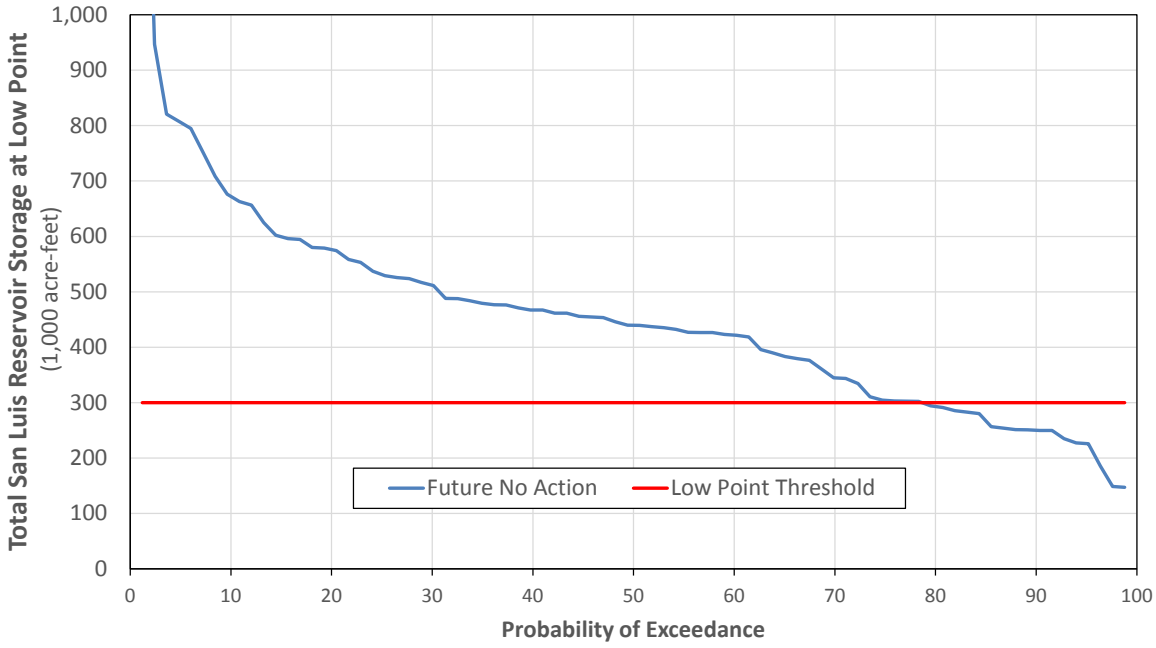


Figure 3-3. Probability of Total San Luis Reservoir Low Point Storage

Figure 3-3 illustrates annual San Luis Reservoir storage at low-point as a probability of exceedance. Results presented in Figure 3-3 indicate that storage may be below 300,000 AF in approximately 20 percent (17 out of 82) of all years at a future LOD.

Low point issues are assumed to occur when total San Luis Reservoir storage is less than 300,000 AF. When low point issues occur, San Felipe Division M&I contractors do not take delivery due to water quality concerns and deliveries are interrupted.

Table 3-1 is a summary of average annual interrupted San Felipe Division M&I deliveries for the FNA condition. Interrupted supplies reflect the volume of water that would not be delivered relative to the San Felipe M&I allocation for each water year type.

Table 3-1. Average Annual Interrupted San Felipe Division M&I Deliveries

Sacramento Valley Index	Future No Action (1,000 AFAF)
Wet	0.7
Above Normal	5.2
Below Normal	6.7
Dry	2.6
Critical	3.5
All Years	3.2

3.2 Future No Action Conditions: WEAP

SCVWD's WEAP model was run to understand how interrupted San Felipe Division M&I deliveries affect SCVWD surface and groundwater storage conditions, as well as SCVWD's ability to meet treated water demands. WEAP outputs have been summarized in the following figures and tables.

Imported water supplies entering the SCVWD system are either sent directly to one of the WTPs, or routed into storage, either in one of the local surface water reservoirs or recharged into one of the local groundwater basins. While local reservoir and groundwater basin storage levels are dependent on local hydrologic conditions, changes in storage between an alternative and the future no action model run will indicate changes to the volume of imported supply and/or operational changes triggered by the change in imported supplies. Accordingly, Table 3-2 includes relevant WEAP model output, including: annual average WTP delivery , annual average storage levels for total local surface water storage, total local groundwater storage, Semitropic storage, and the total SCVWD Emergency Supply. The total SCVWD Available Storage is a sum of the total local surface storage, total local groundwater storage, and Semitropic storage. Total SCVWD Emergency Supply is the average volume of

water available to the system under a water supply emergency, such as a Delta outage. This value only includes the total local surface storage and the North County groundwater storage that would be accessible in an emergency.

Table 3-2. Annual Average WTP Delivery and Storage Conditions for the Future No Action model run

Annual Average Values (1,000 acre-feet)	Future No Action
Total WTP Delivery/M&I Water Supply	129
Unmet WTP Demand	2
Total Local Surface Storage	90
North County Groundwater Storage	316
Total Local Groundwater Storage	464
Total Semitropic Storage	150
Total SCVWD Available Storage	704
Total SCVWD Emergency Supply	406

The following figure illustrates annual WTP deliveries from the Future No Action WEAP results. Years when total San Luis Reservoir storage falls below 300,000 AF (low point years) are noted. Many of the years with reduced total WTP deliveries correspond to low point years. However, reduced water plant deliveries can also be caused by dry hydrologic conditions in Santa Clara County and in years with low imported water deliveries from the CVP and SWP.

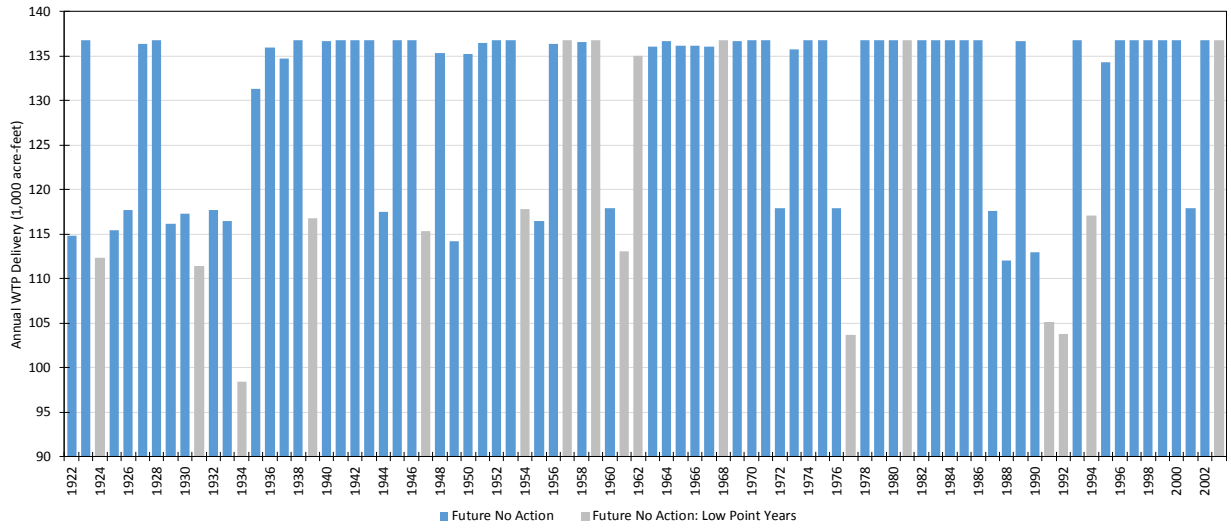


Figure 3-4. Simulated Annual WTP Deliveries, Future No Action

Chapter 4
Lower San Felipe Intake Alternative

This alternative includes construction of a new, lower San Felipe Intake to allow reservoir drawdown to its minimum operating level without algae reaching the San Felipe Intake. Moving the San Felipe Intake to an elevation equal to the Gianelli Intake would allow for continued San Felipe Division deliveries even when the total storage volume in San Luis Reservoir is below the 300,000 AF level.

A new intake would be constructed and connected to the existing San Felipe Division Intake via approximately 20,000 feet of new pipeline or tunnel. The San Felipe Intake is currently at elevation 334 feet, and algae-laden water can reach the intake when reservoir levels reach approximately 369 feet (approximately 300,000 AF in storage). Because the Gianelli Intake is at elevation of 296 feet (approximately 30 feet lower than the minimum operating pool), algae-laden water does not typically reach the Gianelli Intake. The new intake in this alternative would be at elevation 296 feet, the same elevation as the Gianelli Intake. The lower intake facility would allow the San Felipe Division to receive water from the lower reservoir levels that do not contain high concentrations of algae. A hypolimnetic aeration facility would also be constructed.

4.1 Modeling Approach and Assumptions

The Lower San Felipe Intake Alternative allows delivery to San Felipe Division M&I contractors if San Luis Reservoir storage is maintained above dead pool. This operation was simulated in CalSim II by removing the constraint requiring San Luis Reservoir storage to be greater than 300,000 AF for delivery to San Felipe Division M&I contractors.

4.2 Water Operations Modeling Results: CalSim II

The Lower San Felipe Intake Alternative was analyzed over an 82-year period to estimate the potential change in CVP deliveries due to the physical change to the intake. The following sections summarize the effects of the alternative on CVP SOD M&I and agricultural water service contract deliveries and the CVP/SWP system.

4.2.1 CVP Deliveries

The Lower San Felipe Intake Alternative allows for increases to San Felipe Division M&I water service contract deliveries by eliminating delivery interruptions due to low-point issues. San Felipe Division M&I deliveries increase because contractors can take delivery of water when San Luis Reservoir is below 300,000 AF.

Increased deliveries to San Felipe Division M&I contractors reduce CVP deliveries to SOD agricultural water service contractors. Agricultural deliveries decrease, as compared to the FNA Alternative, because interrupted M&I deliveries under the FNA Alternative remain in San Luis Reservoir and are included as supply available for allocation to CVP/SWP contractors in subsequent years. Under the Lower San Felipe Intake Alternative, that water is delivered and allocations in future years may be slightly less than under the no action alternative.

The following tables summarize changes in deliveries to San Felipe Division M&I contractors and CVP SOD agricultural water service contractors with the Lower San Felipe Intake Alternative.

Table 4-1. San Felipe Division M&I Deliveries under the Lower San Felipe Intake Alternative

Sacramento Valley Index	Future No Action (1,000 AF)	Lower San Felipe Intake (1,000 AF)	Change from FNA (1,000 AF)
Wet	114	115	1
Above Normal	98	103	5
Below Normal	95	102	7
Dry	90	92	2
Critical	73	76	3
All Years	97	100	3

Table 4-1 shows an average annual increase in San Felipe Division M&I deliveries of 3,000 AF under the Lower San Felipe Intake Alternative. Delivery increases occur only within the San Felipe Division. There is no meaningful change to CVP SOD M&I contractors outside the San Felipe Division because there is no meaningful change to M&I allocations. Increased deliveries match interrupted San Felipe Division M&I deliveries presented previously in Table 3-1.

Table 4-2. CVP SOD Agricultural Deliveries under the Lower San Felipe Intake Alternative

Sacramento Valley Index	Future No Action (1,000 AF)	Lower San Felipe Intake (1,000 AF)	Change from FNA (1,000 AF)
Wet	1,341	1,341	0
Above Normal	1,009	1,004	-5
Below Normal	878	876	-2
Dry	591	589	-2
Critical	176	176	0
All Years	878	876	-2

Table 4-2 shows an average annual decrease in CVP SOD agricultural service contract deliveries of 2,000 AF. Simulated deliveries decrease because under the FNA Alternative interrupted San Felipe Division M&I deliveries remain in San Luis Reservoir and are available to be allocated to agricultural water service contractors in subsequent years. Slightly lower SOD agricultural deliveries in the Lower San Felipe Intake Alternative result when this interrupted supply is instead delivered to San Felipe Division M&I contractors.

4.2.2 CVP/SWP Effects

The Lower San Felipe Intake Alternative has the potential to affect CVP/SWP operations beyond San Luis Reservoir and the contractors who take delivery of water from the reservoir. As described in the previous section, interrupted M&I deliveries under the FNA Alternative tend to increase allocations and deliveries to other CVP contractors relative to the Lower San Felipe Alternative. Changes in SOD allocations can affect other areas of the CVP and, in some instances, the SWP due to requirements in the Coordinated Operation Agreement. These changes have the potential to affect resources in other parts of the system. Therefore, changes in river flows, reservoir storage, Delta outflow, and Delta export operations were quantified and reviewed in support of the environmental documentation. The following table provides a high-level summary of changes throughout the CVP/SWP system. More detailed results were provided and reviewed by resource area specialists and are illustrated in figures located in Attachment B to this Appendix.

Table 4-3. Summary of CVP/SWP System Effects under the Lower San Felipe Intake Alternative

Future No Action	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Delta Outflow (cfs)	5,905	11,432	20,703	42,028	52,793	42,230	30,980	22,070	12,345	7,785	4,433	9,728
Jones Pumping Plant (cfs)	3,491	3,546	3,918	3,234	3,314	3,114	1,210	1,081	2,575	3,387	3,718	3,972
Banks Pumping Plant (cfs)	3,211	3,798	4,732	3,606	4,040	4,024	1,193	985	2,426	5,832	5,403	5,045
Sac. River into Delta (cfs)	10,870	15,725	21,534	29,935	36,387	30,746	22,316	19,041	15,950	18,013	14,204	17,822
Sac. River at Keswick (cfs)	6,211	6,913	6,488	8,357	10,648	8,336	7,035	8,114	10,768	12,754	10,088	8,125
Sac River at NCP (cfs)	6,012	9,018	11,278	13,679	15,379	14,107	8,840	7,088	5,647	6,248	5,280	7,841
Feather River blw. Thermalito (cfs)	2,538	1,999	2,457	4,043	4,291	5,284	3,033	3,629	3,660	7,061	4,838	5,376
Lower Feather River (cfs)	3,030	2,896	4,794	10,756	11,750	12,395	8,768	7,659	6,210	7,677	5,790	7,100
American River at Nimbus (cfs)	1,618	2,608	3,357	4,542	5,221	4,048	3,369	3,383	3,195	3,273	2,245	2,448
American River at H. St. (cfs)	1,442	2,444	3,219	4,385	5,033	3,855	3,088	3,044	2,805	2,722	1,852	2,135
SJ River at Vernalis (cfs)	2,710	2,605	3,248	4,821	6,203	7,165	7,473	5,747	4,609	3,188	2,032	2,312
Shasta Storage (TAF)	2,612	2,570	2,752	3,023	3,277	3,646	3,938	3,955	3,656	3,196	2,884	2,693
Folsom Storage (TAF)	457	431	456	473	493	592	719	838	803	671	591	505
Oroville Storage (TAF)	1,591	1,565	1,701	1,915	2,192	2,439	2,716	2,854	2,746	2,302	2,011	1,710
CVP San Luis Storage (TAF)	231	351	523	644	738	809	729	573	408	245	146	179
SWP San Luis Storage (TAF)	339	331	431	574	706	814	730	562	404	410	377	381
Lower San Felipe Intake Alt.	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Delta Outflow (cfs)	5,908	11,434	20,704	42,021	52,783	42,227	30,976	22,070	12,345	7,784	4,433	9,729
Jones Pumping Plant (cfs)	3,495	3,548	3,921	3,236	3,317	3,114	1,210	1,081	2,576	3,386	3,716	3,984
Banks Pumping Plant (cfs)	3,211	3,794	4,733	3,606	4,043	4,026	1,193	985	2,427	5,832	5,403	5,045
Sac. River into Delta (cfs)	10,876	15,727	21,538	29,933	36,386	30,744	22,313	19,041	15,951	18,011	14,202	17,836
Sac. River at Keswick (cfs)	6,219	6,913	6,490	8,352	10,642	8,335	7,031	8,114	10,768	12,752	10,086	8,137
Sac River at NCP (cfs)	6,020	9,019	11,279	13,678	15,381	14,106	8,836	7,088	5,647	6,247	5,278	7,854
Feather River blw. Thermalito (cfs)	2,538	1,999	2,457	4,044	4,291	5,283	3,033	3,628	3,659	7,059	4,835	5,374
Lower Feather River (cfs)	3,031	2,896	4,794	10,756	11,750	12,395	8,768	7,658	6,211	7,676	5,790	7,100
American River at Nimbus (cfs)	1,616	2,609	3,358	4,542	5,221	4,049	3,369	3,383	3,195	3,273	2,244	2,449
American River at H. St. (cfs)	1,441	2,446	3,219	4,385	5,033	3,855	3,088	3,044	2,805	2,722	1,852	2,136
SJ River at Vernalis (cfs)	2,710	2,605	3,248	4,821	6,203	7,165	7,473	5,747	4,609	3,188	2,032	2,312
Shasta Storage (TAF)	2,612	2,569	2,751	3,022	3,276	3,646	3,938	3,955	3,656	3,197	2,884	2,693
Folsom Storage (TAF)	457	431	456	473	493	592	719	838	803	671	591	504
Oroville Storage (TAF)	1,591	1,565	1,701	1,915	2,192	2,439	2,716	2,854	2,746	2,302	2,011	1,710
CVP San Luis Storage (TAF)	230	349	521	642	737	808	728	572	407	244	145	178
SWP San Luis Storage (TAF)	339	331	431	574	706	814	730	562	404	410	377	381
Change from Future No Action	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Delta Outflow (cfs)	3	2	1	-7	-11	-2	-4	0	0	0	0	1
Jones Pumping Plant (cfs)	4	3	2	2	3	-1	0	0	0	0	-2	12
Banks Pumping Plant (cfs)	0	-3	1	-1	3	1	0	0	0	0	-1	0
Sac. River into Delta (cfs)	6	2	3	-2	-1	-1	-3	0	1	-2	-2	14
Sac. River at Keswick (cfs)	8	0	2	-5	-5	-1	-4	0	0	-2	-2	12
Sac River at NCP (cfs)	7	1	1	-1	2	-1	-4	0	0	-1	-2	13
Feather River blw. Thermalito (cfs)	1	0	0	0	0	0	0	-1	-1	-3	-2	-2
Lower Feather River (cfs)	1	0	0	0	0	-1	0	0	0	0	0	0
American River at Nimbus (cfs)	-2	1	1	0	0	0	0	0	0	0	0	1
American River at H. St. (cfs)	-1	1	1	0	0	0	0	0	0	0	0	1
SJ River at Vernalis (cfs)	0	0	0	0	0	0	0	0	0	0	0	0
Shasta Storage (TAF)	-1	-1	-1	0	0	0	0	0	0	0	0	0
Folsom Storage (TAF)	0	0	0	0	0	0	0	0	0	0	0	0
Oroville Storage (TAF)	0	0	0	0	0	0	0	0	0	0	0	0
CVP San Luis Storage (TAF)	-2	-2	-2	-2	-2	-1	-1	-1	-1	-1	-1	-1
SWP San Luis Storage (TAF)	0	0	0	0	0	0	0	0	0	0	0	0

Results presented in Table 4-3 show only small changes in the CVP/SWP system.

4.3 Water Operations Modeling Results: WEAP

The additional San Felipe Division deliveries under the Lower San Felipe Intake Alternative provide additional imported supply for the SCVWD system. The results in Table 4-4 demonstrate how the additional supply helps to increase the total WTP deliveries, while also boosting average local surface, groundwater, and Semitropic storage levels. This allows the average annual emergency supply to increase by approximately 2,500 AF. 'Change from FNA' values are calculated and rounded from values with additional precision

compared to those presented in the table. As a result, 'Change from FNA' values may reflect a different value than the difference between the Future No Action and Lower/Intake Treatment results shown in the table.

Table 4-4. Annual Average WTP Delivery and Storage Conditions for the Lower San Felipe Intake Alternative as compared to the FNA.

Annual Average Values (1,000 acre-feet)	Future No Action	Lower Intake/ Treatment	Change from FNA
Total WTP Delivery/M&I Water Supply	129	129	1
Unmet WTP Demand	2	1	-1
Total Local Surface Storage	90	90	0
North County Groundwater Storage	316	318	2
Total Local Groundwater Storage	464	467	2
Total Semitropic Storage	150	179	29
Total SCVWD Available Storage	704	736	32
Total SCVWD Emergency Supply	406	408	2

Compared to the FNA Alternative, annual WTP deliveries are typically higher in years when demand is not fully met, as shown in Figure 4-1. This is especially true in low point years, when additional CVP supply is able to be delivered to the SCVWD system.

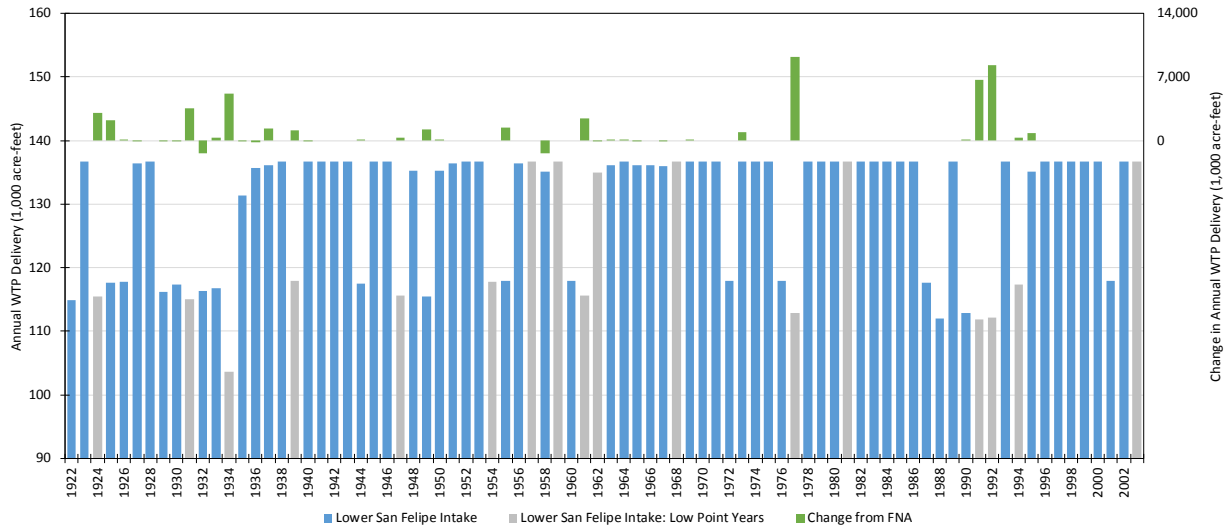


Figure 4-1. Annual Water Treatment Plant Delivery and Change from the FNA

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Chapter 5
San Luis Reservoir Expansion Alternative

The San Luis Reservoir Expansion Alternative would raise Sisk Dam by approximately ten feet above the dam safety raise currently being considered. The dam raise would allow water levels in the reservoir to also increase by ten feet, which results in a total storage increase of approximately 120,000 AF. This expansion would require additional construction at the dam (beyond what is required for the dam safety effort), including raising the impermeable layer to allow the water level increase.

The San Luis Reservoir Expansion Alternative would allocate the increased capacity to the CVP only. This expanded capacity would be operated in the same way as the current CVP portion of San Luis Reservoir, with the reservoir used for seasonal storage. The new capacity would fill after the existing capacity is filled, which would result in increased CVP yield during wetter years.

5.1 Modeling Approach and Assumptions

The San Luis Reservoir Expansion Alternative was simulated in CalSim II by increasing the storage capacity of both the CVP and SWP portion of San Luis Reservoir. The increased capacity of San Luis Reservoir could be filled during times when there is surplus Delta outflow in excess of required Delta outflow and Delta outflow needed to meet Delta water quality standards (Delta surplus). Delta surplus can only be exported when there also is available Delta export capacity. These periods typically overlap with periods when the existing CVP or SWP portion of San Luis Reservoir is full in the FNA.

This alternative may incidentally assist in maintaining storage in San Luis Reservoir above 300,000 AF and thus reducing the magnitude and/or magnitude of delivery interruptions to San Felipe Division M&I contractors.

5.2 Water Operations Modeling Results: CalSim II

The San Luis Reservoir Expansion Alternative was analyzed over an 82-year period to estimate the potential change in CVP deliveries due to the physical change in San Luis Reservoir. The following sections summarize the effects of the alternative on CVP SOD M&I and agricultural water service contract deliveries and the CVP/SWP system.

5.2.1 CVP Deliveries

By allowing for additional CVP SOD storage, the San Luis Reservoir Expansion Alternative increases CVP deliveries to SOD water service contractors. The following tables summarize changes in deliveries to San Felipe Division M&I contractors and CVP SOD agricultural water service contractors under the San Luis Reservoir Expansion Alternative.

Table 5-1. San Felipe Division M&I Deliveries under the San Luis Reservoir Expansion Alternative

Sacramento Valley Index	Future No Action (1,000 AF)	San Luis Reservoir Expansion (1,000 AF)	Change from FNA (1,000 AF)
Wet	114	115	1
Above Normal	98	99	1
Below Normal	95	95	0
Dry	90	91	1
Critical	73	73	0
All Years	97	98	1

Table 5-1 shows minimal changes in the average annual San Felipe Division M&I deliveries under the San Luis Reservoir Expansion Alternative.

Table 5-2. CVP SOD Agricultural Deliveries under the San Luis Reservoir Expansion Alternative

Sacramento Valley Index	Future No Action (1,000 AF)	San Luis Reservoir Expansion (1,000 AF)	Change from FNA (1,000 AF)
Wet	1,341	1,366	25
Above Normal	1,009	1,027	18
Below Normal	878	899	21
Dry	591	593	2
Critical	176	176	0
All Years	878	893	15

Table 5-2 shows an average annual increase in CVP SOD agricultural service contract deliveries of 15 TAF. ‘Change from FNA’ values are calculated and rounded from values with additional precision compared to those presented in the table. As a result, ‘Change from FNA’ values may reflect a different value than the difference between the Future No Action and San Luis Reservoir Expansion results shown in the table.

5.2.2 SWP Deliveries

The San Luis Reservoir Expansion Alternative has the potential to decrease SWP deliveries by reducing SWP exports from the Delta through Banks Pumping Plant. Banks Pumping Plant exports can be reduced as compared to the FNA because the additional CVP storage capacity under the alternative allows the CVP to export more of the water they are entitled to under the Coordinated Operations Agreement. Under the FNA, the SWP is able to export this water when the CVP portion of San Luis Reservoir fills and CVP SOD demands are being met.

The following tables summarize the average annual simulated SWP Table A and Article 21 deliveries for the FNA, CVP Reservoir Expansion Alternative, and the change from the FNA. Results summarized in these tables show relatively small changes compared to the volume of delivery in the FNA.

Table 5-3. SWP Table A Deliveries under the San Luis Reservoir Expansion Alternative

Sacramento Valley Index	Future No Action (1,000 AF)	San Luis Reservoir Expansion (1,000 AF)	Change from FNA (1,000 AF)
Wet	3,177	3,171	-6
Above Normal	2,659	2,656	-3
Below Normal	2,567	2,560	-7
Dry	2,009	2,011	2
Critical	1,242	1,242	0
All Years	2,458	2,455	-3

Table 5-4. SWP Article 21 Deliveries under the San Luis Reservoir Expansion Alternative

Sacramento Valley Index	Future No Action (1,000 AF)	San Luis Reservoir Expansion (1,000 AF)	Change from FNA (1,000 AF)
Wet	83	82	-1
Above Normal	107	107	0
Below Normal	71	57	-14
Dry	25	25	0
Critical	12	12	0
All Years	61	59	-2

5.2.3 CVP/SWP Effects

The Reservoir Expansion Alternative has the potential to affect CVP/SWP operations beyond San Luis Reservoir and the contractors who take delivery of water from the reservoir. Changes in SOD allocations can affect other areas of

the CVP and SWP. These changes have the potential to affect resources in other parts of the system. Therefore, changes in river flows, reservoir storage, Delta outflow, and Delta export operations were quantified and reviewed in support of the environmental documentation. The following tables provide a high-level summary of changes throughout the CVP/SWP system. More detailed results were provided and reviewed by resource area specialists and are illustrated in figures located in Attachment B to this Appendix.

Table 5-5. Summary of CVP/SWP System Effects under the San Luis Reservoir Expansion Alternative

Future No Action	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Delta Outflow (cfs)	5,905	11,432	20,703	42,028	52,793	42,230	30,980	22,070	12,345	7,785	4,433	9,728
Jones Pumping Plant (cfs)	3,491	3,546	3,918	3,234	3,314	3,114	1,210	1,081	2,575	3,387	3,718	3,972
Banks Pumping Plant (cfs)	3,211	3,798	4,732	3,606	4,040	4,024	1,193	985	2,426	5,832	5,403	5,045
Sac. River into Delta (cfs)	10,870	15,725	21,534	29,935	36,387	30,746	22,316	19,041	15,950	18,013	14,204	17,822
Sac. River at Keswick (cfs)	6,211	6,913	6,488	8,357	10,648	8,336	7,035	8,114	10,768	12,754	10,088	8,125
Sac River at NCP (cfs)	6,012	9,018	11,278	13,679	15,379	14,107	8,840	7,088	5,647	6,248	5,280	7,841
Feather River blw. Thermalito (cfs)	2,538	1,999	2,457	4,043	4,291	5,284	3,033	3,629	3,660	7,061	4,838	5,376
Lower Feather River (cfs)	3,030	2,896	4,794	10,756	11,750	12,395	8,768	7,659	6,210	7,677	5,790	7,100
American River at Nimbus (cfs)	1,618	2,608	3,357	4,542	5,221	4,048	3,369	3,383	3,195	3,273	2,245	2,448
American River at H. St. (cfs)	1,442	2,444	3,219	4,385	5,033	3,855	3,088	3,044	2,805	2,722	1,852	2,135
SJ River at Vernalis (cfs)	2,710	2,605	3,248	4,821	6,203	7,165	7,473	5,747	4,609	3,188	2,032	2,312
Shasta Storage (TAF)	2,612	2,570	2,752	3,023	3,277	3,646	3,938	3,955	3,656	3,196	2,884	2,693
Folsom Storage (TAF)	457	431	456	473	493	592	719	838	803	671	591	505
Oroville Storage (TAF)	1,591	1,565	1,701	1,915	2,192	2,439	2,716	2,854	2,746	2,302	2,011	1,710
CVP San Luis Storage (TAF)	231	351	523	644	738	809	729	573	408	245	146	179
SWP San Luis Storage (TAF)	339	331	431	574	706	814	730	562	404	410	377	381
CVP Reservoir Expansion Alt.	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Delta Outflow (cfs)	5,906	11,422	20,697	42,001	52,730	42,156	30,978	22,070	12,344	7,788	4,432	9,724
Jones Pumping Plant (cfs)	3,511	3,511	3,922	3,291	3,347	3,221	1,218	1,081	2,602	3,390	3,716	3,971
Banks Pumping Plant (cfs)	3,230	3,800	4,725	3,573	4,055	3,996	1,193	985	2,400	5,840	5,403	5,048
Sac. River into Delta (cfs)	10,909	15,682	21,522	29,936	36,376	30,743	22,320	19,041	15,949	18,028	14,202	17,822
Sac. River at Keswick (cfs)	6,224	6,878	6,489	8,355	10,635	8,333	7,040	8,117	10,771	12,766	10,095	8,131
Sac River at NCP (cfs)	6,025	8,978	11,276	13,681	15,371	14,109	8,846	7,088	5,645	6,255	5,282	7,847
Feather River blw. Thermalito (cfs)	2,551	1,999	2,448	4,041	4,290	5,292	3,034	3,629	3,648	7,073	4,838	5,378
Lower Feather River (cfs)	3,044	2,896	4,785	10,753	11,749	12,403	8,769	7,658	6,198	7,689	5,791	7,104
American River at Nimbus (cfs)	1,630	2,603	3,356	4,544	5,222	4,047	3,369	3,383	3,207	3,269	2,240	2,438
American River at H. St. (cfs)	1,453	2,439	3,217	4,386	5,033	3,853	3,088	3,044	2,817	2,718	1,851	2,124
SJ River at Vernalis (cfs)	2,710	2,605	3,248	4,821	6,203	7,165	7,474	5,747	4,610	3,188	2,032	2,313
Shasta Storage (TAF)	2,611	2,570	2,752	3,023	3,277	3,647	3,939	3,955	3,656	3,196	2,884	2,693
Folsom Storage (TAF)	457	431	457	473	493	592	719	838	803	671	591	505
Oroville Storage (TAF)	1,591	1,566	1,702	1,916	2,194	2,440	2,717	2,855	2,748	2,303	2,012	1,711
CVP San Luis Storage (TAF)	238	356	527	651	748	825	745	587	421	254	153	186
SWP San Luis Storage (TAF)	338	331	431	571	705	812	728	561	401	408	376	380
Change from Future No Action	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Delta Outflow (cfs)	0	-10	-6	-27	-63	-74	-2	0	-1	3	0	-3
Jones Pumping Plant (cfs)	20	-35	4	57	32	107	8	0	27	4	-2	-1
Banks Pumping Plant (cfs)	19	2	-7	-33	14	-28	0	0	-26	8	0	3
Sac. River into Delta (cfs)	39	-43	-13	2	-11	-3	4	0	-1	15	-2	-1
Sac. River at Keswick (cfs)	13	-35	1	-2	-12	-3	6	3	4	12	7	6
Sac River at NCP (cfs)	13	-40	-2	3	-8	1	6	1	-1	7	2	6
Feather River blw. Thermalito (cfs)	14	0	-9	-3	-1	8	1	0	-13	11	0	2
Lower Feather River (cfs)	14	0	-9	-3	-1	8	1	0	-12	12	1	4
American River at Nimbus (cfs)	13	-5	-1	2	1	-1	-1	0	13	-4	-5	-10
American River at H. St. (cfs)	11	-5	-1	1	1	-1	-1	0	13	-5	-1	-10
SJ River at Vernalis (cfs)	0	0	0	0	0	0	0	0	0	0	0	0
Shasta Storage (TAF)	-2	1	0	0	1	1	0	0	0	0	0	-1
Folsom Storage (TAF)	0	0	0	0	0	0	0	0	-1	0	0	1
Oroville Storage (TAF)	0	1	1	1	2	1	1	1	2	1	1	1
CVP San Luis Storage (TAF)	7	5	4	8	10	16	15	14	13	10	7	7
SWP San Luis Storage (TAF)	0	0	0	-3	-1	-2	-2	-1	-3	-2	-2	-1

Average monthly results presented in Table 5-5 show relatively small changes in reservoir levels, river flow, Delta inflow and outflow, and Delta exports. The primary change in CVP and SWP operations with the San Luis Reservoir

Expansion Alternative is an increase in Delta exports at both Jones Pumping Plant to capture available Delta surplus and store it in the additional storage capacity provided by the alternative. This increase in Jones Pumping Plant exports results in a reduction in Delta outflow in these same months, and in some instances, a reduction in Banks Pumping Plant exports by the SWP. These changes tend to increase the average monthly storage in the CVP portion of San Luis Reservoir and decrease the average monthly storage in the SWP portion. Total San Luis Reservoir storage goes below 300,000 acre-feet in 18 of the 82-year simulation in the San Luis Reservoir Expansion Alternative.

5.3 Water Operations Modeling Results: WEAP

Local SCVWD results from the WEAP model indicate minimal to no change in local operations and supply under the San Luis Reservoir Expansion Alternative, as shown in Table 5-6. This is largely expected given the small changes in San Felipe Division deliveries shown in Table 5-1. 'Change from FNA' values are calculated and rounded from values with additional precision compared to those presented in the table. As a result, 'Change from FNA' values may reflect a different value than the difference between the Future No Action and the San Luis Reservoir Expansion results shown in the table.

Table 5-6. Annual Average WTP Delivery and Storage Conditions for the San Luis Reservoir Expansion Alternative as compared to the FNA.

Annual Average Values (1,000 acre-feet)	Future No Action	San Luis Res. Expansion	Change from FNA
Total WTP Delivery/M&I Water Supply	129	129	0
Unmet WTP Demand	2	2	0
Total Local Surface Storage	90	90	0
North County Groundwater Storage	316	316	0
Total Local Groundwater Storage	464	464	0
Total Semitropic Storage	150	151	1
Total SCVWD Available Storage	704	705	1
Total SCVWD Emergency Supply	406	406	0

Figure 5-1 shows annual SCVWD WTP deliveries under the San Luis Reservoir Expansion Alternative. There is little change in annual WTP deliveries under this alternative.

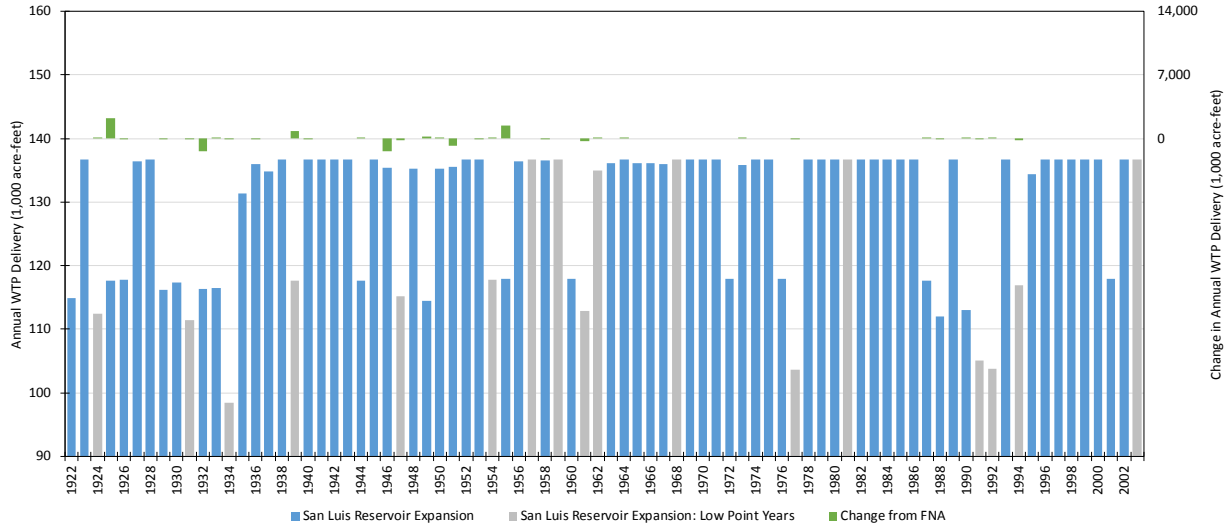


Figure 5-1. Annual Water Treatment Plant Delivery and Change from the FNA

Chapter 6
Treatment Alternative

The Treatment alternative includes infrastructure improvements to SCVWD water treatment facilities that would allow San Felipe Division diversions from San Luis Reservoir even when total storage in the reservoir is below 300,000 AF.

6.1 Modeling Approach and Assumptions

The Treatment Alternative would include the same assumptions as the Lower San Felipe Intake Alternative, with the addition of improvements to SCVWD water treatment facilities. San Luis Reservoir would continue to function as seasonal storage. This alternative allows delivery to San Felipe Division M&I contractors if San Luis Reservoir storage is maintained above dead pool. This operation was simulated in CalSim II by removing the constraint requiring San Luis Reservoir storage to be greater than 300,000 AF for delivery to San Felipe Division M&I contractors.

6.2 Water Operations Modeling Results

The Treatment Alternative was analyzed over an 82-year period to estimate the potential change in CVP deliveries due to the ability to continue deliveries to San Felipe M&I contractors during periods when San Luis Reservoir is below 300,000 AF. Overall results for both CalSim II and WEAP model runs are identical to those presented for the Lower San Felipe Intake Alternative. Please refer to results from Chapter 4 for effects to CVP deliveries, CVP/SWP system operations, and local SCVWD effects.

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Chapter 7
Pacheco Reservoir Expansion Alternative

The Pacheco Reservoir Expansion Alternative includes construction and operation of a new Pacheco dam and reservoir, pump station, conveyance facilities, and related miscellaneous infrastructure. The new dam and reservoir would be constructed on Pacheco Creek, 0.5 mile upstream from the existing North Fork Dam, and would inundate most of the existing Pacheco Reservoir. The proposed total storage for the new reservoir is 141,600 AF, with an active storage of 140,800 AF. The full pool elevation would be 694 feet and would inundate an additional 1,245 acres, for a total of 1,385 total acres inundated. Water would be collected in the new reservoir during the winter months from runoff from the local watershed area, and diversion of CVP supplies from the Pacheco Conduit, when needed.

7.1 Modeling Approach and Assumptions

The Pacheco Reservoir Expansion Alternative allows delivery to San Felipe Division CVP M&I contractors if San Luis Reservoir storage is maintained above dead pool. This operation was simulated in CalSim II by removing the constraint requiring San Luis Reservoir storage to be greater than 300,000 AF for delivery to San Felipe Division M&I contractors.

Operation of Pacheco Reservoir includes a transfer of 2,000 AF of San Felipe Division water supply to CVP SOD Refuge Supply in Below Normal years under the Accelerated Water Transfer Program. This operation is included in the CalSim II simulation.

7.2 Water Operations Modeling Results: CalSim II

The Pacheco Reservoir Expansion Alternative was analyzed over an 82-year period to estimate the potential change in CVP deliveries due to the ability to continue deliveries to San Felipe M&I contractors during periods when San Luis Reservoir is below 300,000 AF. The following sections summarize the effects of the alternative on CVP SOD M&I and agricultural water service contract deliveries and CVP/SWP system.

7.2.1 CVP Deliveries

The Pacheco Reservoir Expansion Alternative increases San Felipe Division CVP M&I water service contract deliveries by eliminating interruptions due to low-point issues. San Felipe Division CVP M&I deliveries increase because contractors can take delivery of water when San Luis Reservoir is below 300,000 AF.

The following tables summarize changes in deliveries to San Felipe Division CVP M&I contractors, CVP SOD agricultural water service contractors, and CVP SOD refuges under the Pacheco Reservoir Expansion Alternative.

Table 7-1. San Felipe Division CVP M&I Deliveries under the Pacheco Reservoir Expansion Alternative

Sacramento Valley Index	Future No Action (1,000 AF)	Pacheco Reservoir Expansion (1,000 AF)	Change from FNA (1,000 AF)
Wet	114	115	1
Above Normal	98	103	5
Below Normal	95	100	5
Dry	90	93	2
Critical	73	76	3
All Years	97	100	3

Table 7-1 shows an average annual increase in San Felipe Division CVP M&I deliveries of 3,000 AF under the Pacheco Reservoir Expansion Alternative. Delivery increases occur only within the San Felipe Division. There is no meaningful change to CVP SOD M&I contractors outside the San Felipe Division because there is no meaningful change to CVP M&I allocations. Increased deliveries match interrupted San Felipe Division M&I deliveries, as presented in Table 3-1, except for below normal years when 2,000 AF of San Felipe M&I supply is shifted to CVP SOD refuge supply. ‘Change from FNA’ values are calculated and rounded from values with additional precision compared to those presented in the table. As a result, ‘Change from FNA’ values may reflect a different value than the difference between the Future No Action and Pacheco Reservoir Expansion results shown in the table.

Table 7-2. CVP SOD Agricultural Deliveries under the Pacheco Reservoir Expansion Alternative

Sacramento Valley Index	Future No Action (1,000 AF)	Pacheco Reservoir Expansion (1,000 AF)	Change from FNA (1,000 AF)
Wet	1,341	1,341	0
Above Normal	1,009	1,004	-5
Below Normal	878	876	-2
Dry	591	589	-2
Critical	176	176	0
All Years	878	877	-2

Table 7-2 shows an average annual decrease in CVP SOD agricultural service contract deliveries of 2,000 AF. Simulated deliveries decrease because under the FNA Alternative interrupted San Felipe Division M&I deliveries remain in San Luis Reservoir and are available to be allocated to agricultural water service contractors in subsequent years. Under the Pacheco Reservoir Expansion Alternative, this interrupted supply is instead delivered to San Felipe Division M&I contractors, resulting in slightly lower CVP SOD agricultural deliveries. 'Change from FNA' values are calculated and rounded from values with additional precision compared to those presented in the table. As a result, 'Change from FNA' values may reflect a different value than the difference between the Future No Action and Pacheco Reservoir Expansion results shown in the table.

Table 7-3. CVP SOD Refuge Deliveries under the Pacheco Reservoir Expansion Alternative

Sacramento Valley Index	Future No Action (1,000 AF)	Pacheco Reservoir (1,000 AF)	Change from FNA (1,000 AF)
Wet	280	280	0
Above Normal	275	275	0
Below Normal	278	280	2
Dry	275	275	0
Critical	249	249	0
All Years	273	273	0

Table 7-3 shows an average annual increase in CVP SOD refuge deliveries of 2,000 AF in Below Normal years. This additional refuge delivery is part of the Pacheco Reservoir Expansion operations plan, which dedicates 2,000 AF of San Felipe Division CVP M&I supply in Below Normal years to CVP SOD refuges. This supply comes out of total SCVWD deliveries, as shown and discussed above in Table 7-1.

7.2.2 CVP/SWP Effects

The Pacheco Reservoir Expansion Alternative has the potential to affect CVP/SWP operations beyond San Luis Reservoir and the contractors who take delivery of water from the reservoir. As described in the previous section, interrupted M&I deliveries under the FNA tend to increase allocations and deliveries to other CVP contractors relative to the Pacheco Reservoir Expansion Alternative. Changes in SOD allocations can affect other areas of the CVP and, in some instances, the SWP due to requirements in the Coordinated Operation Agreement. These changes have the potential to affect resources in other parts of the system. Therefore, changes in river flows, reservoir storage, Delta outflow, and Delta export operations were quantified and reviewed in support of the environmental documentation. The following tables provide a high-level summary of changes throughout the CVP/SWP system. More detailed results were provided and reviewed by resource area specialists and are illustrated in figures located in Attachment B to this Appendix.

Table 7-4. Summary CVP/SWP System Effects under the Pacheco Reservoir Expansion Alternative

Future No Action	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Delta Outflow (cfs)	5,905	11,432	20,703	42,028	52,793	42,230	30,980	22,070	12,345	7,785	4,433	9,728
Jones Pumping Plant (cfs)	3,491	3,546	3,918	3,234	3,314	3,114	1,210	1,081	2,575	3,387	3,718	3,972
Banks Pumping Plant (cfs)	3,211	3,798	4,732	3,606	4,040	4,024	1,193	985	2,426	5,832	5,403	5,045
Sac. River into Delta (cfs)	10,870	15,725	21,534	29,935	36,387	30,746	22,316	19,041	15,950	18,013	14,204	17,822
Sac. River at Keswick (cfs)	6,211	6,913	6,488	8,357	10,648	8,336	7,035	8,114	10,768	12,754	10,088	8,125
Sac River at NCP (cfs)	6,012	9,018	11,278	13,679	15,379	14,107	8,840	7,088	5,647	6,248	5,280	7,841
Feather River blw. Thermalito (cfs)	2,538	1,999	2,457	4,043	4,291	5,284	3,033	3,629	3,660	7,061	4,838	5,376
Lower Feather River (cfs)	3,030	2,896	4,794	10,756	11,750	12,395	8,768	7,659	6,210	7,677	5,790	7,100
American River at Nimbus (cfs)	1,618	2,608	3,357	4,542	5,221	4,048	3,369	3,383	3,195	3,273	2,245	2,448
American River at H. St. (cfs)	1,442	2,444	3,219	4,385	5,033	3,855	3,088	3,044	2,805	2,722	1,852	2,135
SJ River at Vernalis (cfs)	2,710	2,605	3,248	4,821	6,203	7,165	7,473	5,747	4,609	3,188	2,032	2,312
Shasta Storage (TAF)	2,612	2,570	2,752	3,023	3,277	3,646	3,938	3,955	3,656	3,196	2,884	2,693
Folsom Storage (TAF)	457	431	456	473	493	592	719	838	803	671	591	505
Oroville Storage (TAF)	1,591	1,565	1,701	1,915	2,192	2,439	2,716	2,854	2,746	2,302	2,011	1,710
CVP San Luis Storage (TAF)	231	351	523	644	738	809	729	573	408	245	146	179
SWP San Luis Storage (TAF)	339	331	431	574	706	814	730	562	404	410	377	381
Pacheco Reservoir	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Delta Outflow (cfs)	5,908	11,434	20,703	42,021	52,783	42,227	30,976	22,070	12,345	7,784	4,433	9,729
Jones Pumping Plant (cfs)	3,496	3,548	3,920	3,236	3,317	3,114	1,210	1,081	2,576	3,386	3,716	3,984
Banks Pumping Plant (cfs)	3,211	3,794	4,733	3,606	4,043	4,025	1,193	985	2,427	5,832	5,403	5,044
Sac. River into Delta (cfs)	10,877	15,726	21,537	29,933	36,386	30,744	22,313	19,041	15,951	18,011	14,202	17,836
Sac. River at Keswick (cfs)	6,219	6,913	6,489	8,352	10,643	8,335	7,031	8,114	10,768	12,752	10,086	8,137
Sac River at NCP (cfs)	6,020	9,018	11,278	13,678	15,381	14,106	8,836	7,088	5,647	6,247	5,278	7,854
Feather River blw. Thermalito (cfs)	2,539	1,999	2,457	4,044	4,291	5,283	3,033	3,628	3,659	7,059	4,836	5,374
Lower Feather River (cfs)	3,031	2,896	4,794	10,756	11,750	12,395	8,768	7,658	6,211	7,676	5,790	7,100
American River at Nimbus (cfs)	1,616	2,609	3,358	4,542	5,221	4,049	3,369	3,383	3,195	3,273	2,244	2,449
American River at H. St. (cfs)	1,441	2,446	3,219	4,385	5,033	3,855	3,088	3,044	2,805	2,723	1,852	2,136
SJ River at Vernalis (cfs)	2,710	2,605	3,248	4,821	6,203	7,165	7,473	5,747	4,609	3,188	2,032	2,312
Shasta Storage (TAF)	2,611	2,569	2,751	3,022	3,276	3,646	3,938	3,955	3,656	3,197	2,884	2,693
Folsom Storage (TAF)	457	431	456	473	493	592	719	838	803	671	591	505
Oroville Storage (TAF)	1,591	1,565	1,701	1,915	2,192	2,439	2,716	2,854	2,746	2,302	2,011	1,710
CVP San Luis Storage (TAF)	230	349	521	642	736	808	728	572	407	244	145	178
SWP San Luis Storage (TAF)	339	331	431	574	706	814	730	562	404	410	377	381
Change from Future No Action	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Delta Outflow (cfs)	3	2	0	-7	-11	-3	-4	0	0	0	1	1
Jones Pumping Plant (cfs)	5	3	2	2	3	0	0	0	0	0	-2	12
Banks Pumping Plant (cfs)	-1	-4	1	-1	3	1	0	0	0	0	-1	0
Sac. River into Delta (cfs)	7	1	2	-2	-1	-2	-3	0	1	-2	-2	14
Sac. River at Keswick (cfs)	8	-1	1	-5	-5	-1	-4	0	0	-2	-2	13
Sac River at NCP (cfs)	8	0	1	-1	1	-1	-4	0	0	-1	-2	13
Feather River blw. Thermalito (cfs)	1	0	0	0	0	0	0	-1	-1	-3	-2	-1
Lower Feather River (cfs)	1	0	0	0	0	-1	0	0	0	0	0	0
American River at Nimbus (cfs)	-2	1	1	0	0	0	0	0	0	0	0	1
American River at H. St. (cfs)	-1	1	1	0	0	0	0	0	0	0	0	1
SJ River at Vernalis (cfs)	0	0	0	0	0	0	0	0	0	0	0	0
Shasta Storage (TAF)	-1	-1	-1	-1	0	0	0	0	0	0	0	0
Folsom Storage (TAF)	0	0	0	0	0	0	0	0	0	0	0	0
Oroville Storage (TAF)	0	0	0	0	0	0	0	0	0	0	0	0
CVP San Luis Storage (TAF)	-2	-2	-2	-2	-2	-1	-1	-1	-1	-1	-1	-1
SWP San Luis Storage (TAF)	0	0	0	0	0	0	0	0	0	0	0	0

Results presented in Table 7-4 show only small changes in the CVP/SWP system.

7.3 Water Operations Modeling Results: WEAP

The additional San Felipe deliveries under the Pacheco Reservoir Expansion Alternative provide additional imported supply into the SCVWD system as summarized by the WEAP results in Table 7-5. The additional supply helps to increase the total WTP deliveries, while also boosting local surface, groundwater, and Semitropic storage levels. Total local surface storage is much higher as a result of the expansion of the existing Pacheco Reservoir. This provides an important boost not only local surface water supply, but also to

SCVWD emergency supplies, which are approximately 102,000 AF higher compared to the FNA. 'Change from FNA' values are calculated and rounded from values with additional precision compared to those presented in the table. As a result, 'Change from FNA' values may reflect a different value than the difference between the Future No Action and Pacheco Reservoir Expansion results shown in the table.

Table 7-5. Annual Average WTP Delivery and Storage Conditions for the Pacheco Reservoir Expansion Alternative as compared to the FNA.

Annual Average Values (1,000 acre-feet)	Future No Action	New Pacheco Reservoir	Change from FNA
Total WTP Delivery/M&I Water Supply	129	129	0
Unmet WTP Demand	2	1	0
Total Local Surface Storage	90	187	97
North County Groundwater Storage	316	321	5
Total Local Groundwater Storage	464	471	7
Total Semitropic Storage	150	153	3
Total SCVWD Available Storage	704	811	107
Total SCVWD Emergency Supply	406	508	102

Annual WTP deliveries increase in most low point years, as shown in Figure 7-1. Results are similar to the changes in WTP deliveries under the Lower San Felipe Intake Alternative (Figure 4-1).

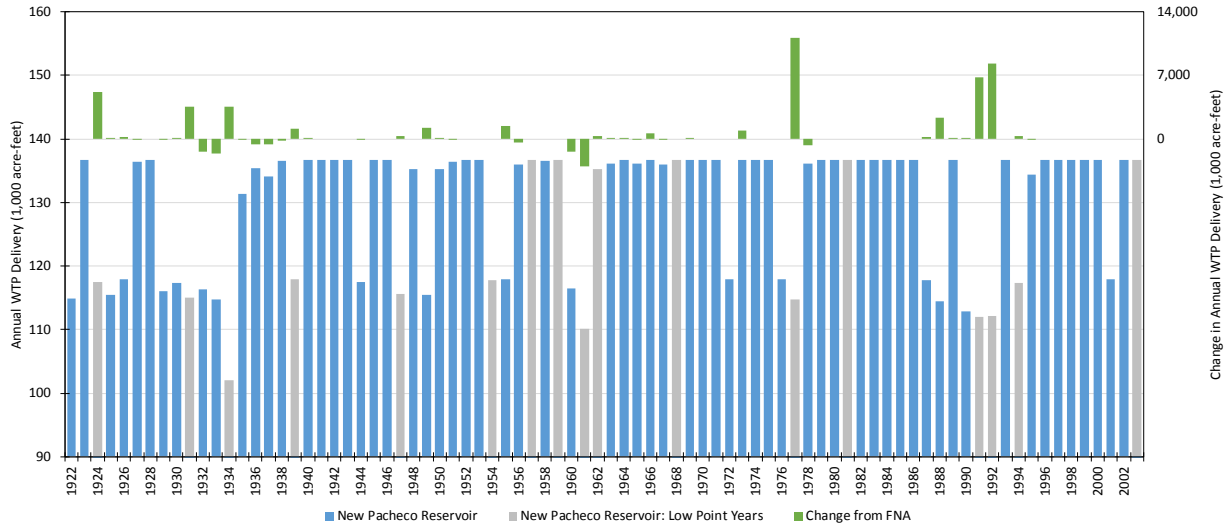


Figure 7-1. Annual Water Treatment Plant Delivery and Change from the FNA

Attachment A
CalSim II Assumptions for Future No Action Conditions

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	Period of Simulation: 82 years (1922-2003)
	Future Level Study
HYDROLOGY	
Level of Development	2020 Level, *DWR Bulletin 160-98*[1]
Sacramento River Region Demands	
CVP	Land use based, limited by full contract
SWP (FRSA)	Land use based, limited by full contract
Non-Project	Land use based
Woodland-Davis Clean Water Agency	Included
Antioch	Pre-1914 water right
CVP Refuges	Firm Level 2 water needs
American River Basin Demands	
Water rights	2020 Level
CVP	2020 Level, full contracts including Freeport Regional Water Project and Sacramento River Water Reliability Project
San Joaquin River Basin Demands	
Friant Unit	Limited by contract amounts, based on current allocation policy
Lower Basin	Land use based with district level operations and constraints
Stanislaus River Basin[2]	Land use based, with New Melones Interim Operations Plan and NMFS biological opinion (June 2009), Actions 3.1.2 and 3.1.3[5]
South of Delta Demands	
CVP	Full contract
Contra Costa Water District	195 taf/yr
SWP (with North Bay Aqueduct)	4.1 maf/yr
SWP Article 21 Demand	Metropolitan Water District of Southern California up to 200 taf/month (Dec-Mar), KCWA demand up to 180 taf/month and others up to 34 taf/month
FACILITIES	
Red Bluff Diversion Dam	Fish Passage Improvement Project in place with 2,500 cfs capacity
Freeport Regional Water Project	Included with diversions to EBMUD
Banks Pumping Capacity	Physical capacity is 10,300 cfs, 6,680 cfs permitted capacity up to 8,500 cfs (Dec 15th–Mar 15th) depending on Vernalis flow conditions[3] additional capacity of 500 cfs (up to 7,180 cfs) allowed for Jul–Sep for reducing impact of NMFS biological opinion on SWP (Jun 2009), Action 4.2.1[5]
Jones Pumping Capacity	Exports up to 4,600 cfs permit capacity in all months
Delta-Mendota Canal-California Aqueduct Intertie	Included with 400 cfs capacity
Los Vaqueros Reservoir Capacity	160 taf
South Bay Aqueduct	South Bay Aqueduct Enlargement to 430 cfs
REGULATORY STANDARDS	
Trinity River	
Minimum Flow below Lewiston Dam	Trinity EIS Preferred Alternative (369-815 taf/yr)
Trinity Reservoir End-of-September Minimum Storage	Trinity EIS Preferred Alternative (600 taf as able)

	Period of Simulation: 82 years (1922-2003)
	Future Level Study
Clear Creek	
Minimum Flow below Whiskeytown Dam	Downstream water rights, 1963 Reclamation Proposal to USFWS and NPS, predetermined Central Valley Project Improvement Act 3406(b)(2) flows and NMFS biological opinion (June 2009) Action I.1.1[5]
Upper Sacramento River	
Shasta Lake End-of-September Minimum Storage	NMFS 2004 Winter-run biological opinion (1900 taf), predetermined Central Valley Project Improvement Act 3406(b)(2) flows, and NMFS biological opinion (Jun 2009) Action I.2.1[5]
Minimum Flow below Keswick Dam	Flows for SWRCB Water Rights Order 90-5 and 1993 Winter-run biological opinion temperature control, predetermined Central Valley Project Improvement Act 3406(b)(2) flows, and NMFS biological opinion (Jun 2009), Action I.2.2[5]
Feather River	
Minimum Flow below Thermalito Diversion Dam	2006 Settlement Agreement (700/800 cfs)
Minimum Flow below Thermalito Afterbay outlet	1983 DWR, DFG Agreement (750-1700 cfs)
Yuba River	
Minimum flow below Daguerre Point Dam	D-1644 Operations (Lower Yuba River Accord)[4]
American River	
Minimum Flow below Nimbus Dam	American River Flow Management as required by NMFS biological opinion (Jun 2009), Action 2.1[5]
Minimum Flow at H Street Bridge	SWRCB D-893
Lower Sacramento River	
Minimum Flow near Rio Vista	SWRCB D-1641
Mokelumne River	
Minimum Flow below Camanche Dam	Federal Energy Regulatory Commission 2916-029, 1996 Joint Settlement Agreement (100 – 325 cfs)
Minimum Flow below Woodbridge Diversion Dam	Federal Energy Regulatory Commission 2916-029, 1996 Joint Settlement Agreement (25 – 300 cfs)
Stanislaus River	
Minimum Flow below Goodwin Dam	1987 Reclamation, DFG agreement, and flows required for NMFS biological opinion (Jun 2009) Actions III.1.2 and III.1.3[5]
Minimum Dissolved Oxygen	SWRCB D-1422
REGULATORY STANDARDS	
Merced River	
Minimum Flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180 – 220 cfs, Nov – Mar) and Cowell Agreement
Minimum Flow at Shaffer Bridge	Federal Energy Regulatory Commission 2179 (25-100 cfs)
Tuolumne River	
Minimum Flow at Lagrange Bridge	Federal Energy Regulatory Commission 2299-024, 1995 Settlement Agreement (94-301 taf/yr)
San Joaquin River	
San Joaquin River Restoration	Full flows
Maximum Salinity near Vernalis	SWRCB D-1641
Minimum Flow near Vernalis	SWRCB D-1641, NMFS biological opinion (Jun 2009), Action 4.2.1[5]

	Period of Simulation: 82 years (1922-2003)
	Future Level Study
Sacramento River-San Joaquin River Delta	
Delta Outflow Index (Flow and Salinity)	SWRCB D-1641, USFWS biological opinion (Dec 2008), Action 4[5]
Delta Cross Channel Gates	SWRCB D-1641, NMFS biological opinion (Jun 2009) Action 4.1.2[5]
Delta Exports	SWRCB D-1641, NMFS biological opinion (Jun 2009) Action 4.2.1[5]
Combined Flow in Old and Middle River	USFWS biological opinion (Dec 2008), Actions 1–3 and NMFS biological opinion (Jun 2009), Action 4.2.3[5]
OPERATIONS CRITERIA	
Subsystem	
Upper Sacramento River	
Flow Objective for Navigation (Wilkins Slough)	NMFS biological opinion (Jun 2009) Action I.4[5]; 3,250 – 5,000 cfs based on CVP water supply condition
American River	
Folsom Dam Flood Control	Variable 400/670 without outlet modifications
Feather River	
Flow at Mouth	Maintain DFG/DWR flow target above Verona or 2800 cfs Apr-Sep, dependent on Oroville inflow and FRSA allocation
System-wide	
CVP Water Allocation	
CVP Settlement and Exchange	100% (75% in Shasta Critical years)
CVP Refuges	100% (75% in Shasta Critical years)
CVP Agriculture	100% - 0% based on supply; additionally limited due to D-1641, USFWS biological opinion (Dec 2008) and NMFS biological opinion (Jun 2009) export restrictions[5]
CVP Municipal & Industrial	100% - 0% based on supply; additionally limited due to D-1641, USFWS biological opinion (Dec 2008) and NMFS biological opinion (Jun 2009) export restrictions[5]
OPERATIONS CRITERIA	
SWP Water Allocation	
North of Delta (FRSA)	Contract specific
South of Delta	Based on supply, Monterey Agreement; allocations limited due to D-1641, USFWS biological opinion (Dec2008) and NMFS biological opinion (Jun 2009) export restrictions[5]
CVP/SWP Coordinated Operations	
Sharing of Responsibility for In Basin Use	1986 Coordinated Operations Agreement
Sharing of Surplus Flows	1986 Coordinated Operations Agreement
Sharing of Restricted Export Capacity	Equal sharing of export capacity under SWRCB D-1641, USFWS biological opinion (Dec 2008) and NMFS biological opinion (Jun 2009) export restrictions[5]
Transfers	
Lower Yuba River Accord[6]	Yuba River acquisitions for reducing impact of NMFS biological opinion export restrictions on SWP

[1] The Sacramento Valley hydrology used in the Future Conditions CalSim II model reflects 2020 land-use assumptions associated with Bulletin 160-98. The San Joaquin Valley hydrology reflects draft 2030 land-use assumptions developed by Reclamation. Development of future-level projected land-use assumptions are being coordinated with the California Water Plan Update for future models.

[2] The CalSim II model representation for the Stanislaus River does not necessarily represent Reclamation's current or future operational policies. A suitable plan for supporting flows has not been developed for NMFS biological opinion (Jun 2009), Action 3.1.3.

[3] Current US Army Corps of Engineers permit for Harvey O. Banks Pumping Plant allows for an average diversion rate of 6,680 cfs in all months. Diversion rate can increase up to 1/3 of the rate of San Joaquin River flow at Vernalis during Dec 15th–Mar 15th up to a maximum diversion of 8,500 cfs, if Vernalis flow exceeds 1,000 cfs.

[4] D-1644 and the Lower Yuba River Accord are assumed to be implemented for Future Conditions. The Yuba River is not dynamically modeled in CalSim II. Yuba River hydrology and availability of water acquisitions under the Lower Yuba River Accord are based on modeling performed and provided by the Lower Yuba River Accord EIS/EIR study team.

[5] In cooperation with USBR, NMFS, USFWS, and DGF, the DWR has developed assumptions for implementation of the USFWS biological opinion (December 15, 2008) and NMFS biological opinion (June 4, 2009) in CalSim II.

[6] Acquisitions of Component 1 water under the Lower Yuba River Accord, and use of 500 cfs dedicated capacity at Banks Pumping Plant during Jul–Sep, are assumed to be used to reduce as much of the effect of the April–May Delta export actions on SWP contractors as possible.

San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix B: Attachment B, Comparison of Future No Action Conditions and Project Alternatives at Future LOD

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Figure 1: Comparison of Trinity Storage for Lower San Felipe Intake Alternative

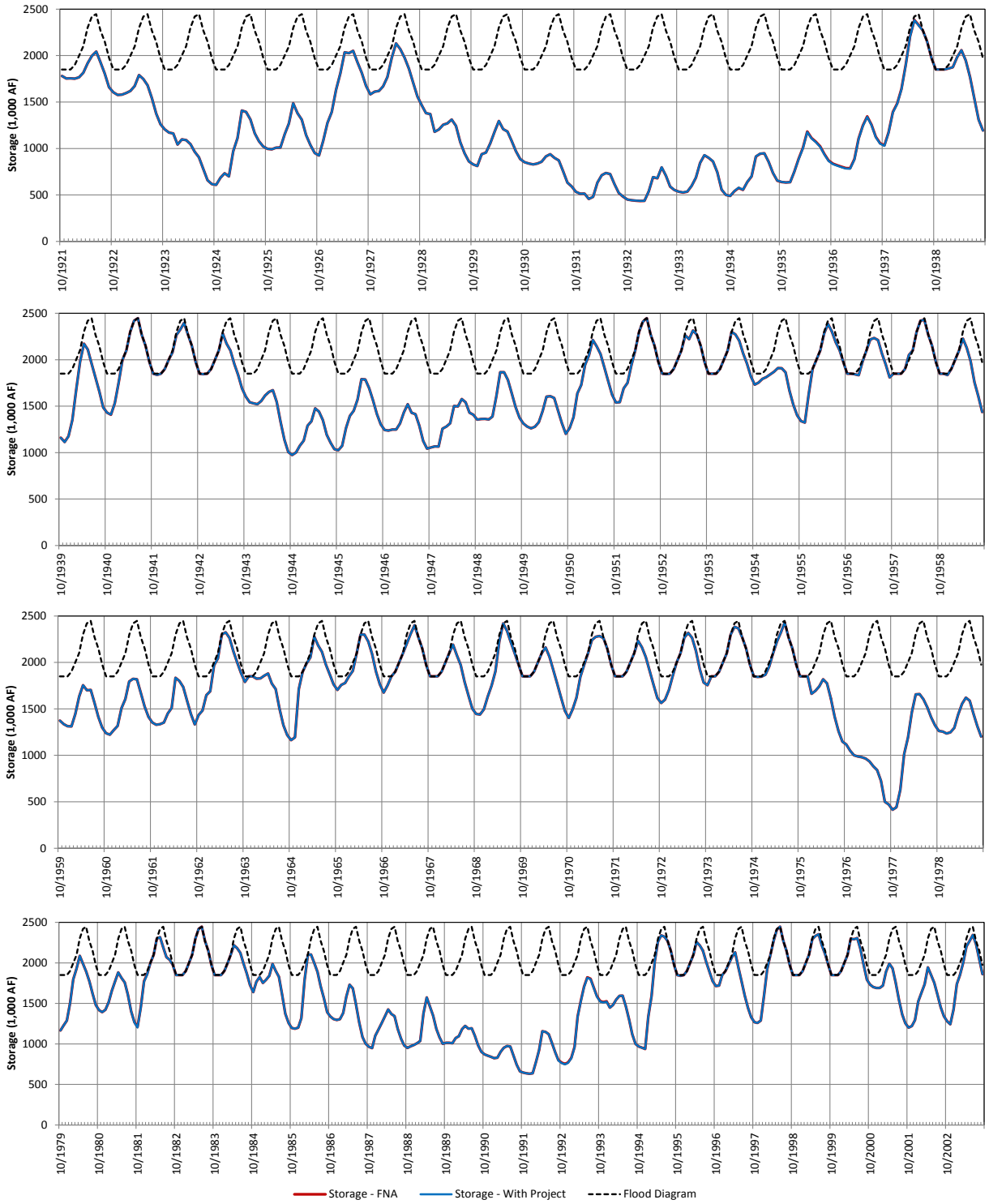


Figure 2: Comparison of Shasta Storage for Lower San Felipe Intake Alternative

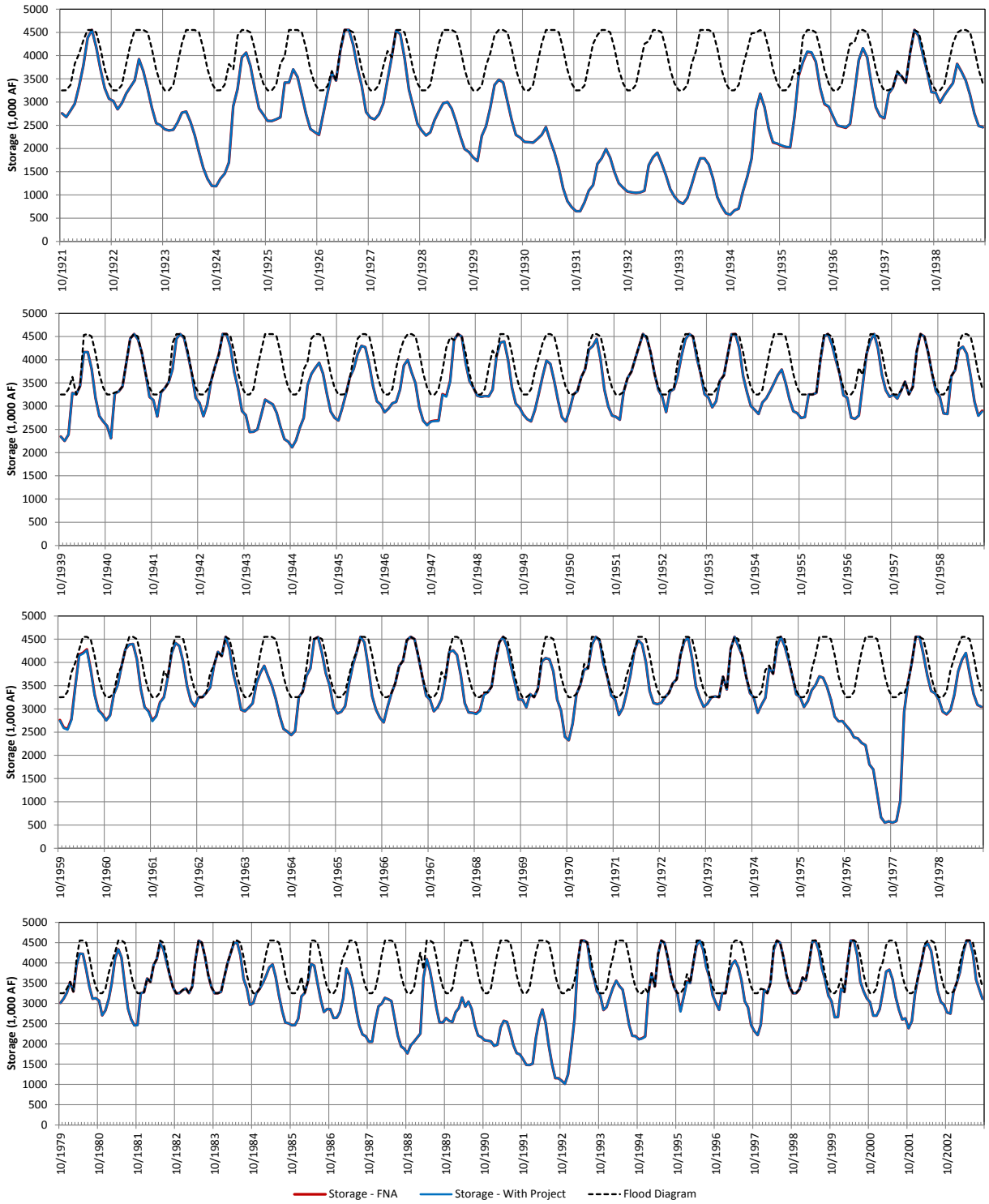


Figure 3: Comparison of Folsom Storage for Lower San Felipe Intake Alternative

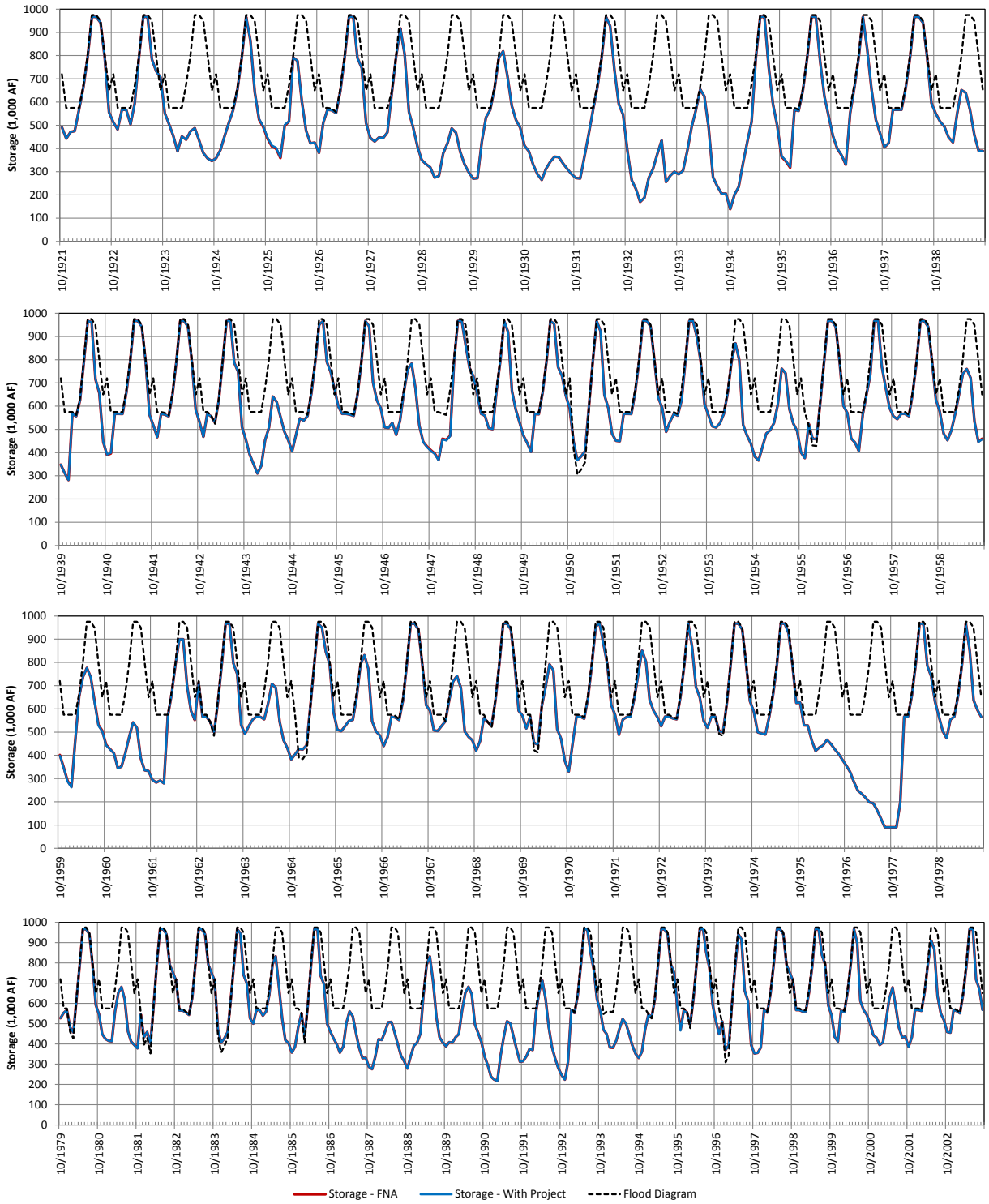


Figure 4: Comparison of Oroville Storage for Lower San Felipe Intake Alternative

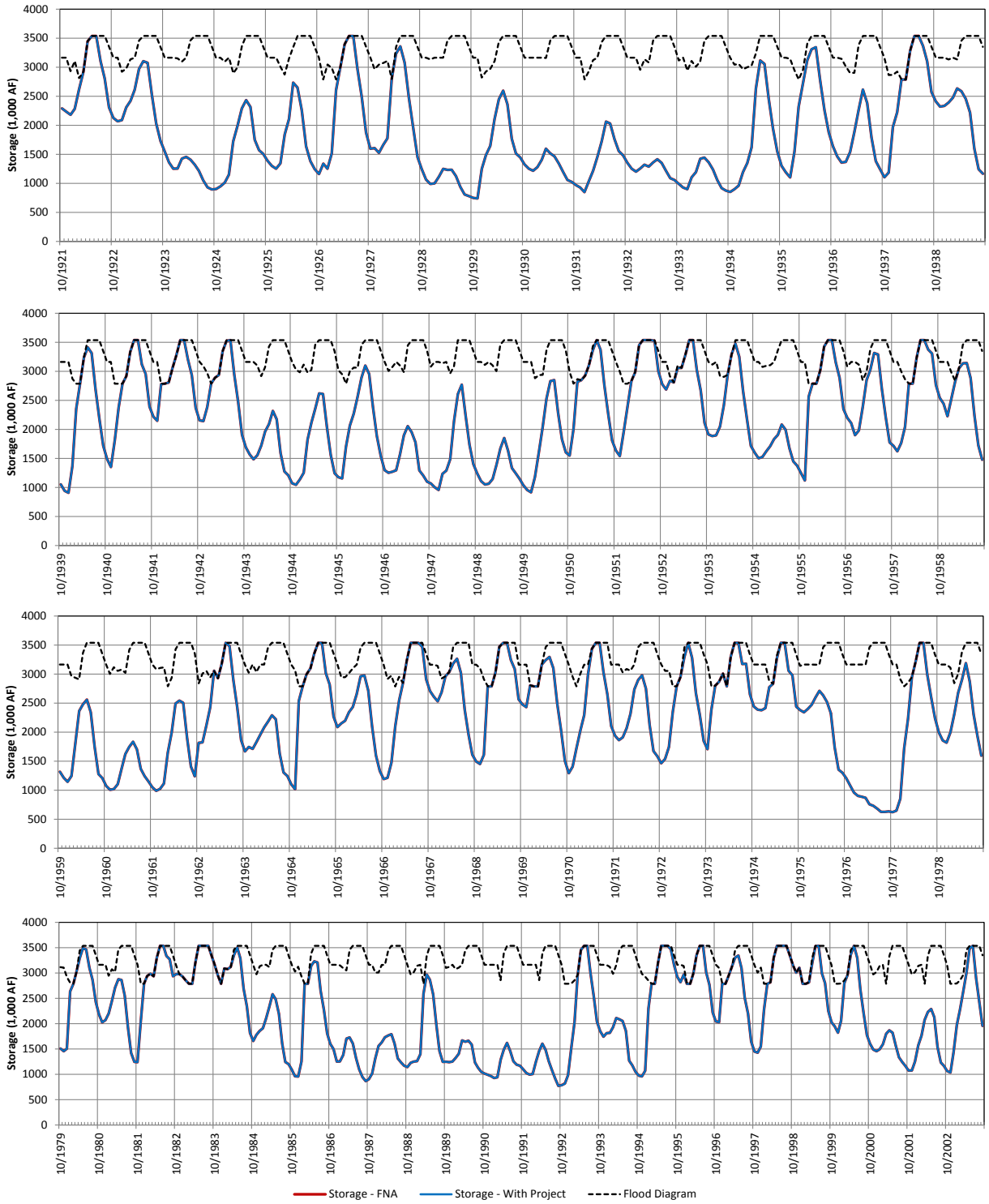


Figure 5: Comparison of Sacramento River below Keswick Flow for Lower San Felipe Intake Alternative

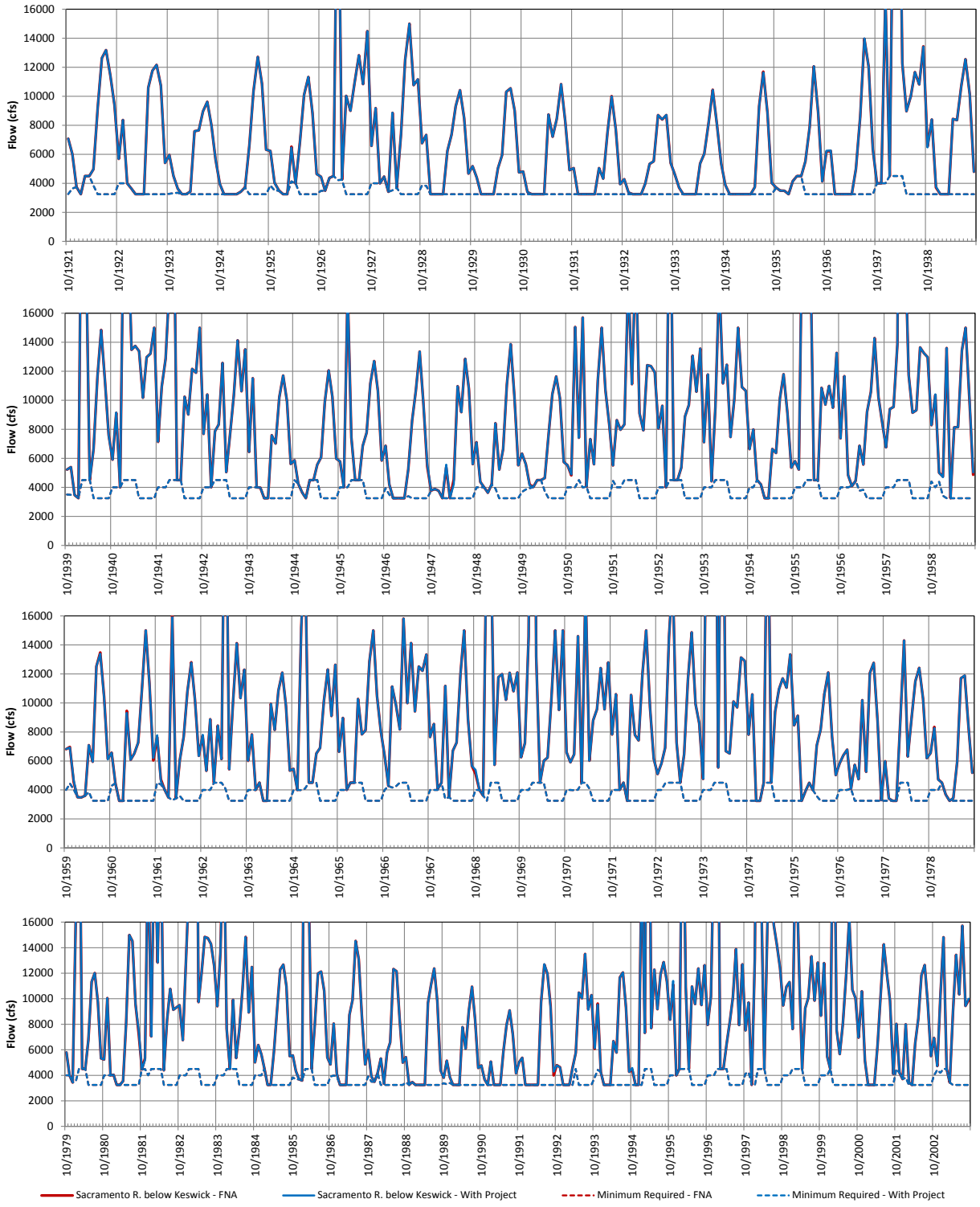


Figure 6: Comparison of Sacramento River at Wilkins Slough Flow for Lower San Felipe Intake Alternative

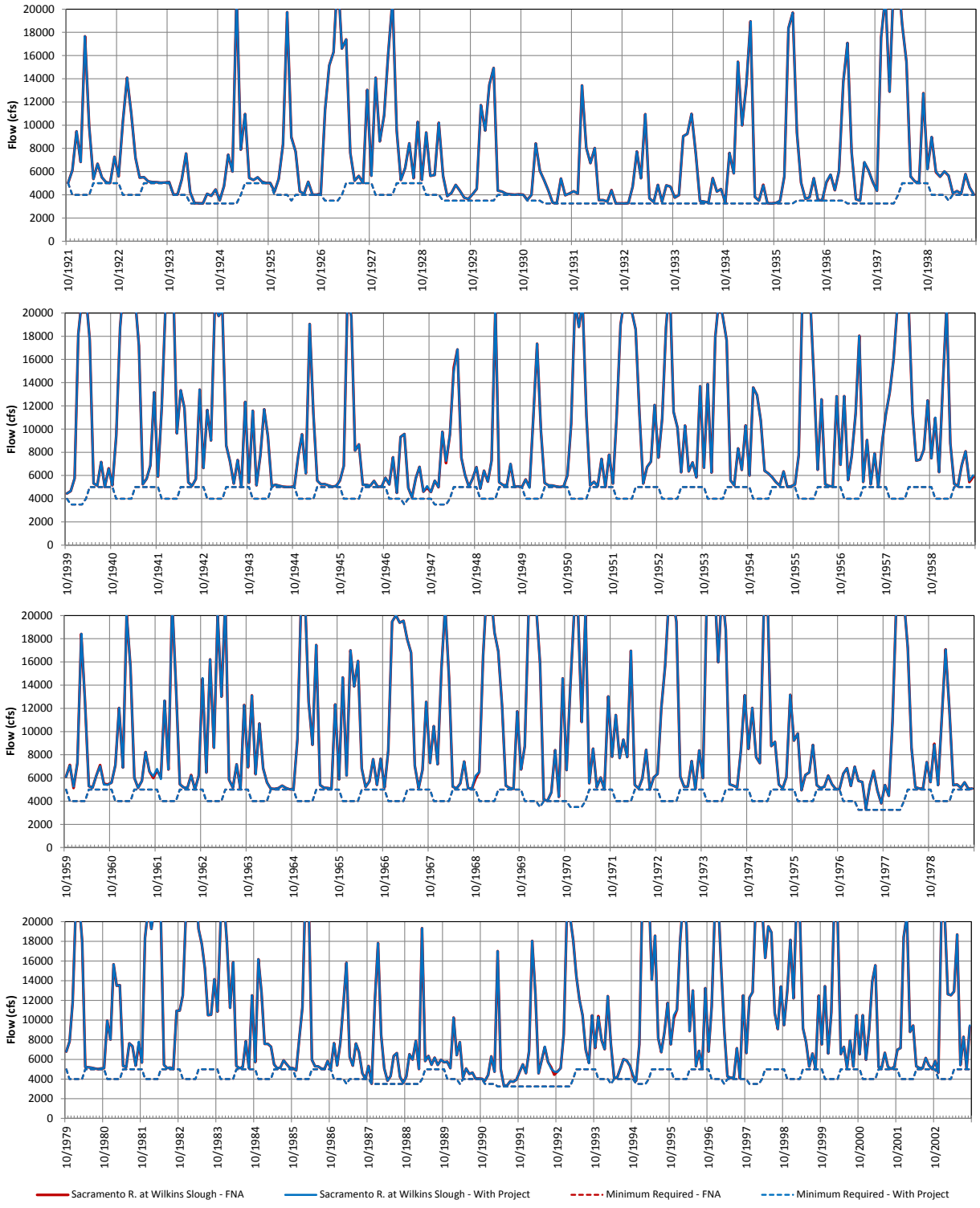


Figure 7: Comparison of American River below Nimbus Flow for Lower San Felipe Intake Alternative

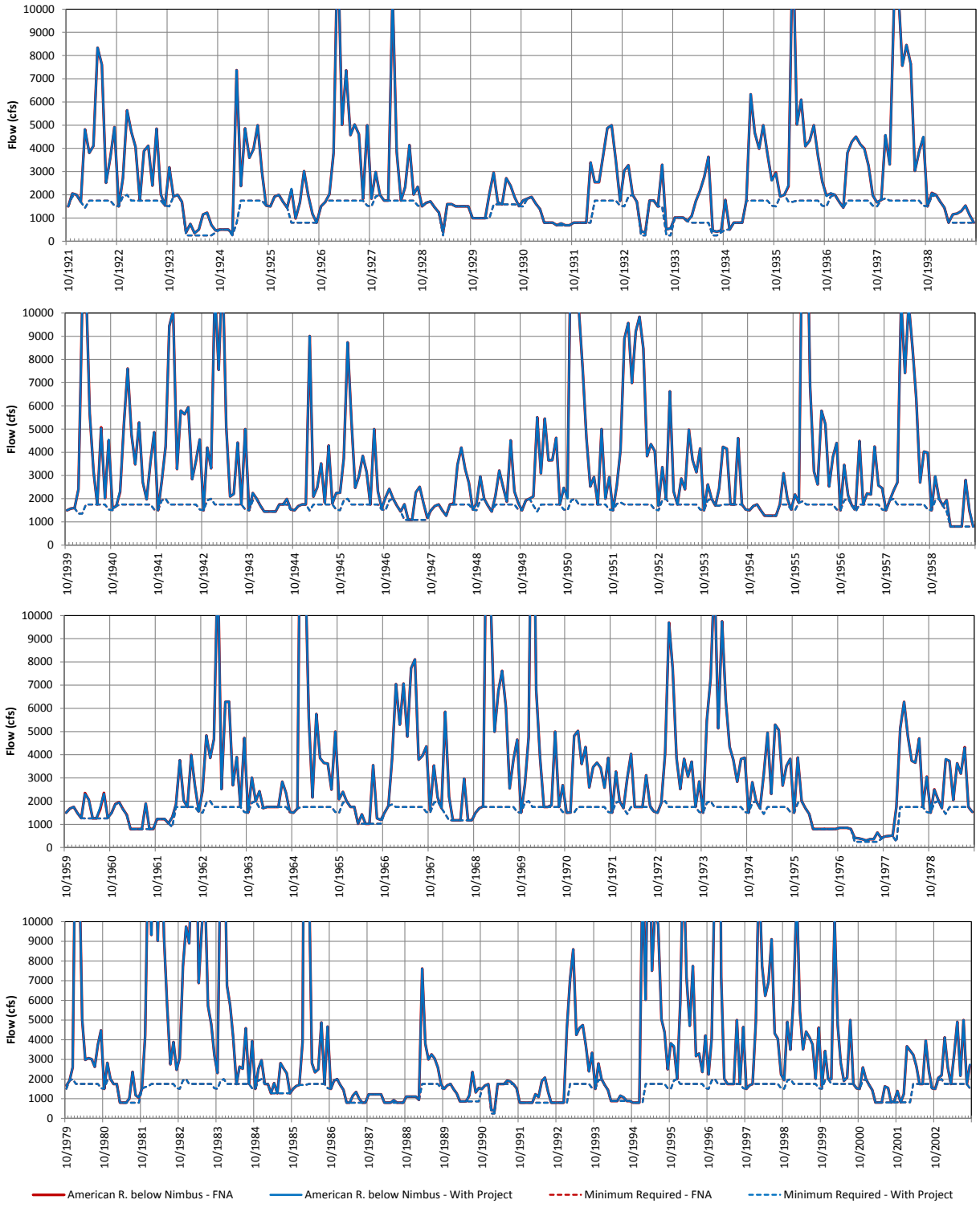


Figure 8: Comparison of Lower Feather River Flow for Lower San Felipe Intake Alternative

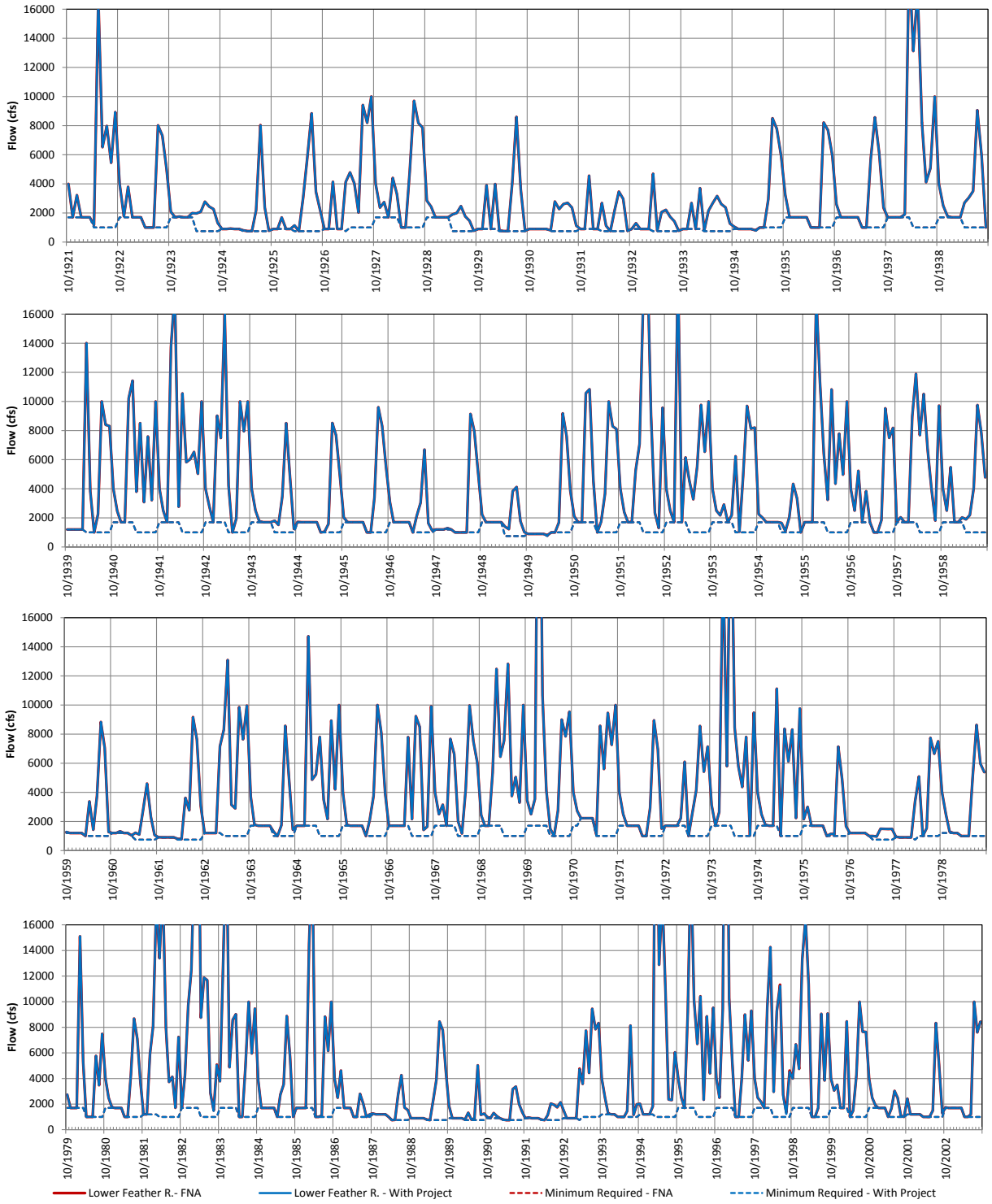


Figure 9: Comparison of Delta Inflow for Lower San Felipe Intake Alternative

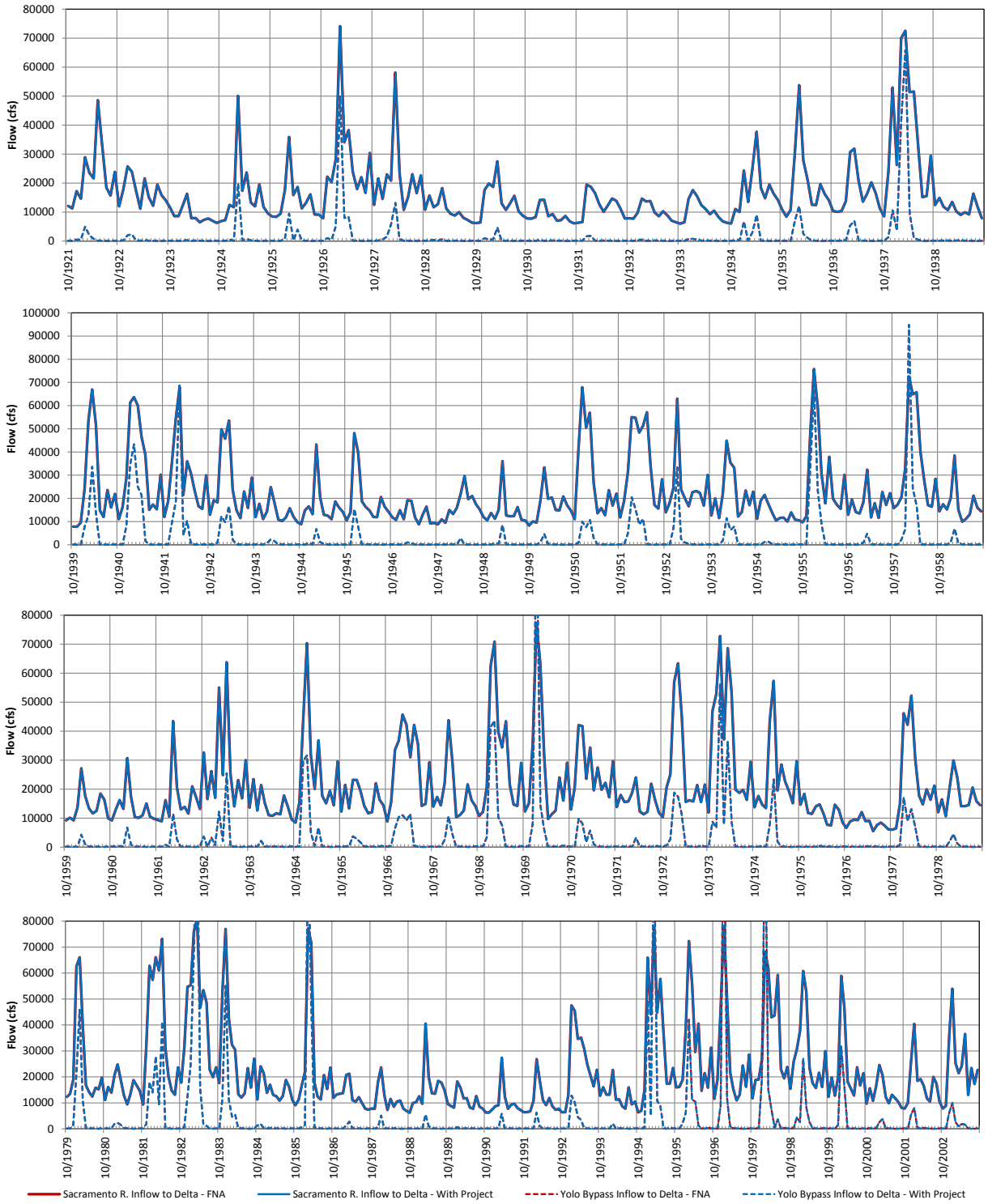


Figure 10: Comparison of Delta Outflow for Lower San Felipe Intake Alternative

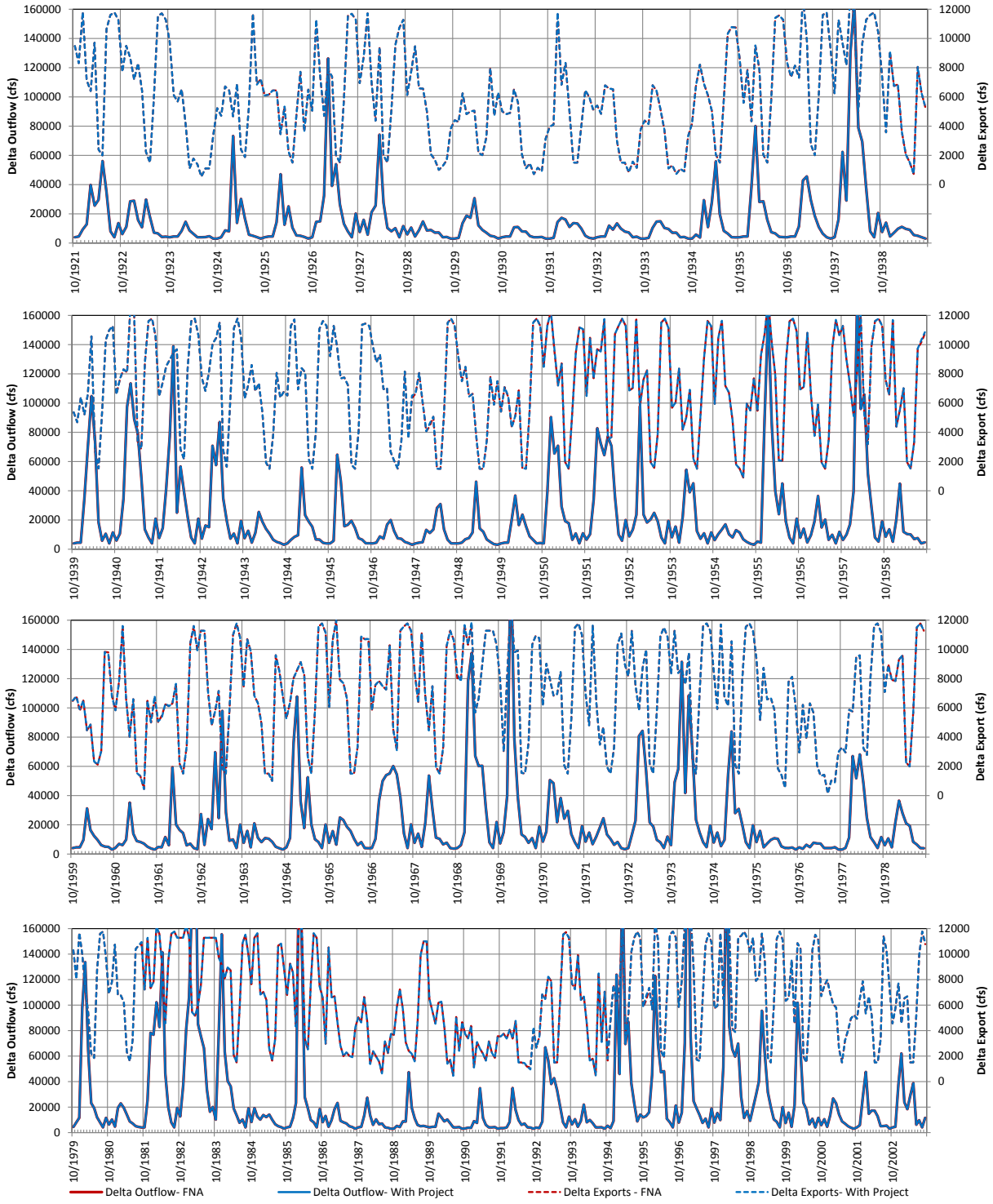


Figure 11: Comparison of San Luis Reservoir Storage for Lower San Felipe Intake Alternative

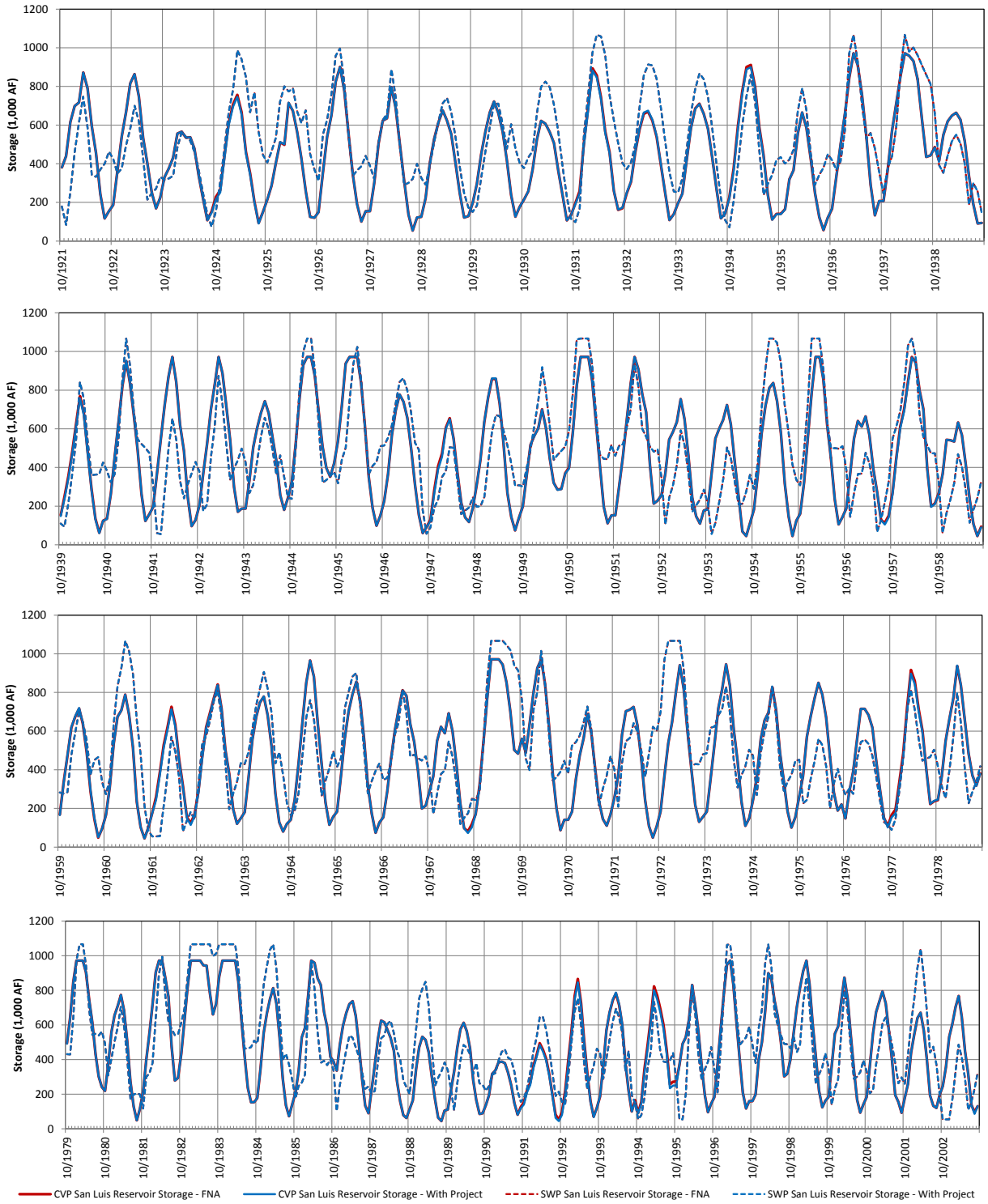


Figure 12: Comparison of Trinity Storage for San Luis Reservoir Expansion Alternative

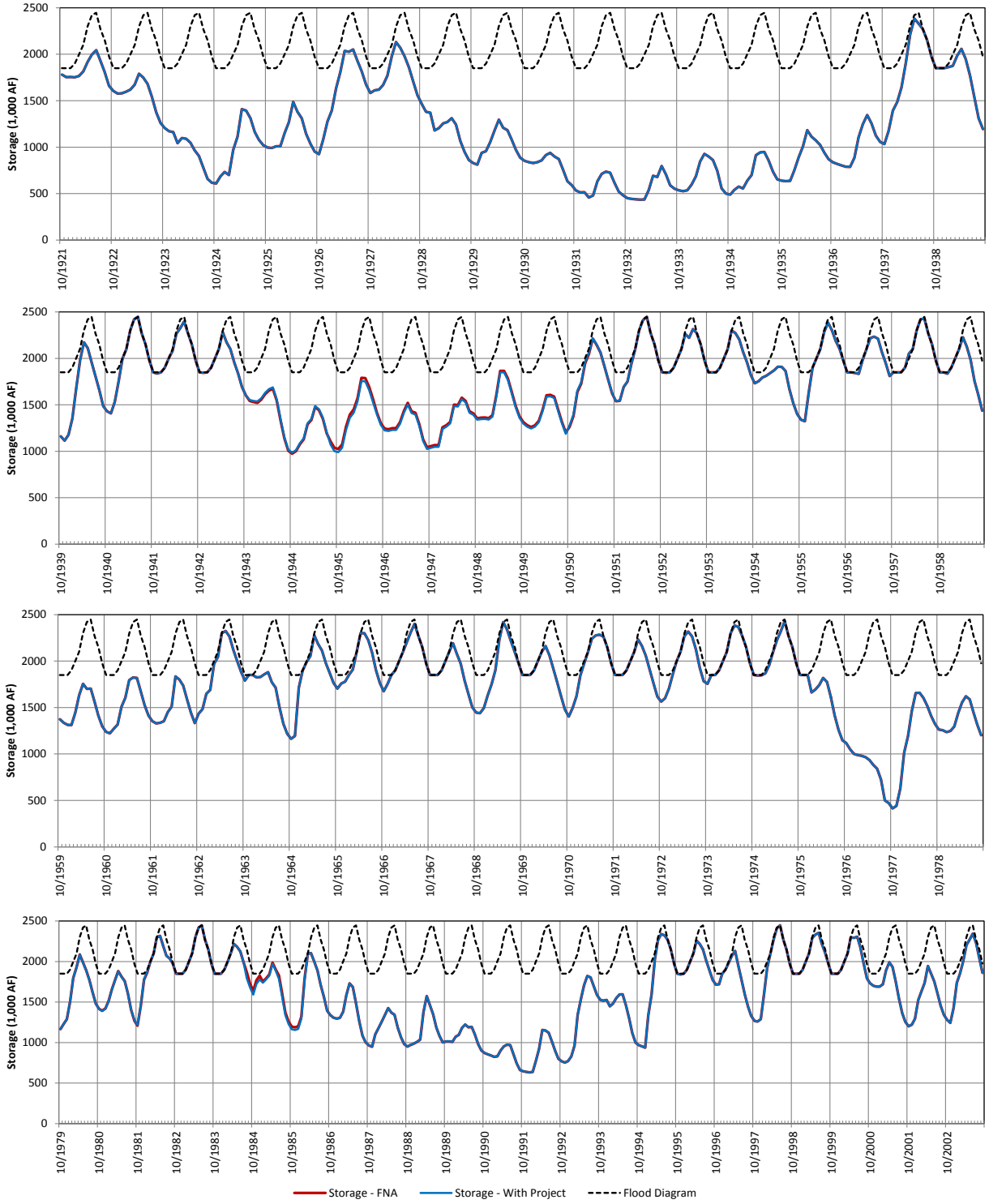


Figure 13: Comparison of Shasta Storage for San Luis Reservoir Expansion Alternative

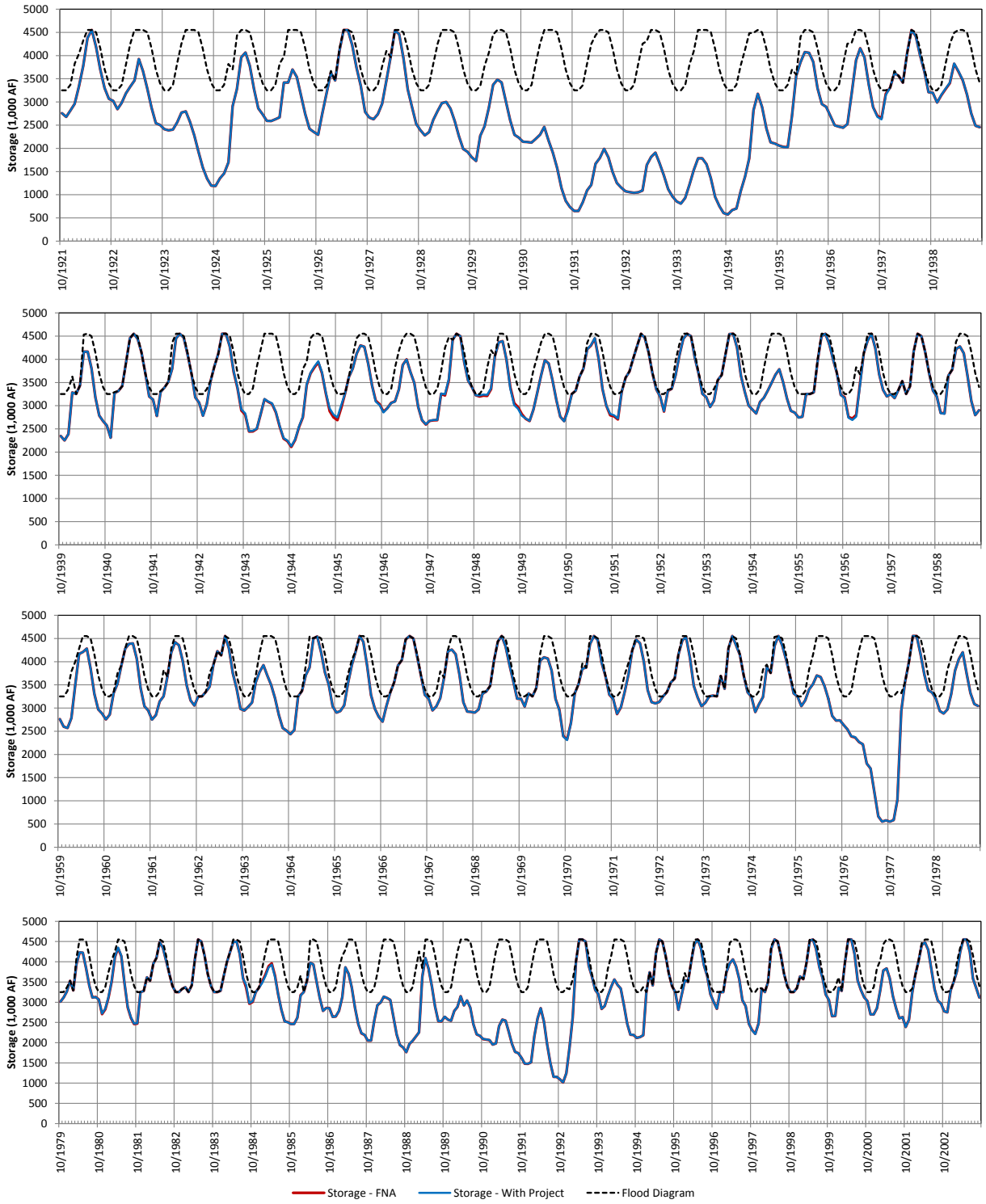


Figure 14: Comparison of Folsom Storage for San Luis Reservoir Expansion Alternative

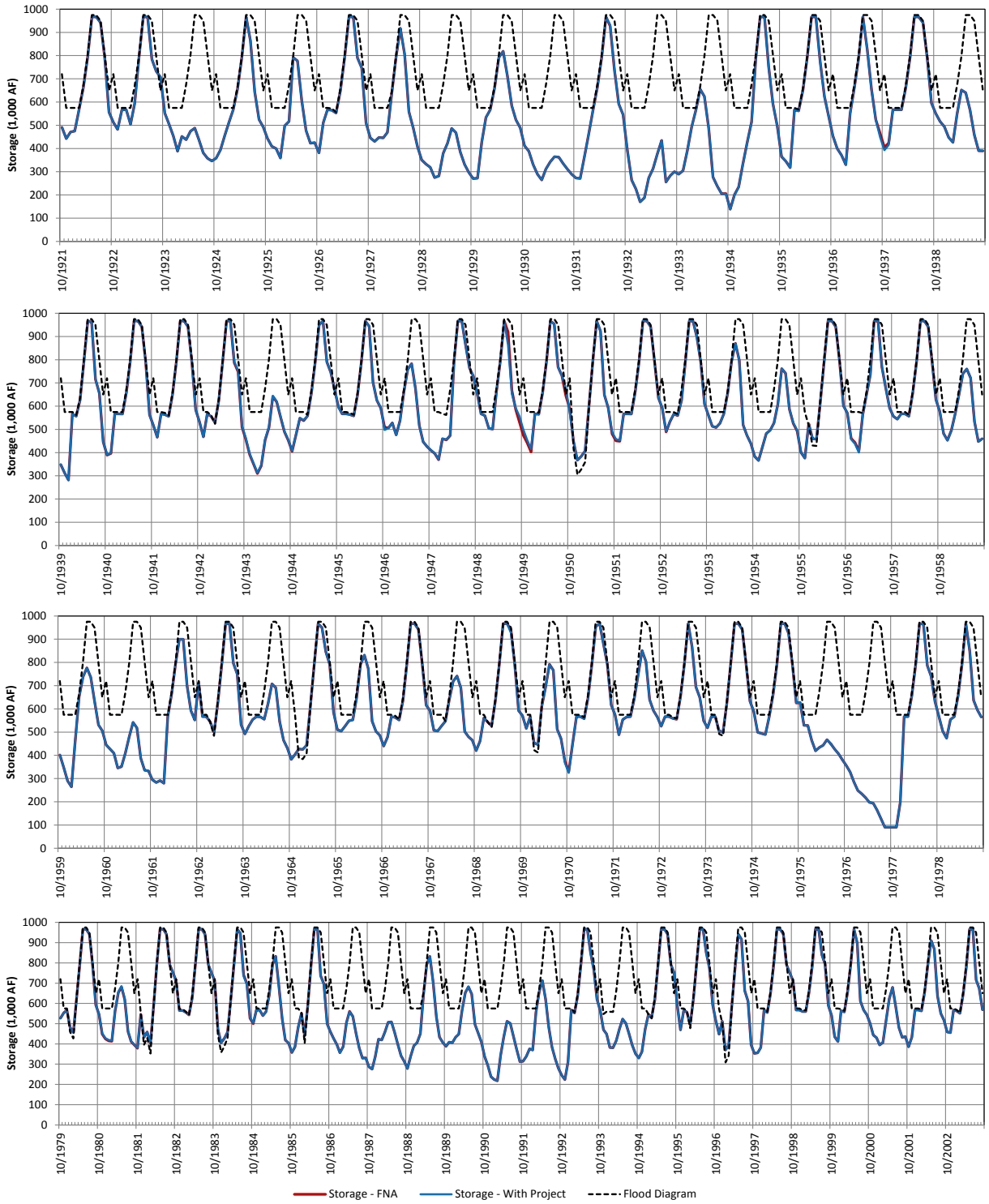


Figure 15: Comparison of Oroville Storage for San Luis Reservoir Expansion Alternative

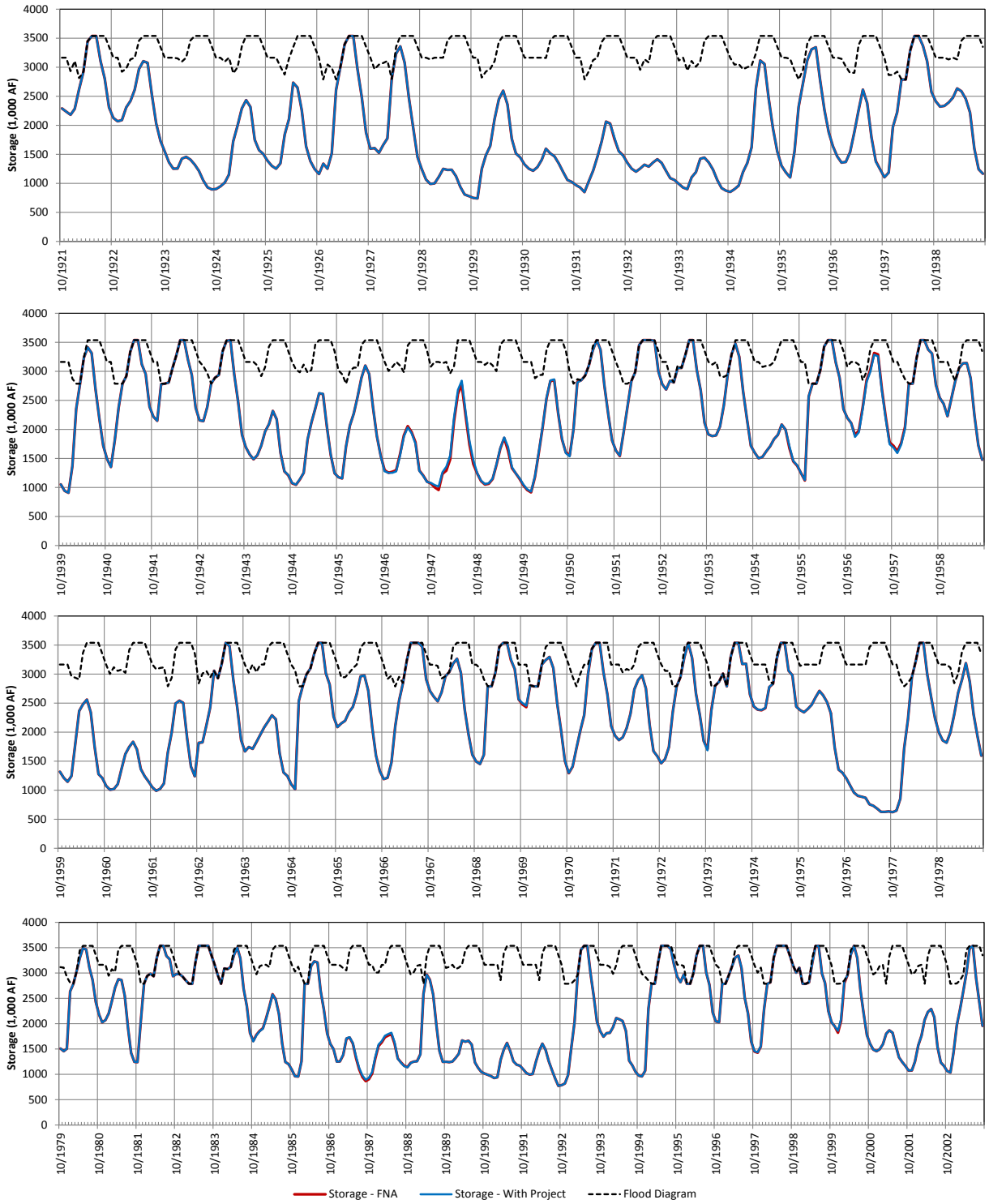


Figure 16: Comparison of Sacramento River below Keswick Flow for San Luis Reservoir Expansion Alternative

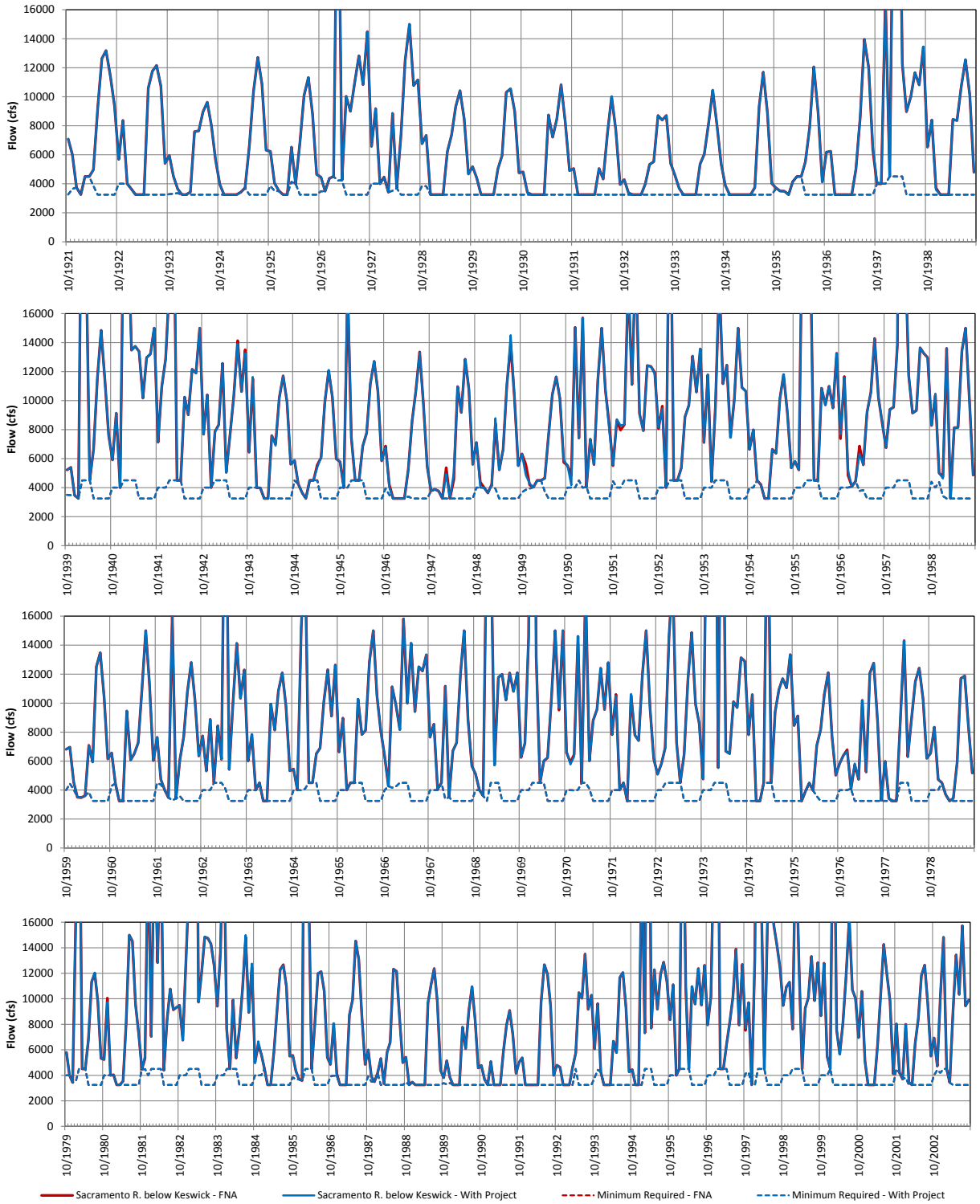


Figure 17: Comparison of Sacramento River at Wilkins Slough Flow for San Luis Reservoir Expansion Alternative

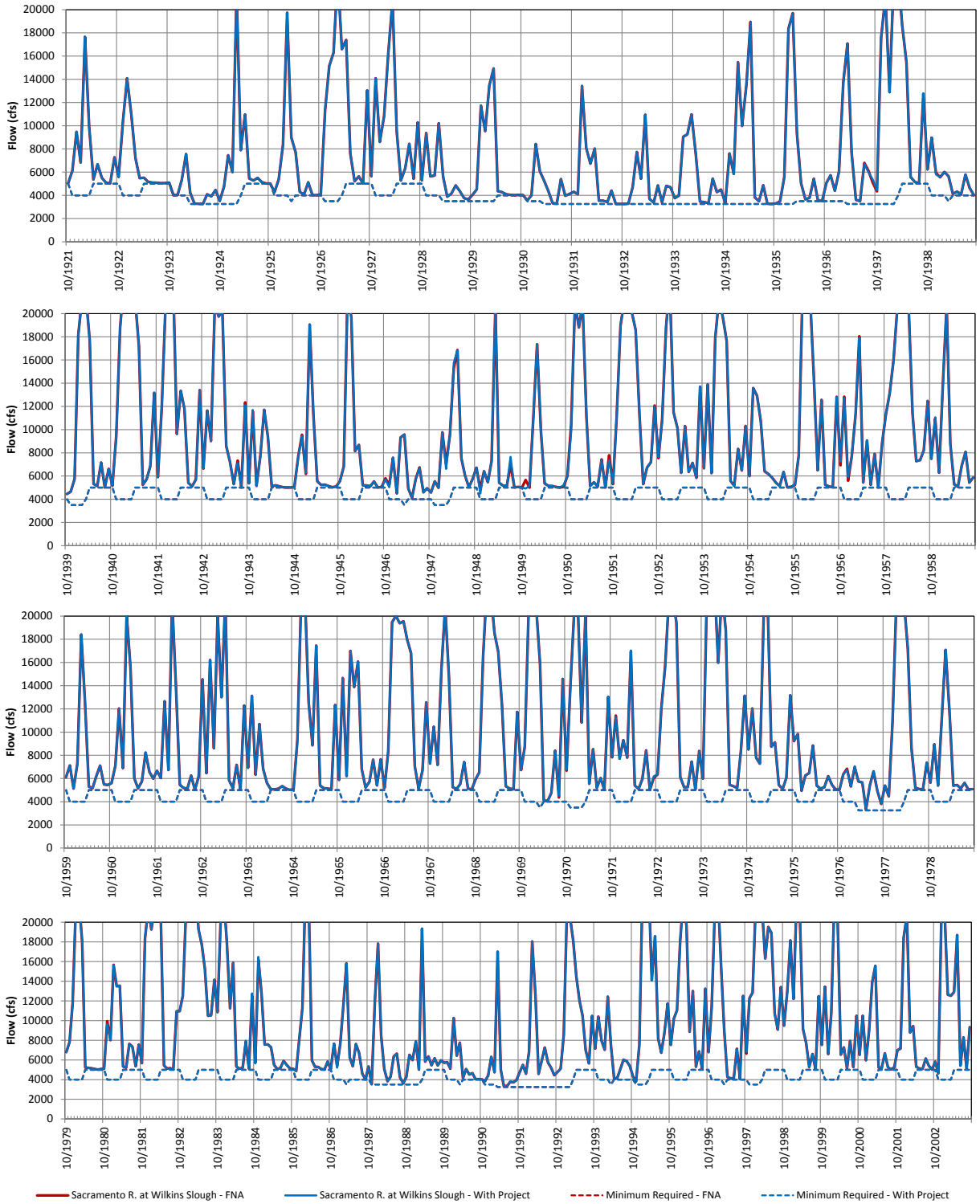


Figure 18: Comparison of American River below Nimbus Flow for San Luis Reservoir Expansion Alternative

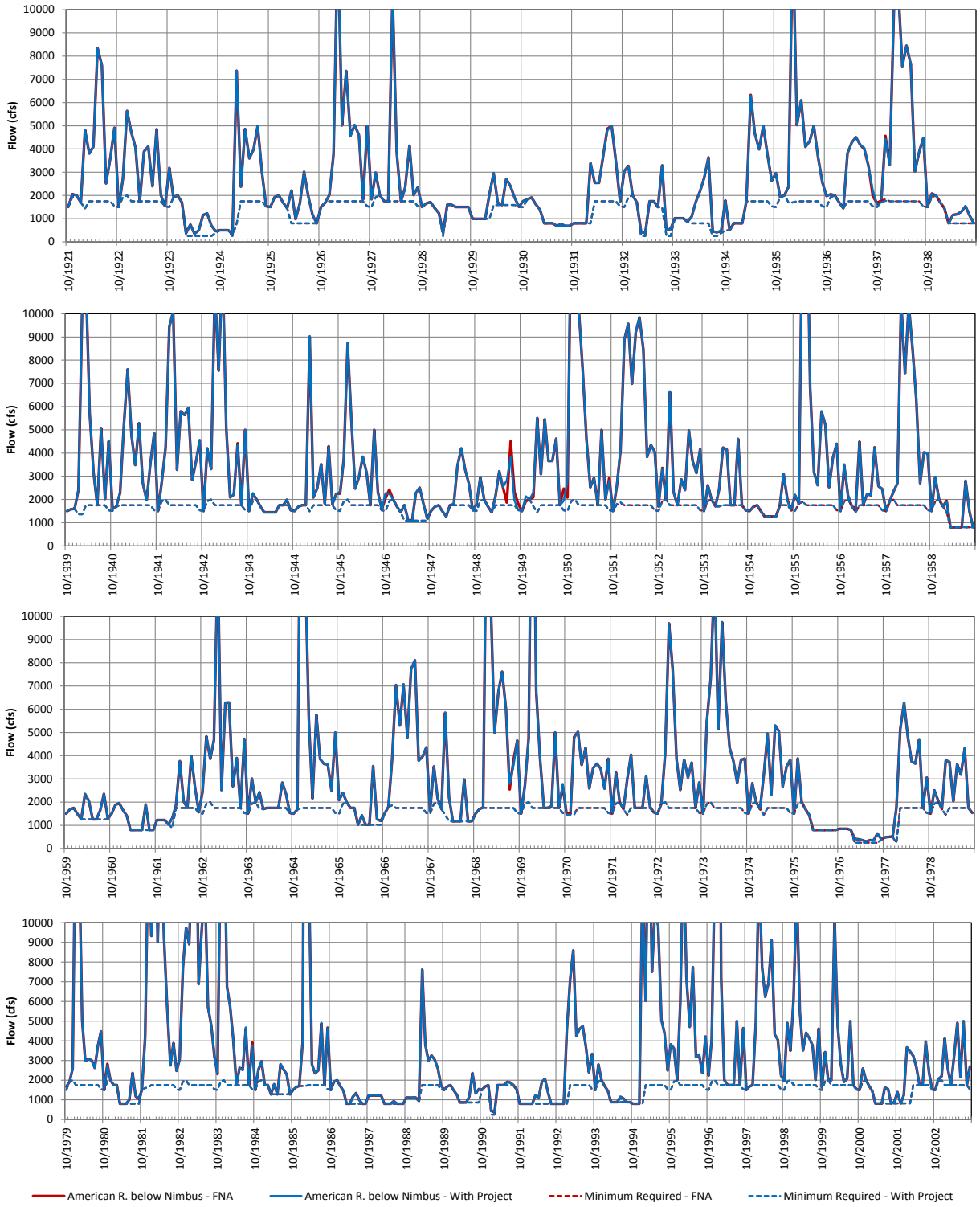


Figure 19: Comparison of Lower Feather River Flow for San Luis Reservoir Expansion Alternative

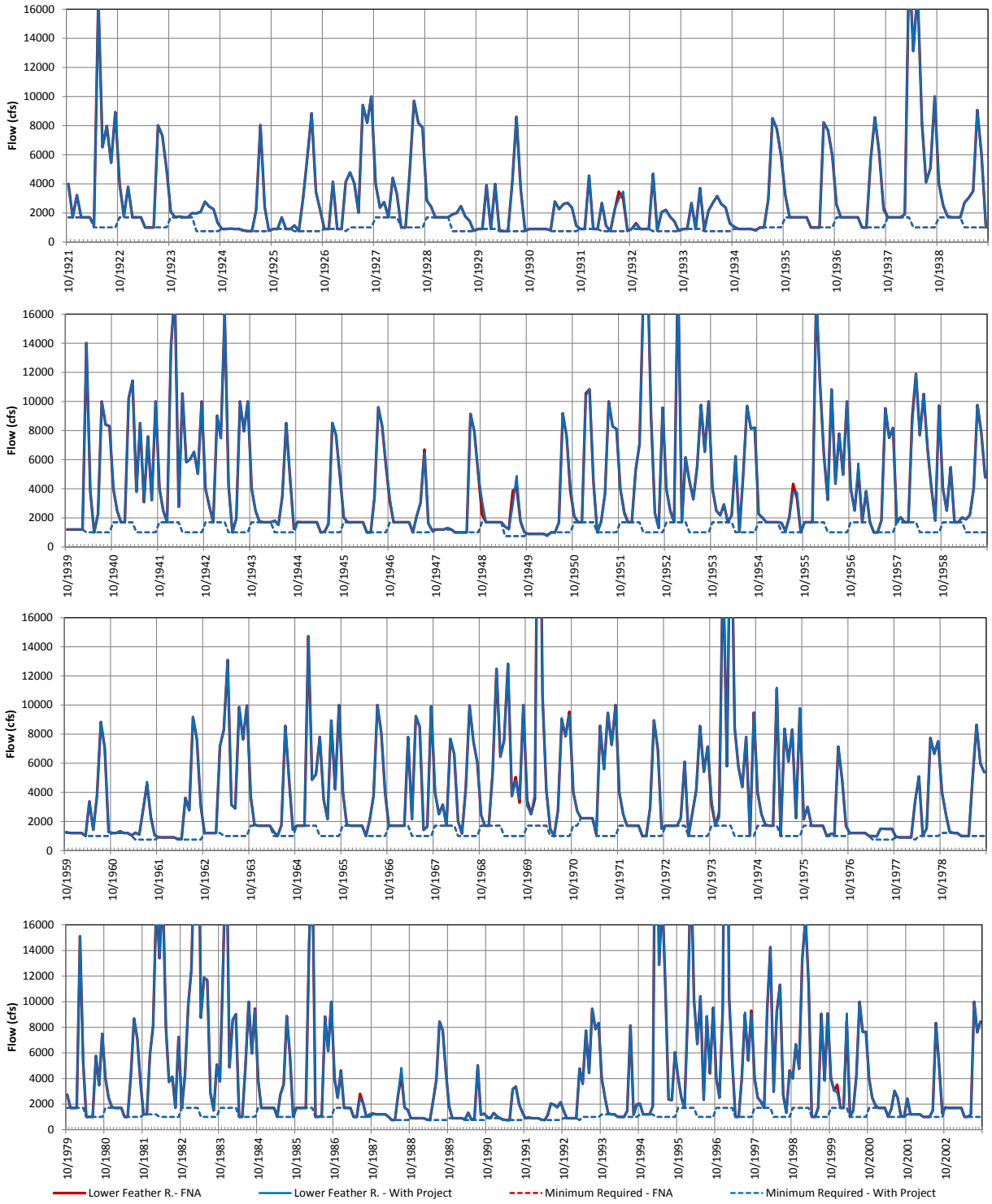


Figure 20: Comparison of Delta Inflow for San Luis Reservoir Expansion Alternative

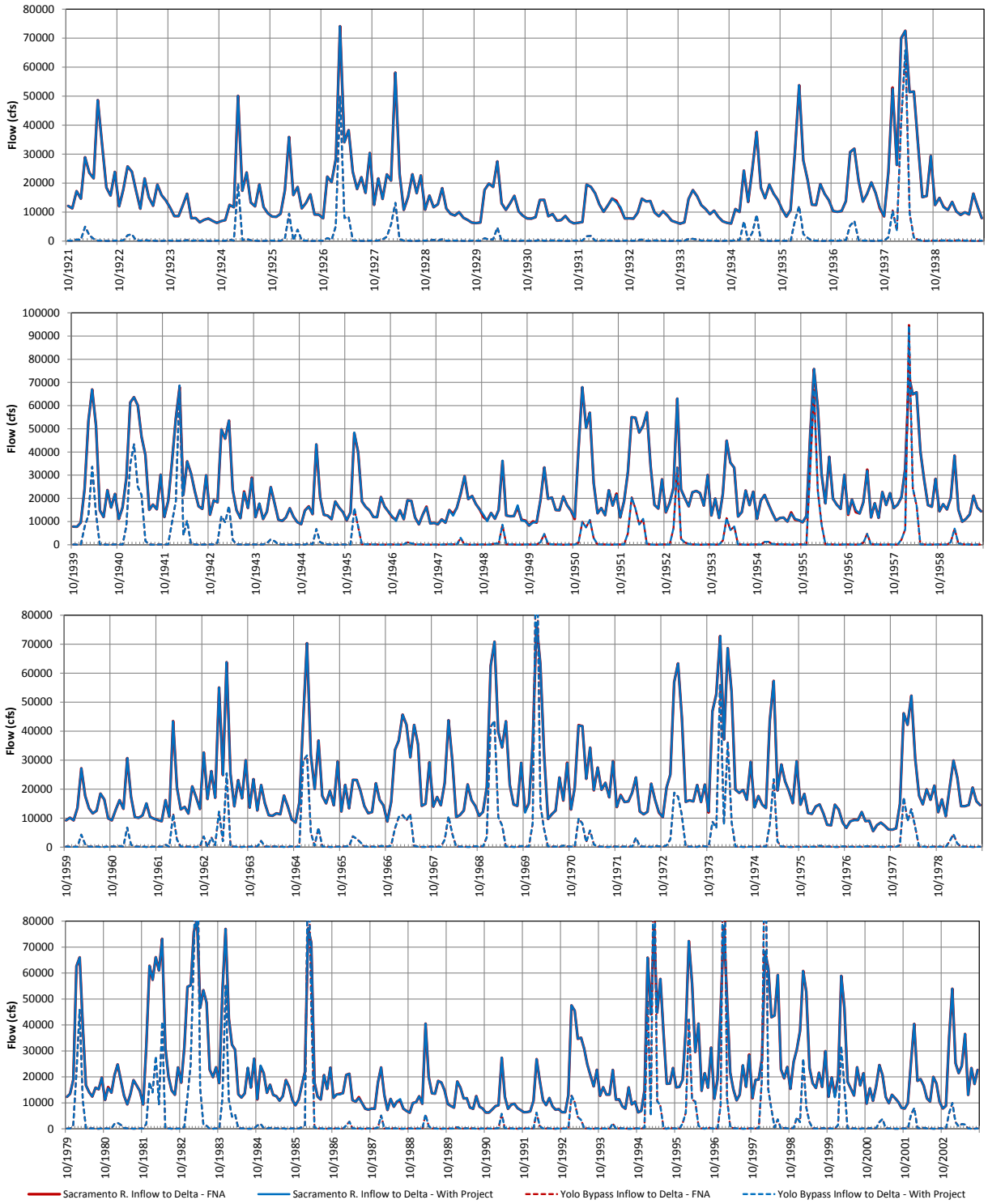


Figure 21: Comparison of Delta Outflow for San Luis Reservoir Expansion Alternative

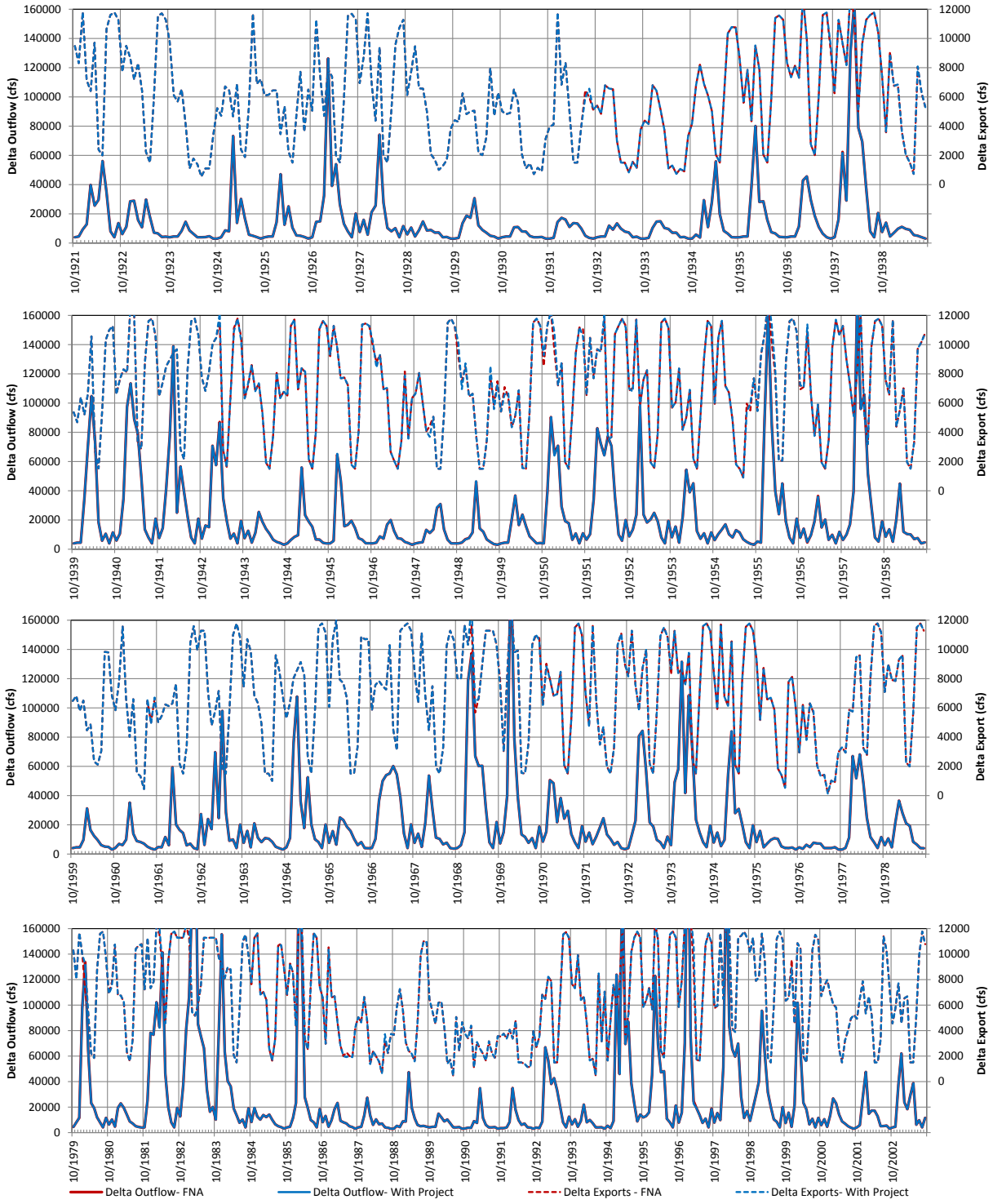


Figure 22: Comparison of San Luis Reservoir Storage for San Luis Reservoir Expansion Alternative

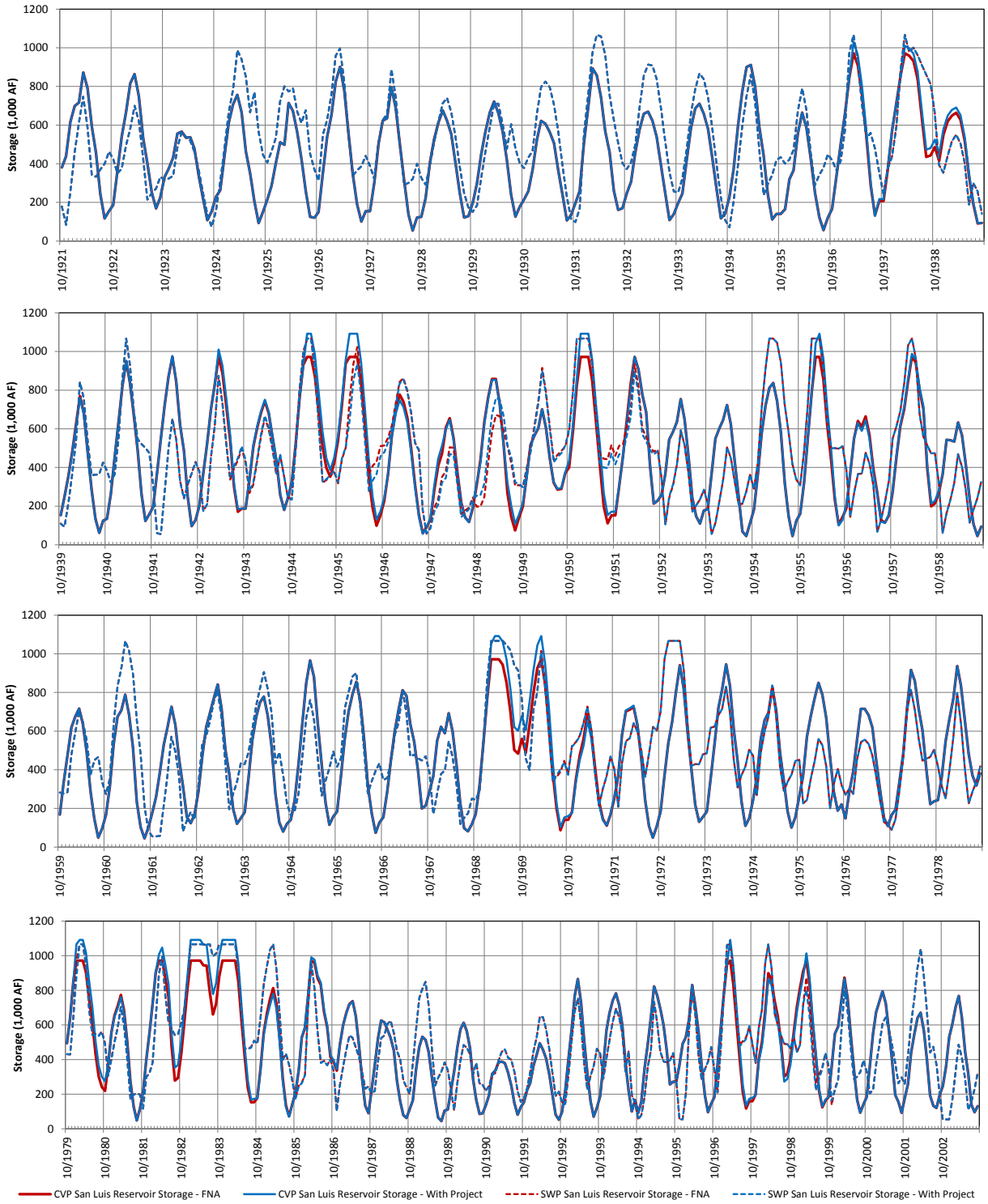


Figure 23: Comparison of Trinity Storage for Pacheco Reservoir Expansion Alternative

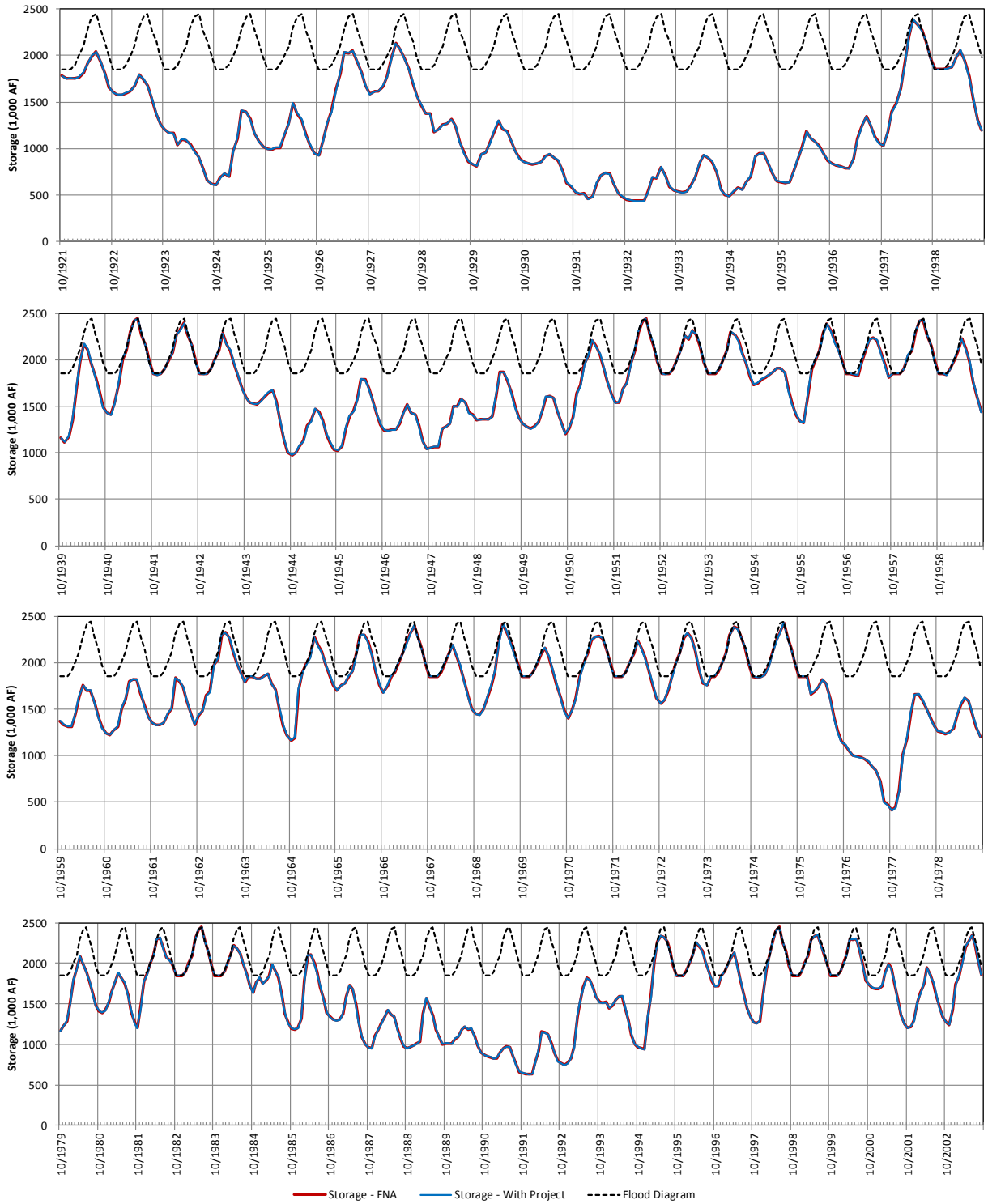


Figure 24: Comparison of Shasta Storage for Pacheco Reservoir Expansion Alternative

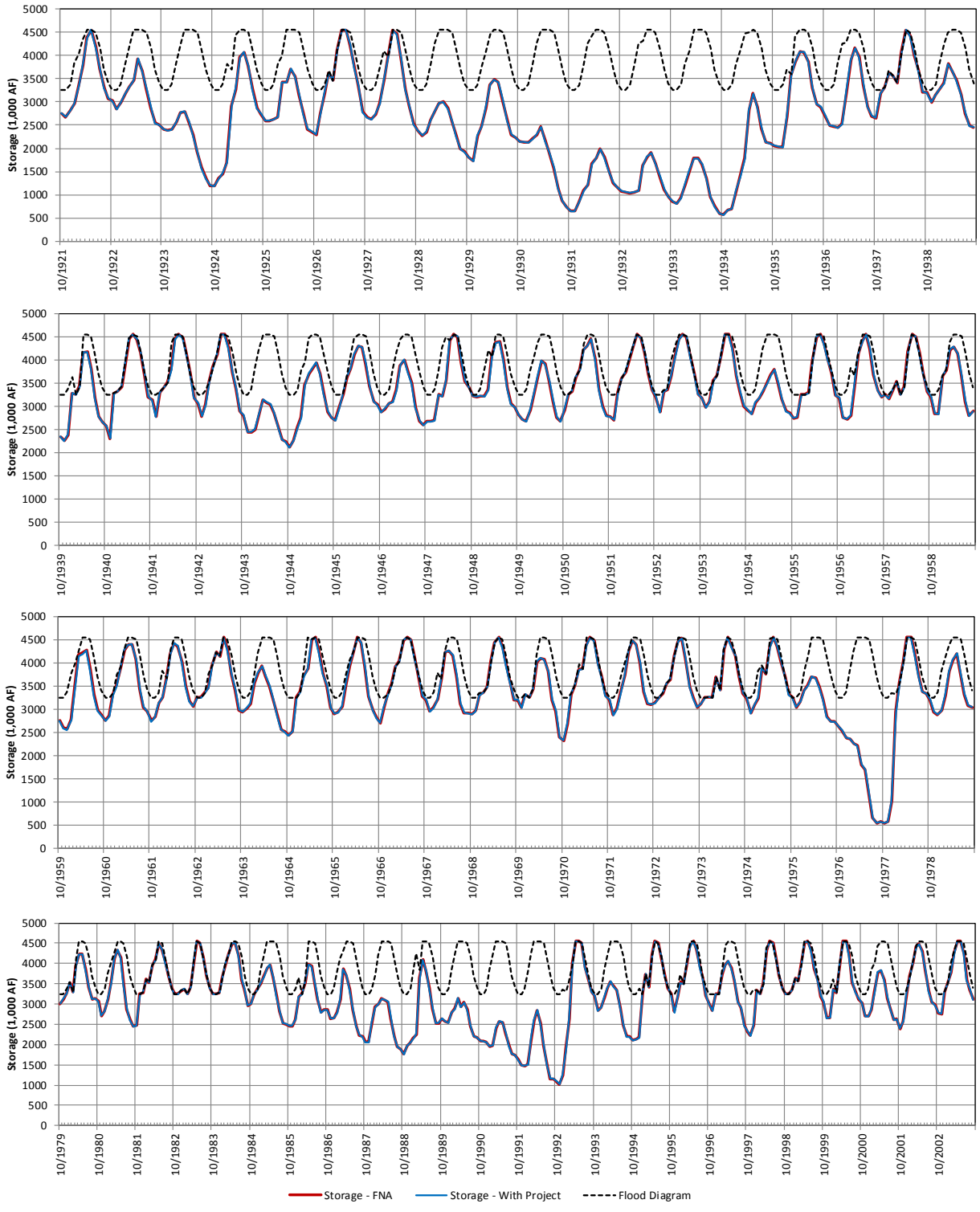


Figure 25: Comparison of Folsom Storage for Pacheco Reservoir Expansion Alternative

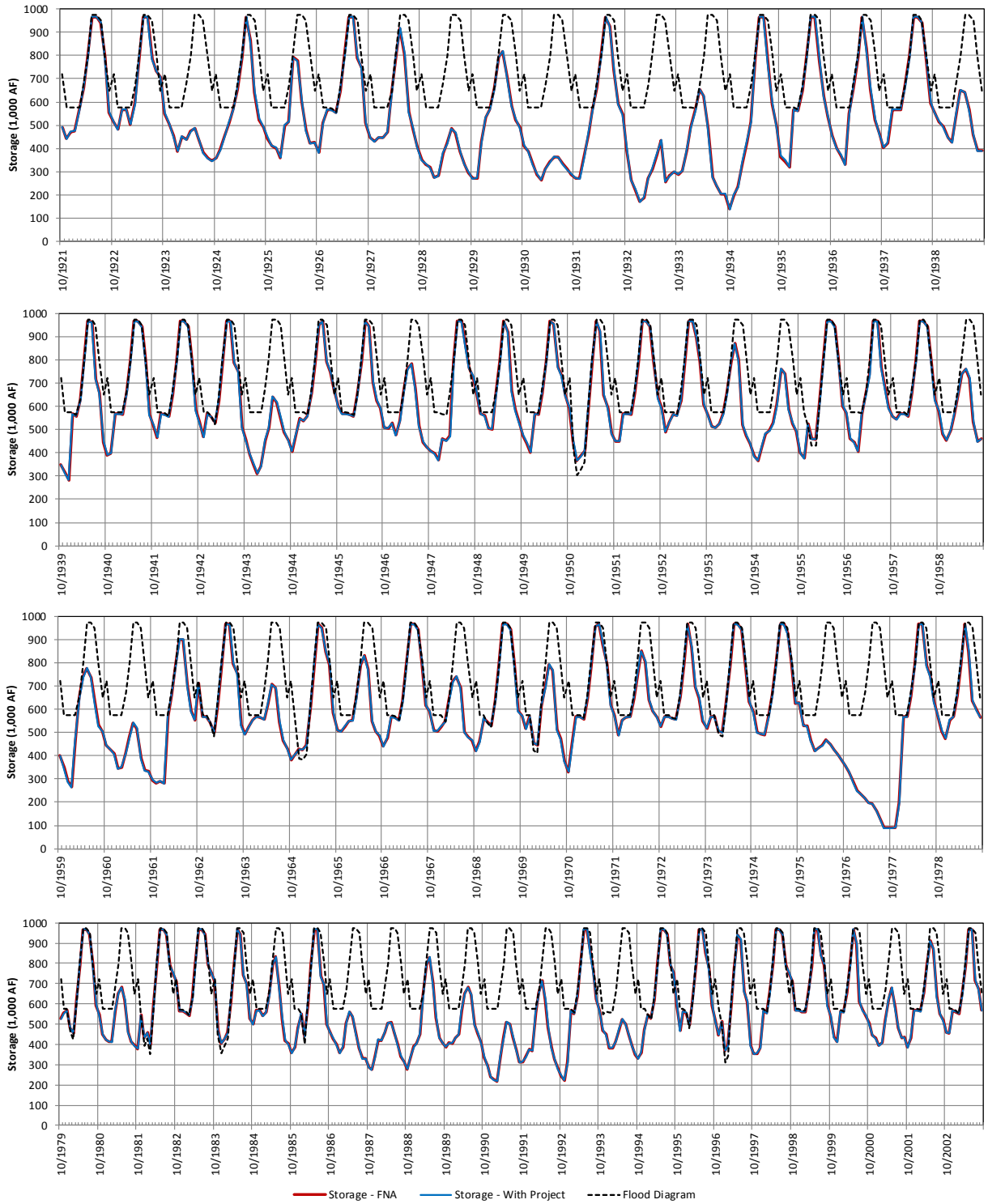


Figure 26: Comparison of Oroville Storage for Pacheco Reservoir Expansion Alternative

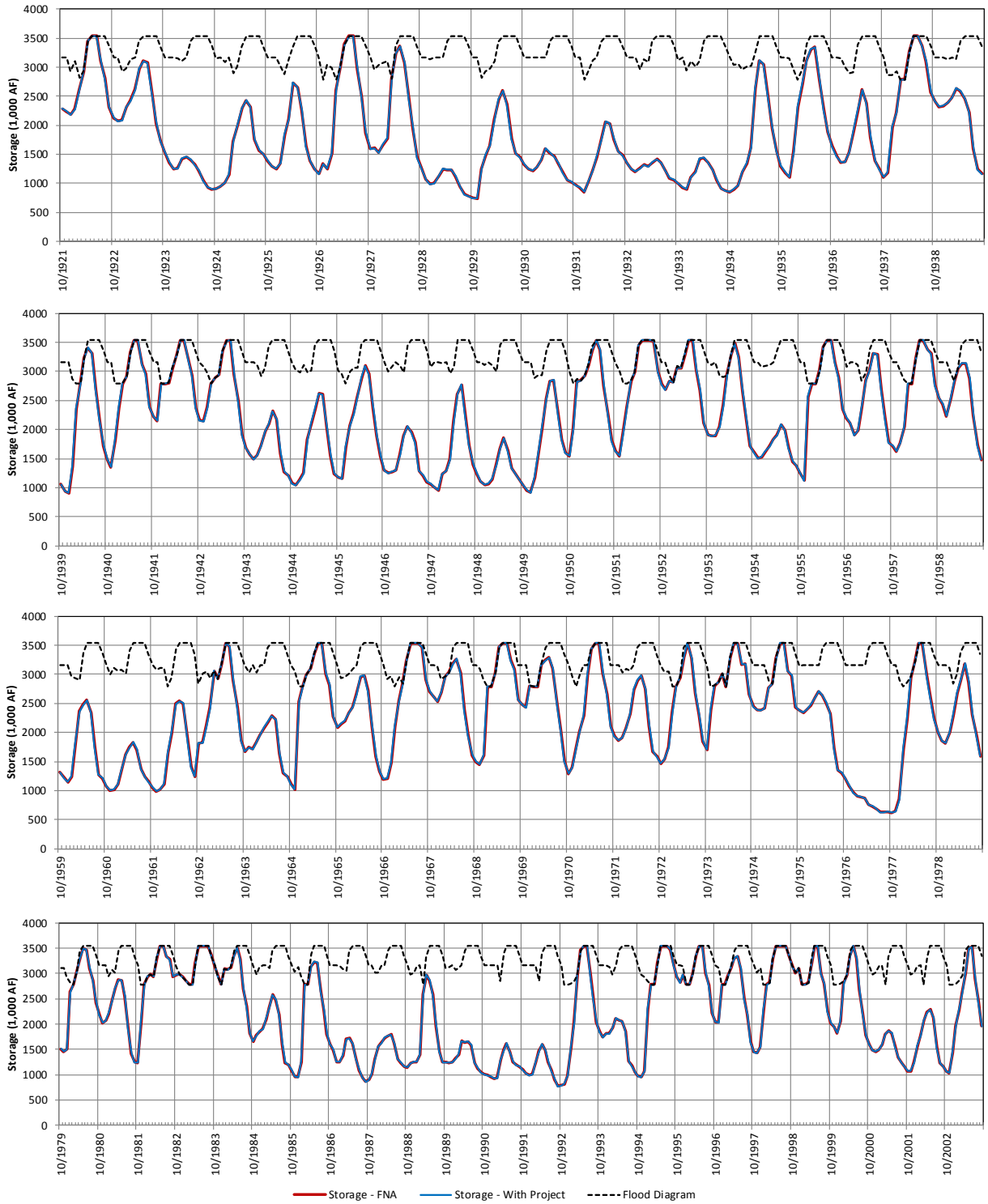


Figure 27: Comparison of Sacramento River below Keswick Flow for Pacheco Reservoir Expansion Alternative

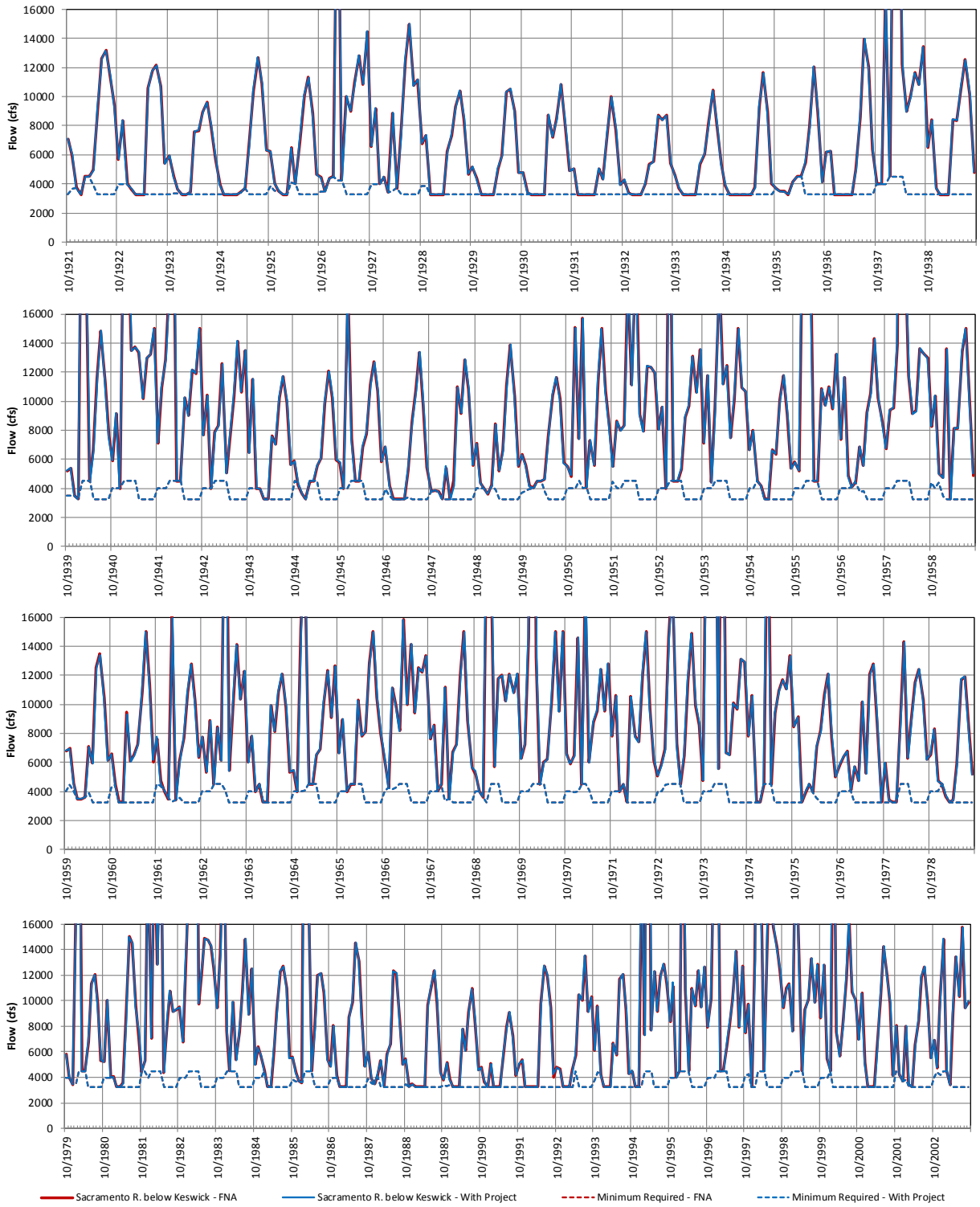


Figure 28: Comparison of Sacramento River at Wilkins Slough Flow for Pacheco Reservoir Expansion Alternative

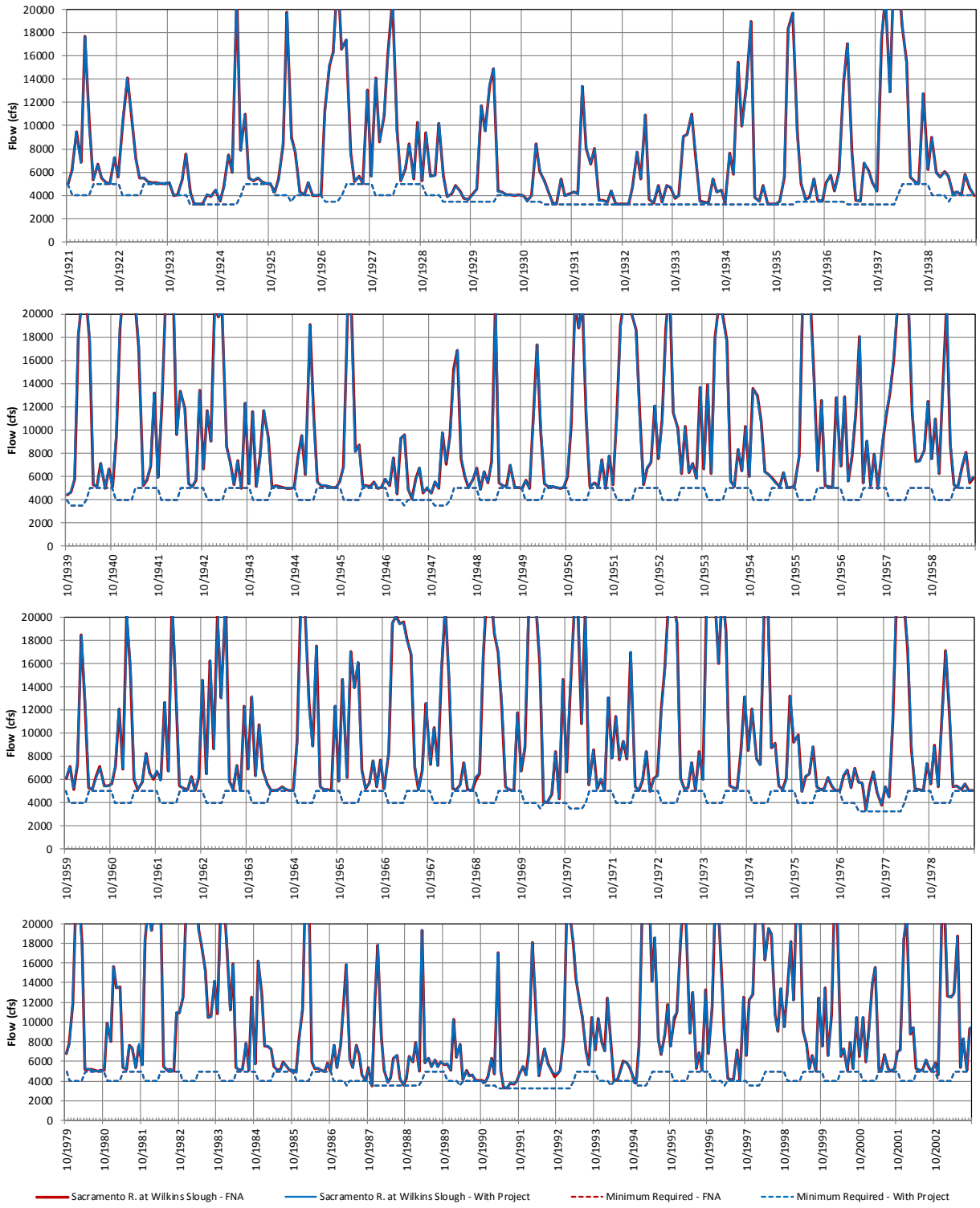


Figure 29: Comparison of American River below Nimbus Flow for Pacheco Reservoir Expansion Alternative

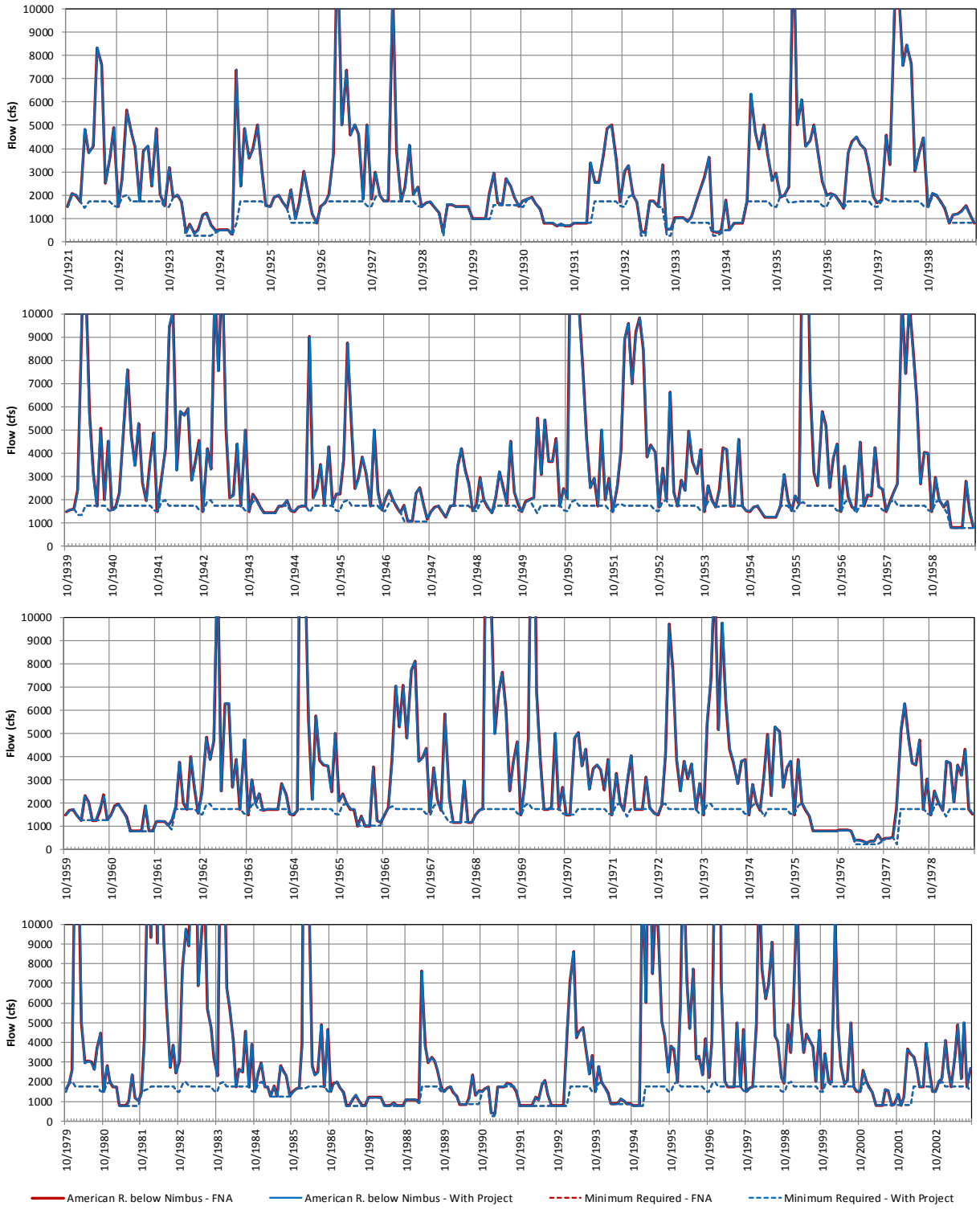


Figure 30: Comparison of Lower Feather River Flow for Pacheco Reservoir Expansion Alternative

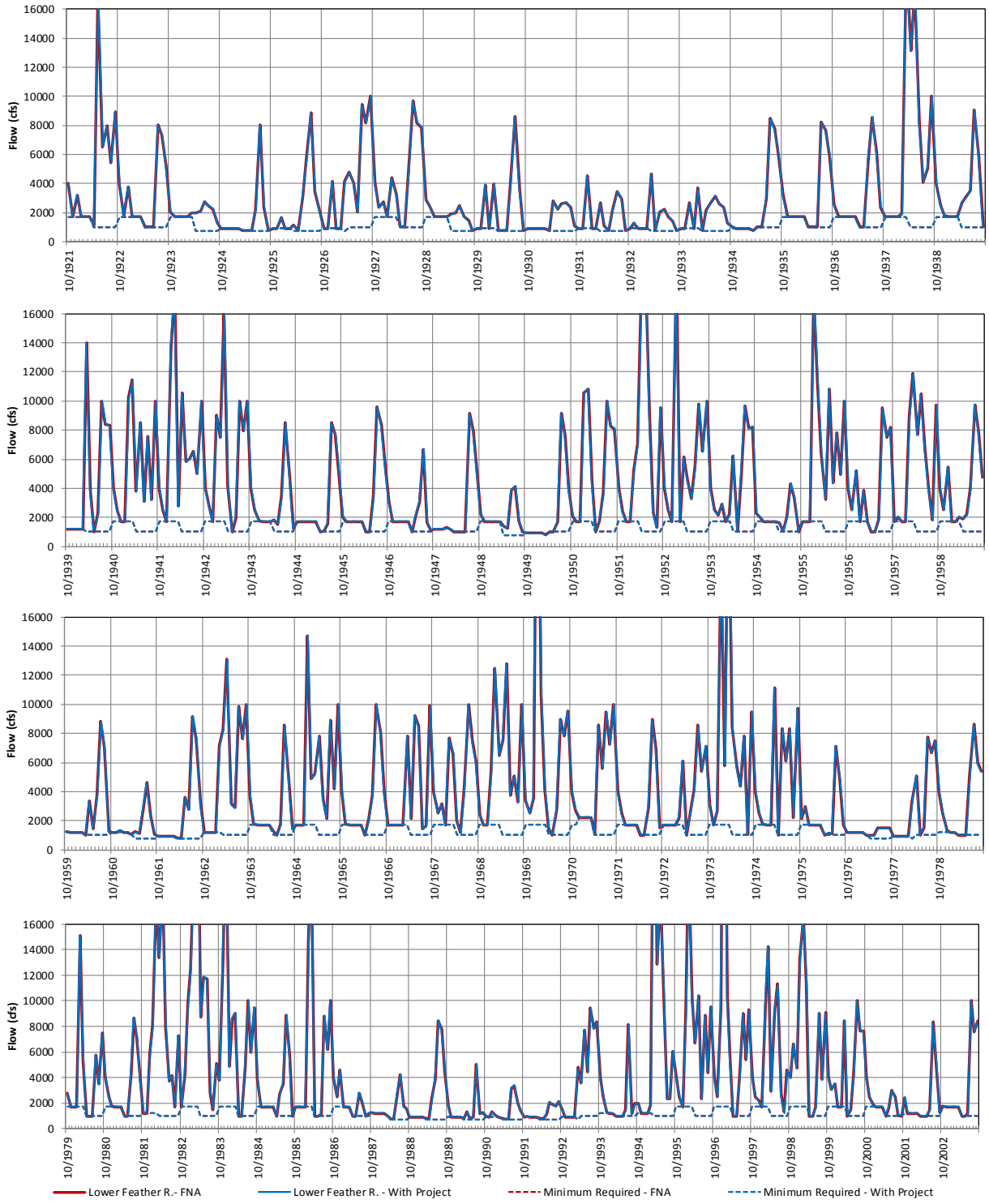


Figure 31: Comparison of Delta Inflow for Pacheco Reservoir Expansion Alternative

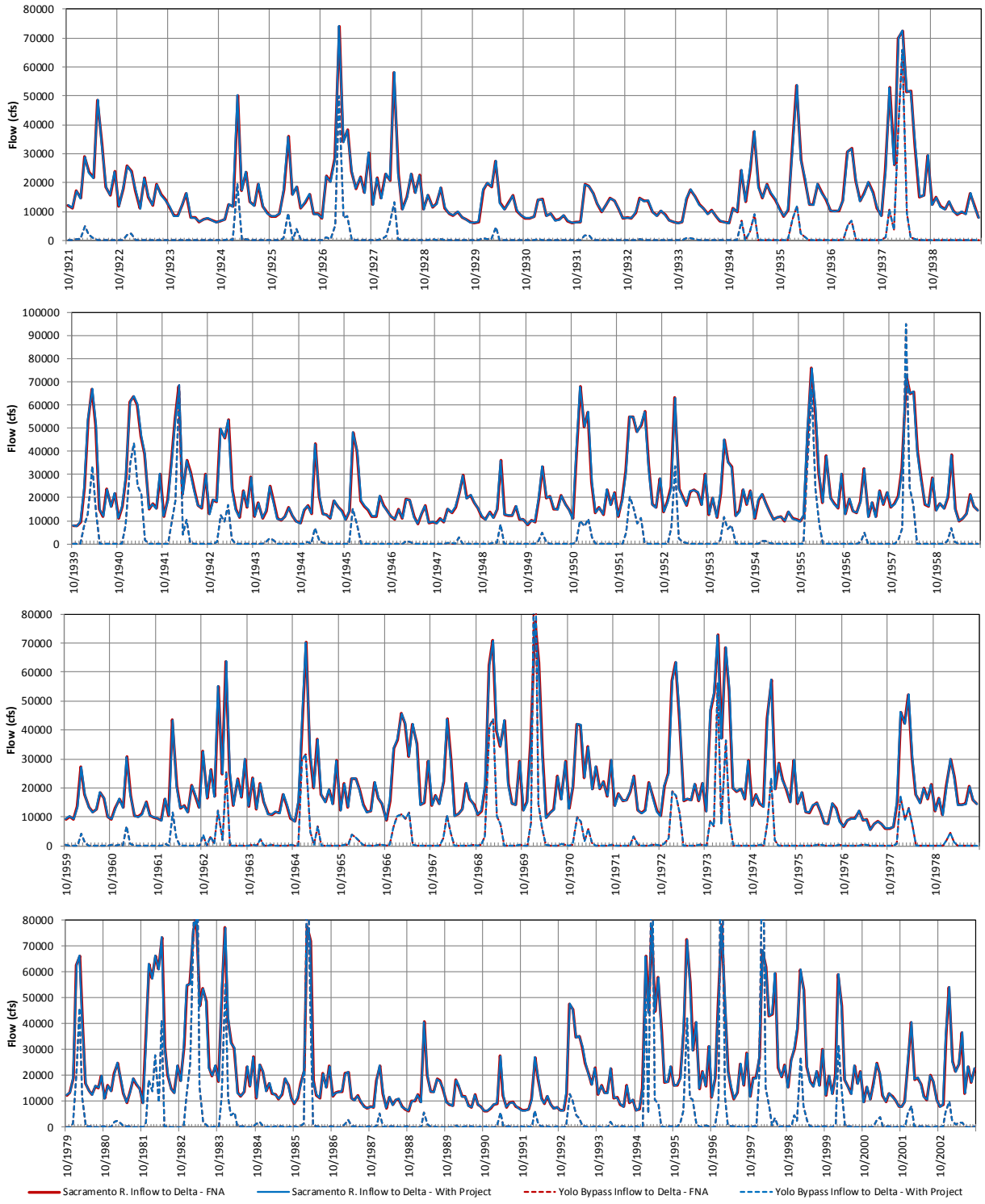


Figure 32: Comparison of Delta Outflow for Pacheco Reservoir Expansion Alternative

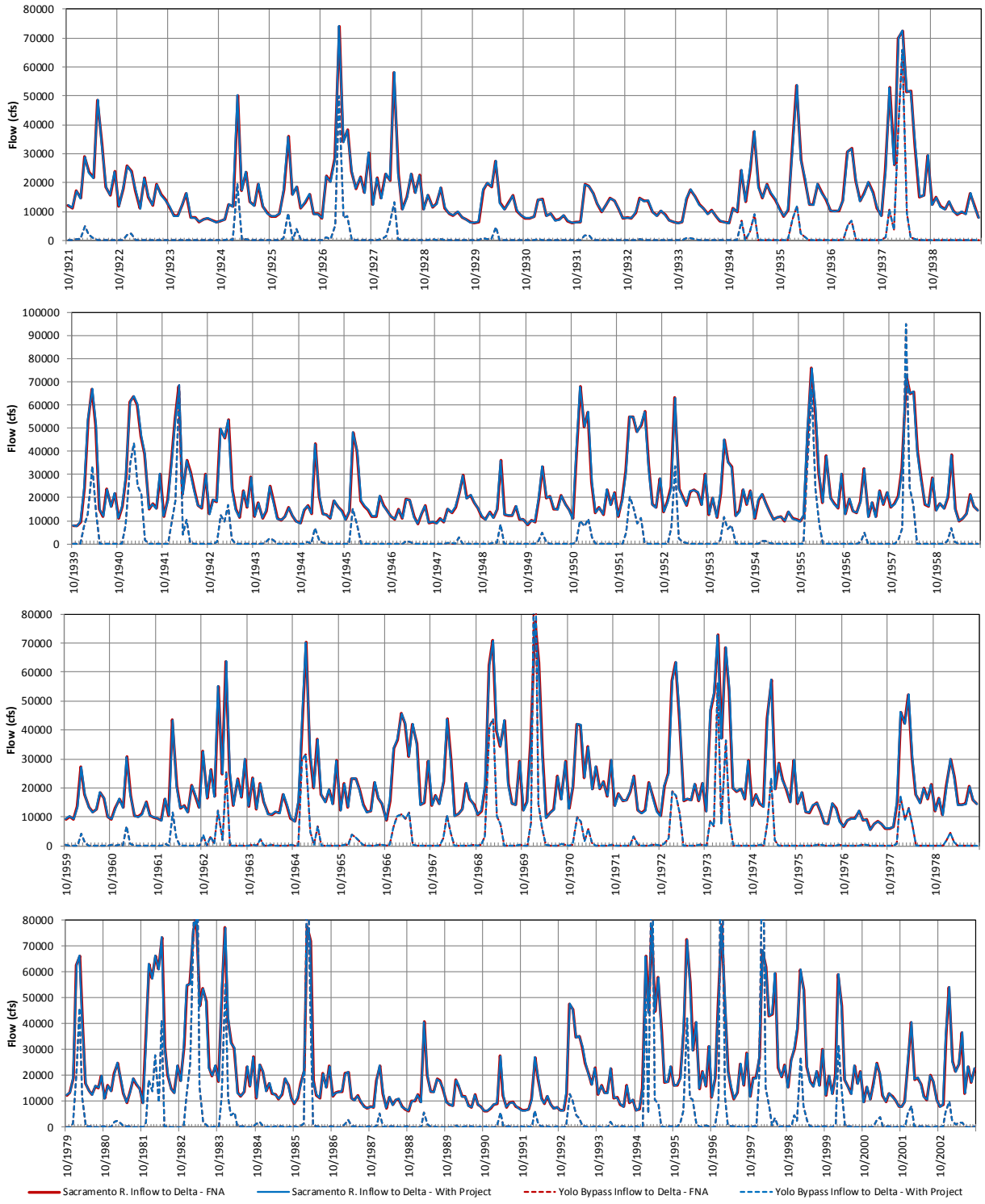
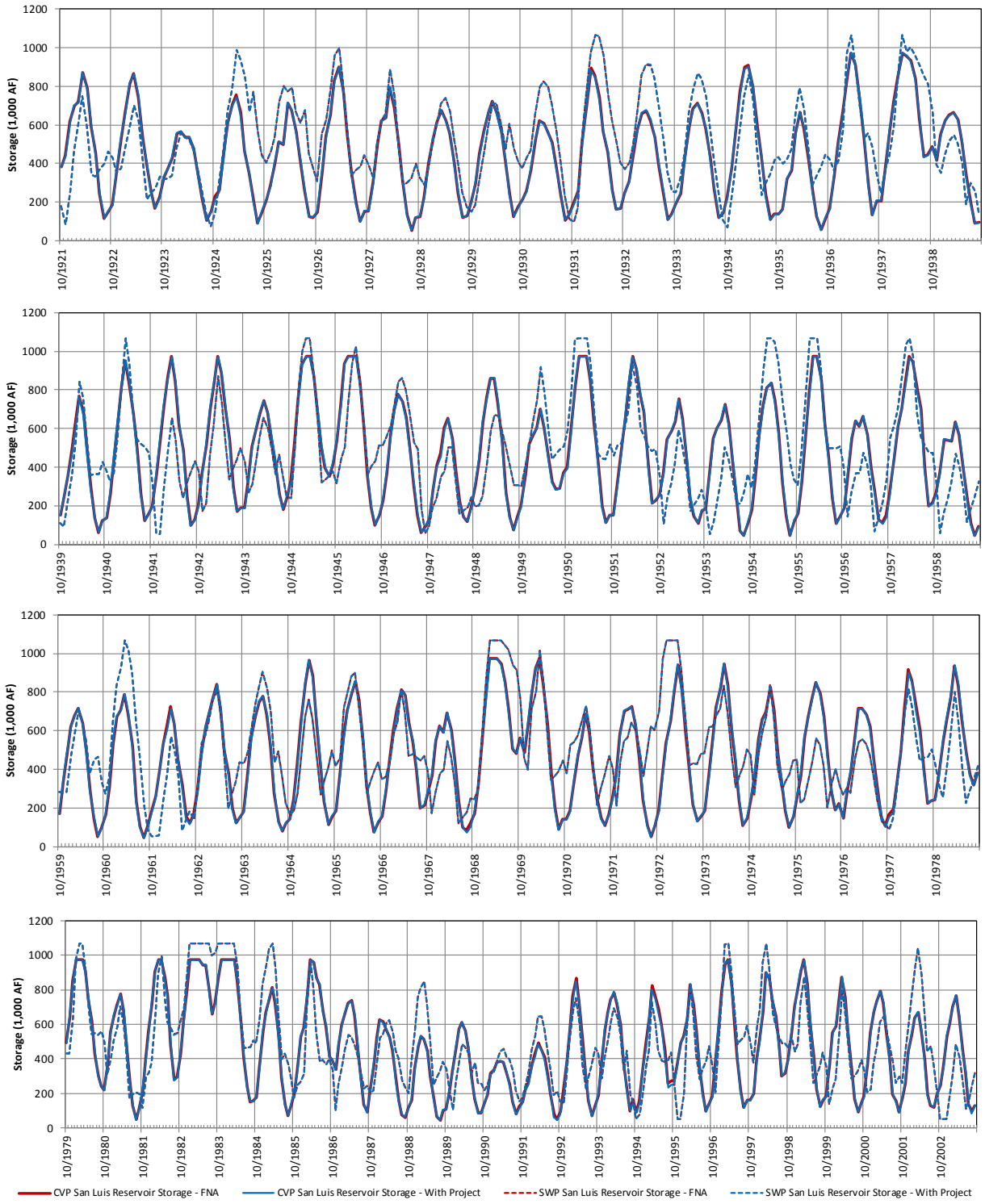


Figure 33: Comparison of San Luis Reservoir Storage for Pacheco Reservoir Expansion Alternative



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Attachment C
Improvements to CalSim San Luis Operations Technical Memorandum

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MBK ENGINEERS

Water Resources ◆ Flood Control ◆ Water Rights

TECHNICAL MEMORANDUM

DATE: July 16, 2015

SUBJECT: Improvements to CalSim San Luis Operations

PREPARED BY: Dan Easton

REVIEWED BY: Walter Bourez and Jennifer Wilson

MBK Engineers was tasked with improving San Luis operations in CalSim. At the December 2014 scoping meeting with CalSim modelers and Central Valley Project (CVP) and State Water Project (SWP) operators, issues with CalSim San Luis operations were outlined, and it was decided that there was not sufficient budget to resolve all issues under this task order. As such, the three key items listed below were selected for MBK to address and determine whether significant improvements could be made.

1. Reduce frequency of drawing San Luis to dead pool and shorting South-of-Delta (SOD) contract deliveries by improving the export forecasts used in SWP and CVP allocations.
2. Reduce excessive carryover in CVP San Luis during the critical period (particularly the 1930's) through reasonable increases in service contractor allocations.
3. Refine rulecurve formulations used to balance storage between North-of-Delta (NOD) project reservoirs and San Luis Reservoir.

While the problems outlined at the meeting have been present in CalSim for years, MBK used Reclamation's latest CalSim baseline generated on January 27, 2015 as a starting point. For the rest of this document, this baseline will be referred to as CalSim_27JAN2015, and the model edited to address the above three issues will be referred to as CalSim_27JAN2015_Revised. Any reference to CalSim in general includes CalSim_27JAN2015 and preceding versions.

REFINEMENT OF CVP AND SWP EXPORT FORECASTS USED IN CALSIM ALLOCATION LOGIC TO REDUCE SOD CONTRACT DELIVERY SHORTAGES

Since implementation of the smelt and salmon biological opinions, CalSim tended to over-allocate water to SOD CVP and SWP contractors in many years of the simulation. Although this does not occur in every year, it happens enough to skew results in water supply planning analysis. Over-allocation can result in breaking San Luis (drawing San Luis down to dead pool) and shorting project contractors. Figure 1 and Figure 2 relate annual SOD contractor shortages and San Luis low point for both the CVP and SWP, respectively, as simulated by CalSim_27JAN2015. CVP San Luis storage is drawn to dead pool (dashed line) in 15 years of the 82-year simulation; SWP San Luis storage is drawn to dead pool in 21 years of the simulation. Annual shortages to CVP contractors range as

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high as 100 thousand acre-feet (TAF). Running debt to SWP contractors reaches higher than 400 TAF in year 1995 of the simulation and greater than 100 TAF in several other years.

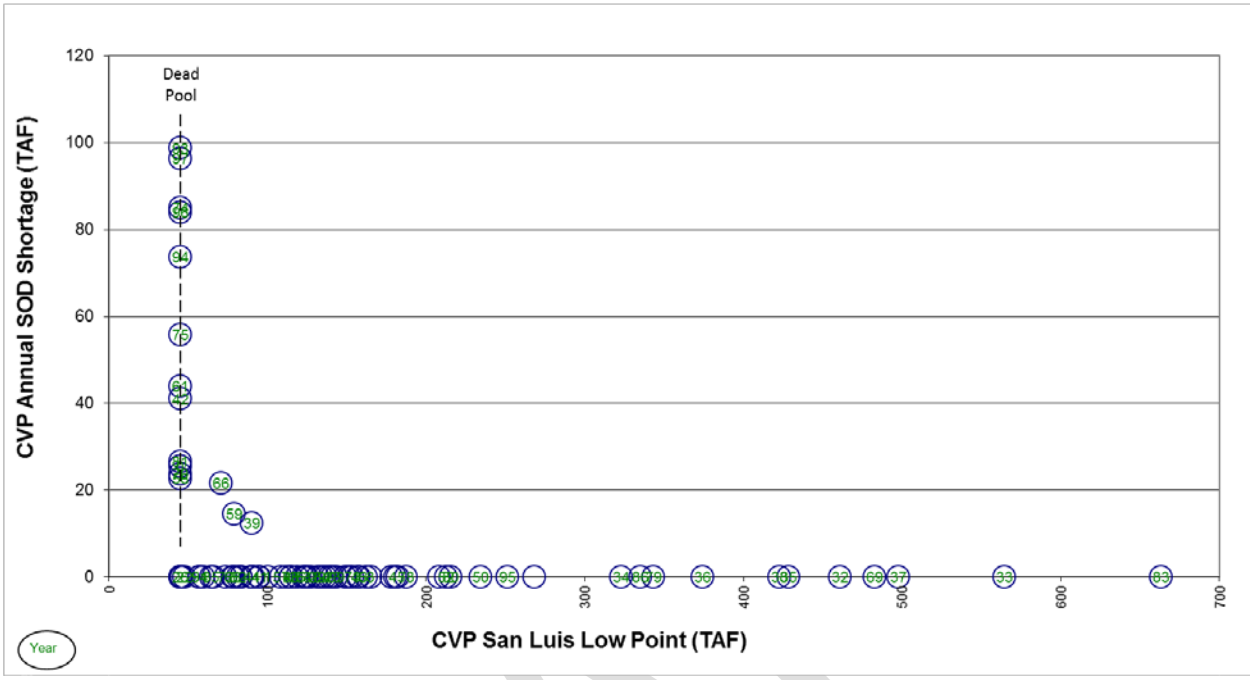


Figure 1. CVP annual SOD shortage versus CVP San Luis storage low point as simulated in CalSim_27JAN2015

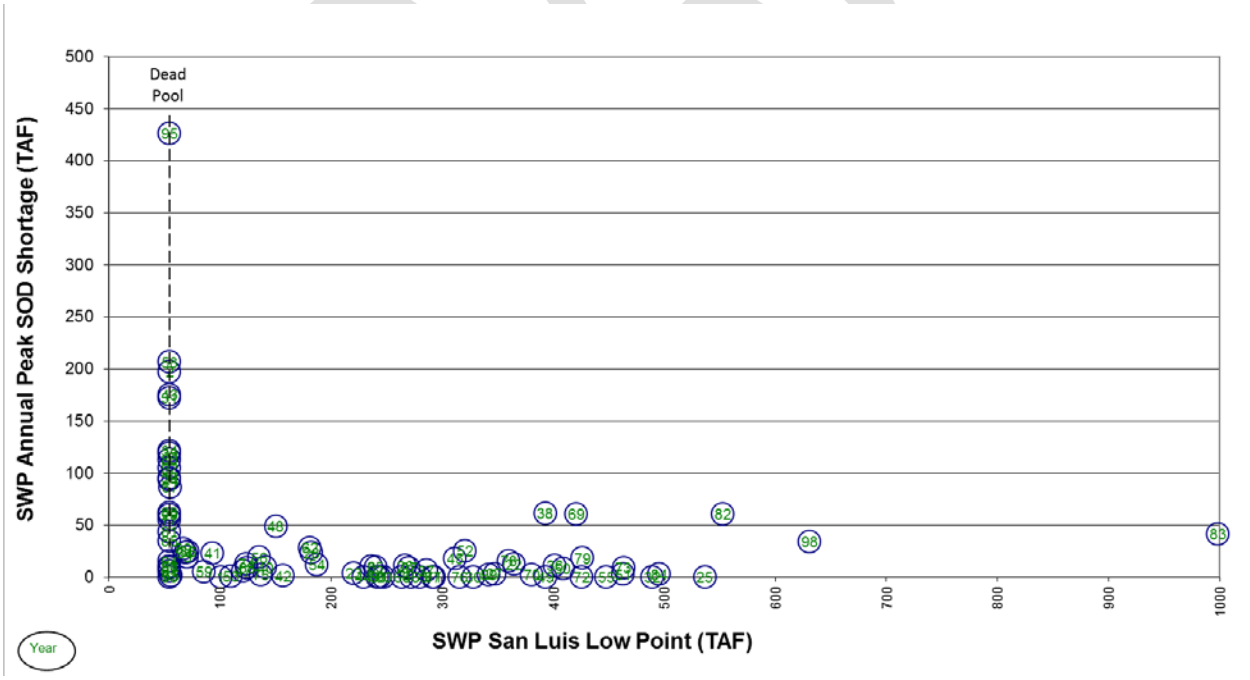


Figure 2. SWP annual maximum SOD shortage versus SWP San Luis storage low point as simulated in CalSim_27JAN2015

Over-allocation in CalSim can be traced back to the model methodology used for both the SWP Table A allocations and CVP SOD Agriculture (Ag) and Municipal and Industrial (M&I) allocations.

The CalSim allocation methodology (used for both the CVP and SWP) combines the Water Supply Index – Delivery Index (WSI-DI)–based allocation with an export forecast–based allocation. The minimum of the two is the final allocation for each project in each contract year. (Note that the CalSim model allocation methodology bears minimal resemblance to the methodology used in real-time allocations.)

The WSI-DI–based allocation assesses aggregate supply (forecasted inflow plus storage), but it does not adequately address limitations of available export capacity necessary to move the NOD supply to SOD contractors. Conversely, the export forecast–based allocation is intended to address export capacity limitations, but the current implementation has limited accuracy. Also, the export forecast–based allocation does not consider demand for export capacity. In other words, the export estimate does not consider whether or not the projects would release stored water from upstream reservoirs to make use of the available export capacity. If NOD storage is low, the projects will not want to release stored water to support exports. This should be explicitly incorporated into the allocation decisions, and it currently is not in CalSim.

The purpose of combining the WSI-DI allocation with an export forecast–based allocation was to have each allocation method cover the weaknesses of the other. However, as seen in current CalSim results (Figure 1 and Figure 2), this has not been accomplished. Ideally, the allocation methodology used in CalSim should better reflect real-time operations methodologies where consideration of supply, demand, conveyance capacity, and carryover in upstream reservoirs are physically integrated. This has been attempted by the Department of Water Resources (DWR) in the form of its Forecast Allocation Model (FAM), but it is beyond the scope of this contract.

The objective is to improve allocation decisions with the current methodology thereby preventing drawing San Luis to dead pool and shorting contractors. The most appropriate improvement is to create a more accurate export forecast—one that takes into account both the availability of and the demand for export capacity. However, before potential improvements are discussed, it is important to examine the CVP and SWP export forecast currently used in CalSim.

During the CVP allocation season (March–May), the current version of CalSim has only two possible export forecasts: one when it is a wet year as classified by the San Joaquin River (SJR) 60-20-20 index; and another when it is critical, dry, below normal, or above normal year classification. Table 1 shows the export estimates for each month from March to August. The export forecast–based allocation sums the export estimates from the current month through August.

In Table 1, only April, May, and June are conditioned on the SJR 60-20-20 index because those are the months where exports are most likely controlled by either the SJR inflow-export (IE) ratio or Old and Middle River (OMR) flow requirements. The sum total of the export estimates from April to June in a wet year is 516 TAF (2,000 cubic feet per second [cfs], 2,000 cfs, and 4,600 cfs); in a non-wet year the sum total is 240 TAF (1,000 cfs, 1,000 cfs, and 2,000 cfs). Such a coarse export estimate does not adequately account for the variability in SJR hydrology or in the conditionality of the SJR IE ratio or OMR flow regulations. It also does not reflect the information that operators have at hand to refine their forecasts, which include current SJR flows at Vernalis, forecasted operations on the SJR and its tributaries, and ongoing discussions with the U.S. Fish and Wildlife Service (FWS) about fish take, trawl data and expected OMR flow requirements.

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Table 1. Monthly CVP export estimates found in the CalSim_27JAN2015 lookup table ExportEstimate_CVP

CalSim Baseline CVP Export Forecast for SOD Ag and M&I Allocation			
Month	Export Estimate (cfs)	Wet SJR Export Estimate (cfs)	Delivery Pattern Fraction
MAR	2500	0	0.68
APR	1000	2000	0.622
MAY	1000	2000	0.553
JUN	2000	4600	0
JUL	4600	0	0
AUG	4600	0	0

The July and August export estimates for the CVP are listed in Table 1 at 4,600 cfs, which is Jones Pumping Plant's full capacity. Obviously this will never be an underestimate of simulated Jones pumping in July and August, but it is often an overestimate. Even though 4,600 cfs capacity is available, the CVP does not always want to release water from upstream reservoirs to fill that capacity. CalSim overestimates exports in these months with the expectation that the WSI-DI–based allocation will prevent an over-allocation. The WSI-DI does serve as a backstop in many years, but there are many years when it does not limit the export estimate based on available supply.

Figure 3 compares annual CVP SOD delivery shortage with the error in the CVP export forecast used in the export forecast–based allocation. The CVP export forecast error is calculated as the April–August CVP export forecast minus the modeled total April–August CVP Jones Pumping Plant exports. As shown in Figure 3, the error is both negative and positive but skews positive. There are no shortages when the export forecast is an underestimate of exports (negative error). There are 15 years with shortages when the forecast is an overestimate. However, the shortages in three of those years — 1939, 1959, and 1966, the three lowest shortages not equal to zero — have nothing to do with over-allocation but a quirk in the SJR model formulation. The remaining 12 are all due to over-allocation, both from the WSI-DI–based approach and the export forecast approach.

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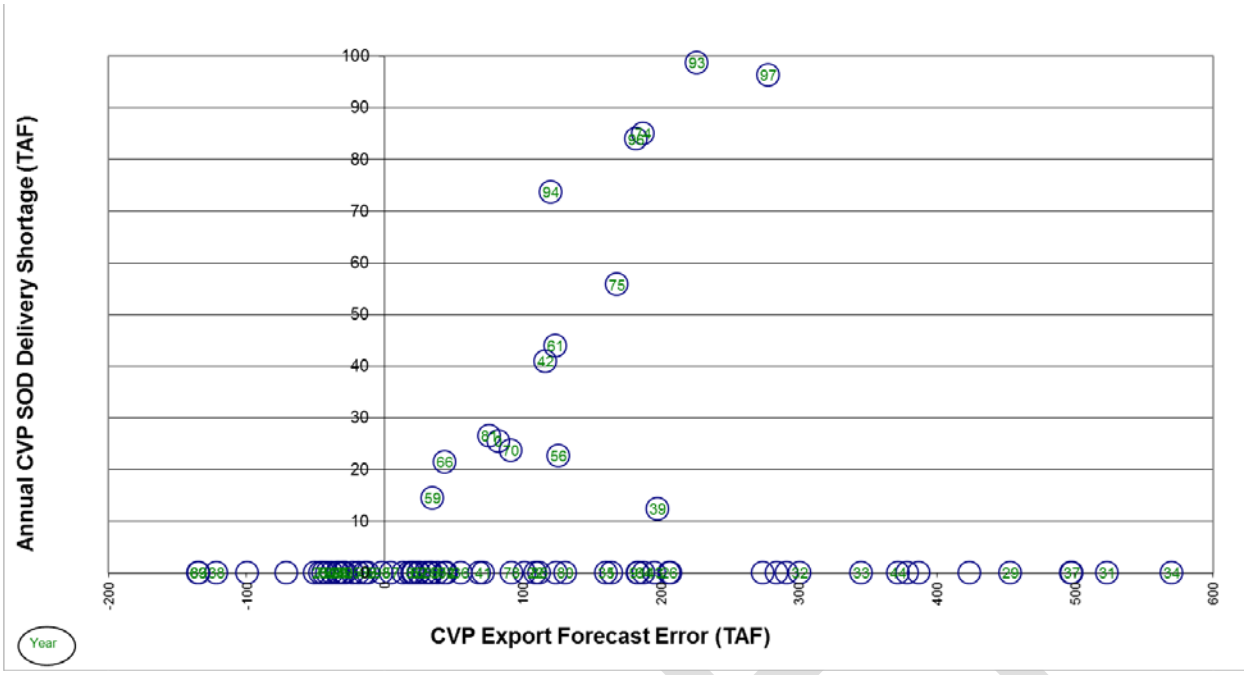


Figure 3. Annual CVP SOD delivery shortage versus CVP export forecast error in CalSim_27JAN2015

Problems with the SWP export forecast are similar to those explained above for the CVP. Table 2 lists the monthly SWP export estimates from January to August. Whereas the CVP contract year begins in March, the SWP contract year begins in January along with SWP allocations. Like the CVP, export estimates are conditioned on the SJR 60-20-20 index in April, May, and June. Unlike the CVP, the SWP export forecast logic adds a flood condition on the SJR in April and May. The flood condition is triggered when flow at Vernalis exceeds 16,000 cfs in March, April, or May. However, even with this added nuance, this is still a very coarse export forecast that does not capture the refinement inherent in real-time operations or what is needed in the model.

Table 2. Monthly SWP export estimates found in the CalSim_27JAN2015 lookup table ExportEstimate_SWP

CalSim Baseline SWP Export Forecast for Table A Allocation				
Month	Export Estimate (cfs)	Wet SJR Export Estimate (cfs)	Flood SJR Export Estimate (cfs)	Delivery Pattern Fraction
JAN	3750	0	0	0.737
FEB	4250	0	0	0.721
MAR	4250	0	0	0.695
APR	1000	2000	6000	0.657
MAY	1000	2000	6000	0.566
JUN	2500	6000	0	0
JUL	7000	0	0	0
AUG	7000	0	0	0

The SWP export forecast for July and August is 7,000 cfs as listed in Table 2. This exceeds permitted capacity of 6,680 cfs in these months, and simulated SWP exports in CalSim_27JAN2015 never exceed permitted capacity in July and August. In fact, simulated July and August SWP exports are often significantly below permitted capacity. The explanation for this is the same as it was for the CVP: just because capacity is available does not mean the SWP wants to use it; that depends on the storage condition of Oroville, and the export forecast in Table 2 does not consider such details.

Figure 4 compares SWP SOD shortage with export forecast error. Export forecast error was again calculated by subtracting April–August total SWP exports from the forecasted exports. Only 1979 had an underestimate of forecasted exports, and that underestimate was slight. In all other years the SWP export forecasts were overestimates with some errors greater than 1 million acre-feet (MAF). The greatest delivery shortage occurred in a wet year, 1995 (Figure 4). The delivery shortage was approximately 425 TAF; it was the result of a 500 TAF overestimate of exports. (Many of the shortages shown that are below 70 TAF in Figure 4 are not due to over-allocation and breaking San Luis; they are due to insufficient California Aqueduct capacity to meet the assumed demand pattern. These are of less concern than the shortages caused by breaking San Luis.)

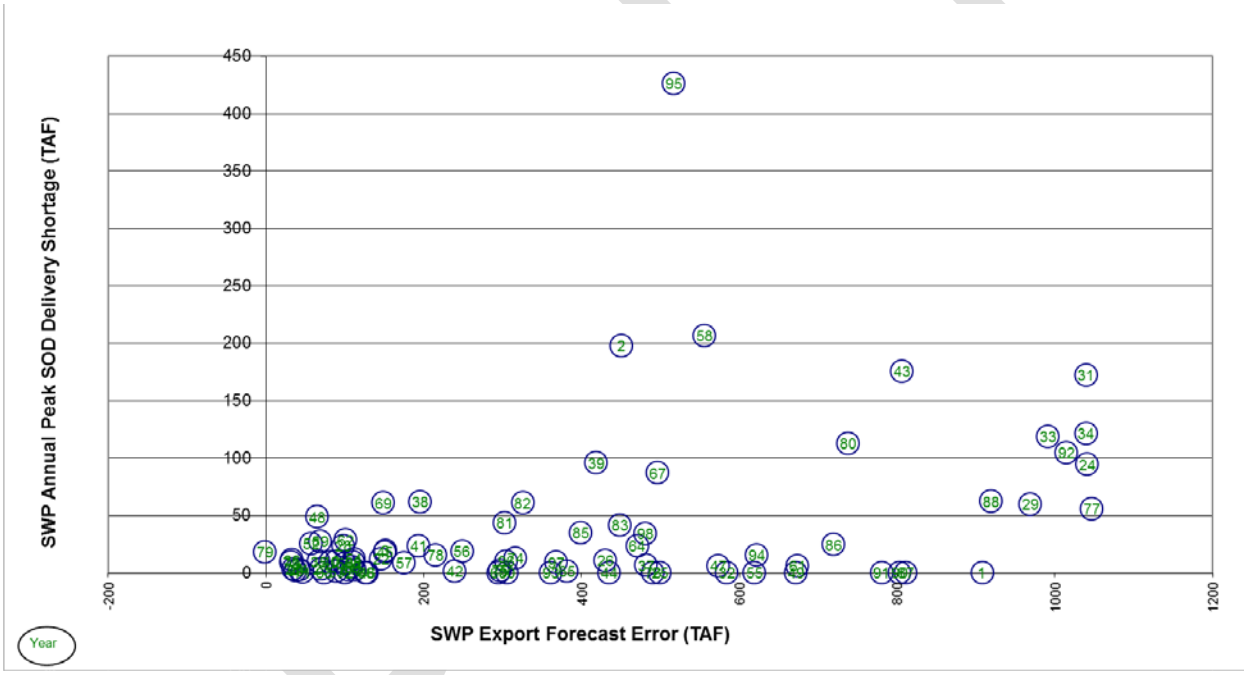


Figure 4. SWP annual peak SOD delivery shortage versus SWP export forecast error in CalSim_27JAN2015

To improve on the export forecasts, it is recognized that more detail is necessary. The two CVP and three SWP export forecast possibilities currently provided in CalSim do not adequately cover the different circumstances found from one year to the next. What follows is a proposal for deriving export forecasts that vary by year and month that will take into account hydrologic, regulatory, and operational variability. The methodology is similar to the WSI-DI procedure in that it requires infrequent iterations of CalSim, and it is best described as a series of steps.

STEP 1

Set the CVP and SWP export forecasts equivalent to Health and Safety (H&S) minimum export levels (800 cfs for the CVP and 300 cfs for the SWP). As such, the respective April to August export forecasts are approximately 240 TAF for the CVP and 90 TAF for the SWP. Run CalSim with this initial export forecast.

STEP 2

Use the CalSim CVP and SWP export results (D418 and D419_SWP, respectively) from Step 1 as new export estimates and re-run CalSim. Repeat until the maximum difference between aggregate export estimates and cumulative simulated exports is less than 100 TAF. Many previous trials indicate this will likely take three iterations. The first iteration (Step 1) uses the H&S export estimate, and the second and third use the CalSim-generated export estimates. A spreadsheet has been set up to process CalSim output into export forecast input for the purpose of expediting this process.

STEP 3

Refine export estimates as necessary to achieve desired balance of contract deliveries and storage carryover. This refinement of export forecasts can be done by an automated procedure or manually. A combination of both was employed in this analysis.

Ideally, the procedure would stop at Step 2. Understanding why the procedure progresses to Step 3 requires an understanding of the logic of the first two steps. Starting with the H&S export forecast in Step 1 ensures very low allocations for both projects in all years of that simulation. As such, export of available Delta supplies without supplemental reservoir release – or export of incidental Delta inflow – are sufficient in almost every year to meet allocated deliveries and San Luis carryover targets. So the final result of that first iteration and the iterations that follow in Step 2 is a lower bound on the SWP and CVP export forecasts. In any year that moving additional water from NOD reservoirs is not desired, the final export forecast derived in Step 2 also represents an upper bound. But in those years where NOD stored water and SOD export capacity are available, the export forecast must be increased to drive higher allocations and movement of that additional water through rulecurve. (Rulecurve will be discussed later in this memo.) There are also very wet years such as 1983, when a full San Luis prevented additional exports during the iterative process. A boost in the export forecast increases allocations and deliveries, which allows for higher exports when San Luis is full. Given the reasons for refinement, the only changes to the export forecasts going from Step 2 to Step 3 were increases.

The final CVP and SWP export forecasts derived from the three-step methodology are listed in Table 3 and Table 4. While these forecasts extend through the period of record (1922–2003), the tables show a small sample (1922–1931) for the sake of brevity. Each export forecast provided by year and month represents cumulative exports from the given month through August. As such, the export forecast can easily be retrieved from a lookup table or DSS timeseries (either data retrieval mechanism will work) and directly input into the current SWP and CVP export-based allocation logic (some minor edits were made for the new format of the export forecasts). Note the variability of

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the SWP and CVP export forecasts from a wet year like 1922, to a below-normal year like 1928, and to a critical year like 1931 (all SJR 60-20-20 index–based classifications). This is a significant change from the rough forecasts found in CalSim_27JAN2015.

Table 3. Sample CVP export forecast derived from the three-step process and used in CalSim_27JAN2015_Revised

Modified CVP Export Forecast for SOD Ag and M&I Allocation (cumulative from current simulation month to August)			
	Cumulative Export Estimate (TAF)		
Year	MAR	APR	MAY
1922	1255	972	901
1923	1083	883	817
1924	388	269	180
1925	1039	856	784
1926	622	339	271
1927	1062	835	775
1928	935	652	592
1929	501	338	269
1930	551	395	329
1931	325	261	189

Table 4. Sample SWP export forecast derived from the three-step process and used in CalSim_27JAN2015_Revised

Modified SWP Export Forecast for Table A Allocation (cumulative from current simulation month to August)					
	Cumulative Export Estimate (TAF)				
Year	JAN	FEB	MAR	APR	MAY
1922	2025	1805	1729	1409	1325
1923	1634	1413	1318	1117	1038
1924	412	232	111	93	75
1925	1227	1029	1049	800	709
1926	1179	981	1015	990	905
1927	1687	1542	1425	1192	1119
1928	1695	1482	1432	1132	1062
1929	684	482	299	136	67
1930	1209	1061	922	767	704
1931	508	308	152	88	71

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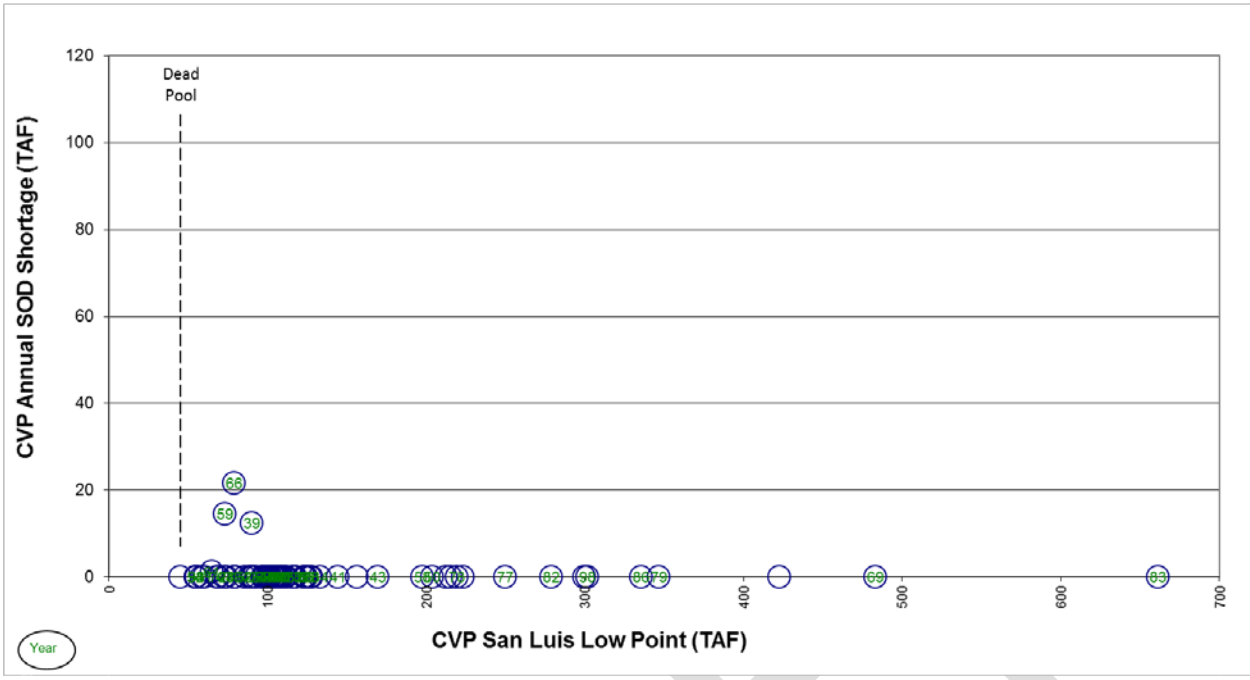


Figure 5. CVP annual SOD shortage versus CVP San Luis storage low point as simulated in CalSim_27JAN2015_Revised

Figure 5 and Figure 6 compare annual shortage and San Luis low point as simulated in CalSim_27JAN2015_Revised with the updated export forecasts listed above. CVP San Luis is drawn to dead pool only once and no shortage occurs in that year. The only years with CVP SOD shortages are 1939, 1959, and 1966; as discussed previously, the shortages are not caused by over-allocation but a quirk in the SJR model formulation. The SWP is drawn to dead pool in four years, but there are shortages in only two of them. (The two dead pool data points where the shortage is zero overlap.) All SWP shortages shown are reasonably small and are almost entirely caused by insufficient California Aqueduct capacity to meet the simulated delivery pattern. This type of shortage is of less concern than those caused by breaking San Luis. To gage the improvement in San Luis operations and reductions in project SOD delivery shortages due to the updated export forecasts, compare Figure 5 to Figure 1 and Figure 6 to Figure 2.

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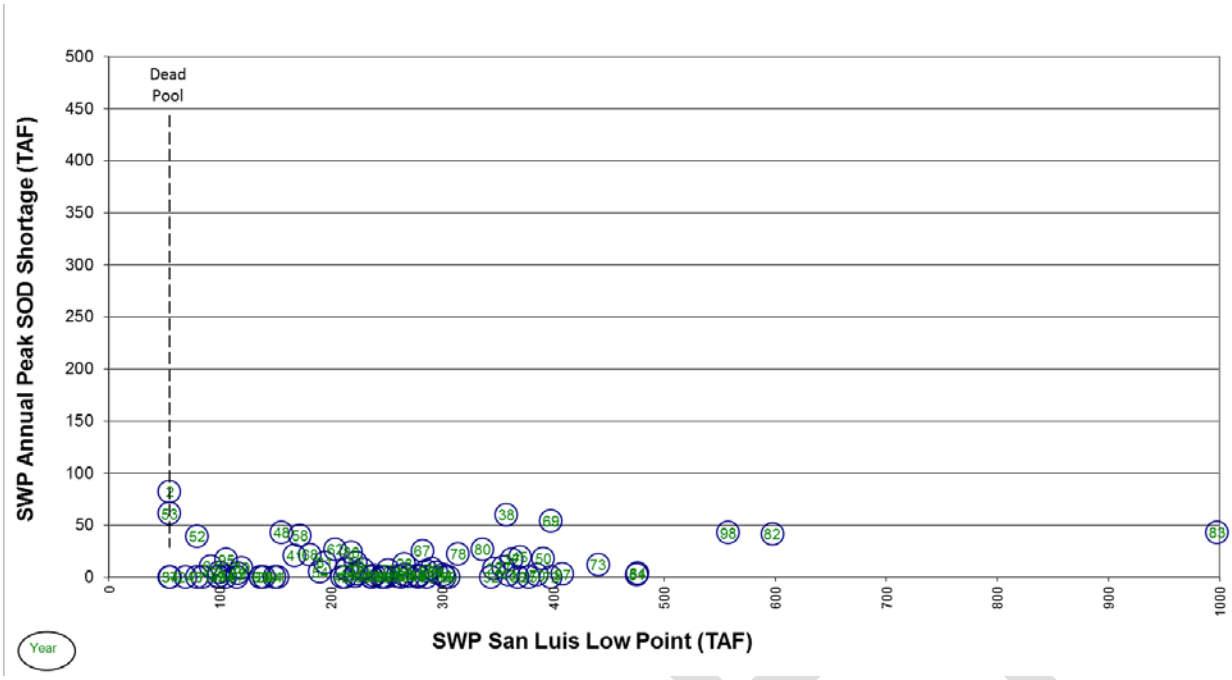


Figure 6. SWP annual maximum SOD shortage versus SWP San Luis storage low point as simulated in CalSim_27JAN2015_Revised

Export forecast error was shown to be large for both the CVP (Figure 3) and SWP (Figure 4) in CalSim_27JAN2015. Reducing export forecast error was essential to the prevention of breaking San Luis and shorting SOD contractors. Figure 7 relates CVP SOD delivery shortage to CVP export forecast error in CalSim_27JAN2015_Revised. As shown, most of the CVP export forecast errors fall under 100 TAF. Those errors above 100 TAF were edited in Step 3 of the proposed export forecast methodology to refine the balance between deliveries and carryover. Figure 8 relates SWP SOD delivery shortage to SWP export forecast error in CalSim_27JAN2015_Revised. The forecast error in three years is above 200 TAF: 1952, 1982, and 1983. It was recognized that in all three of these years there was sufficient water and export capacity to meet a 100% Table A allocation. The export forecast in each was set sufficiently high so that it would not prevent a full allocation. The rest of the SWP export forecast errors were less than 200 TAF. The refinements in Step 3 were responsible for pushing the errors above 100 TAF.

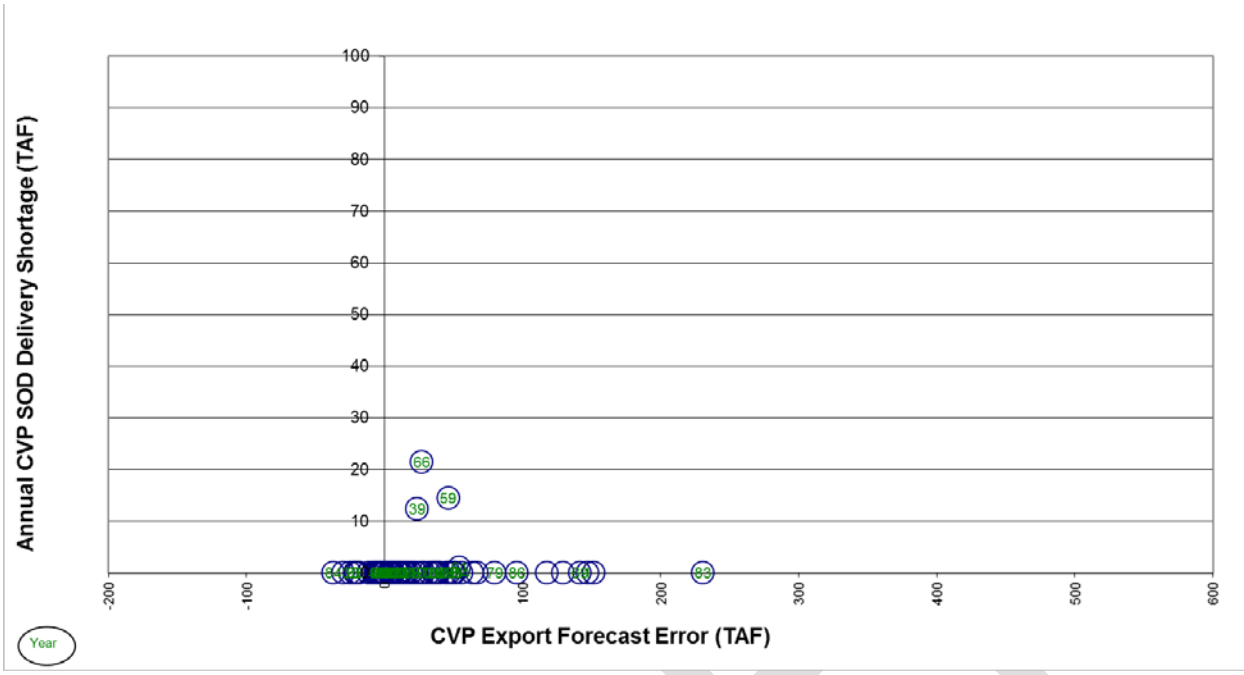


Figure 7. Annual CVP SOD delivery shortage versus CVP export forecast error in CalSim_27JAN2015_Revised

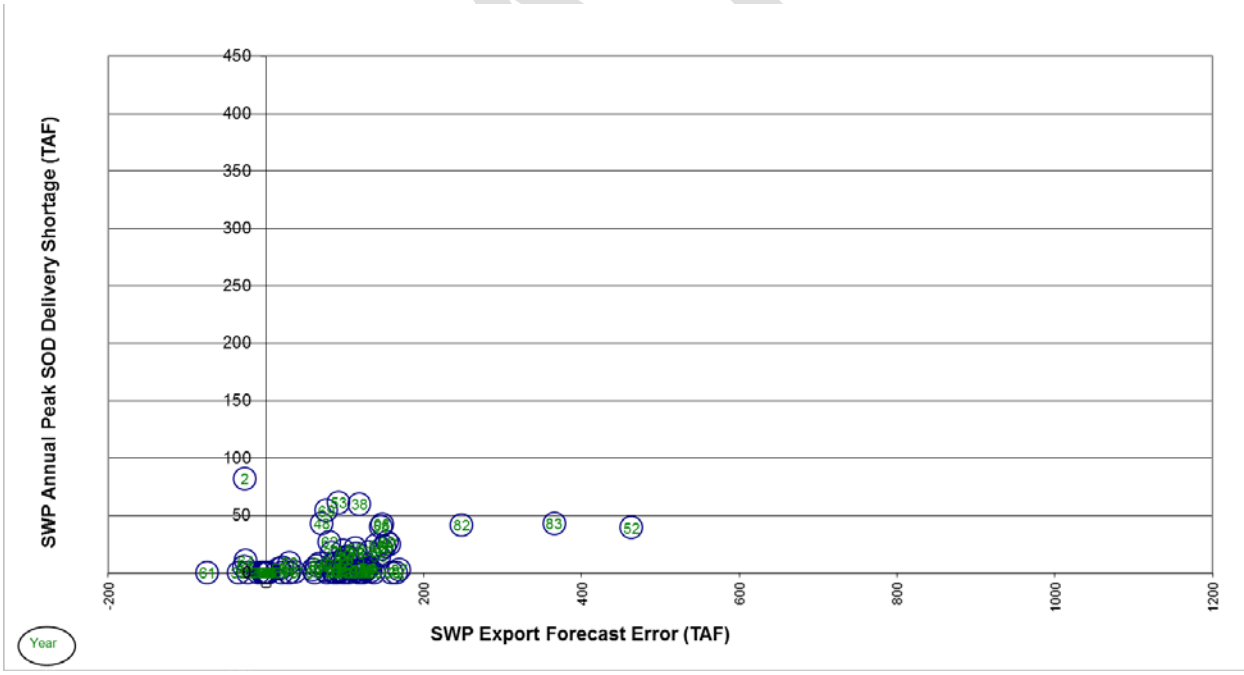


Figure 8. SWP annual peak SOD delivery shortage versus SWP export forecast error in CalSim_27JAN2015_Revised

CalSim CVP Allocation Logic Refinement

Other adjustments were made to CalSim_27JAN2015_Revised in addition to the update of the export forecasts used in CVP and SWP allocations. One was a refinement to the CVP allocation procedure to reduce instances where there are low CVP SOD service contract allocations in years

that end in excessively high San Luis carryover. Figure 9 links CVP San Luis low point with combined Shasta and Folsom carryover as simulated in CalSim_27JAN2015. Six of the annual data points are highlighted in red due the relatively high San Luis low point and low CVP SOD Ag Service allocation (see Figure 10 for the allocation associated with each data point). The highlighted years are 1932–1937, and the SOD Ag Service allocations in these years range from 4% in 1932 to 43% in 1936. The San Luis low point is above 300 TAF throughout this period and reaches almost 600 TAF in 1932. San Luis also fills during critical periods, thereby constraining CVP export of valuable winter surplus. Clearly, higher deliveries could be made SOD without impacting upstream storage; so it is advantageous to determine why the current model does not perform this operation, and what change can be made to more efficiently use available water.

The problem within the model is caused by dry conditions north of the American River and wetter conditions from the American River south. Such a hydrologic imbalance leaves Shasta and Trinity storage low but keeps San Luis storage high through export of surplus originating on the American and San Joaquin Rivers. Low Shasta and Trinity storage results in a low WSI-DI–based allocation. A low WSI-DI allocation supersedes a higher export-based allocation (recall that the model uses the minimum), and SOD service contractor allocations end up being governed by the dry conditions to the north even though there is sufficient water SOD to meet higher demand.

In the end, this is entirely the result of a modeling artifact. It is standard policy within the CVP that NOD service contractor allocations will be equal to or greater than SOD service contractor allocations. The issue lies with how this policy is applied in the model. NOD service contractor allocations are calculated using the WSI-DI method; SOD service contractor allocations are calculated as the minimum of the WSI-DI–based allocation and the export forecast–based allocation. This, at times, artificially constrains system-wide allocations based solely on low conditions at Shasta and Trinity.

In other words, the model ignores the details that operators would consider in developing a real-time service contractor allocation. Note that NOD Ag Service contracts along the Sacramento River total 377 TAF. As such, a NOD Ag Service allocation increase of 1 percent would expose Shasta and Trinity to a combined 4 TAF of additional drawdown. Also consider that SOD Ag Service contracts total 1,987 TAF. Therefore a 1 percent increase in SOD Ag Service allocations would require 20 TAF of combined drawdown in San Luis and/or increased exports. If in actual operations the CVP operators see the potential to boost SOD Ag Service allocations by 100 TAF due to high San Luis storage levels—an allocation increase of approximately 5 percentage points. There may be concern about boosting NOD Ag Service allocations by an equal percentage, but the operators would understand that such an increase would only result in an additional 20 TAF of load on Shasta and Trinity. There are certainly cases where such a tradeoff would be made, and years 1932–1937 as simulated in CalSim_27JAN2015 appear to be such cases.

The modification applied in CalSim_27JAN2015_Revised was to conditionally reformulate CVP Ag Service allocations in contract years 1932–1937. In these years, allocations for both NOD and SOD service contractors are allowed to be driven by the export-based methodology when appropriate. This does not circumvent the standard policy of maintaining NOD service contractor allocations at or above SOD allocations; this policy is maintained. The result of this change in allocation formulation is shown in Figure 11 and Figure 12. The data points highlighted in red correspond to

the same annual data points highlighted in Figure 9 and Figure 10. The San Luis low point in these years has been significantly reduced in CalSim_27JAN2015_Revised as compared to CalSim_27JAN2015 and the impact to upstream carryover is acceptable.

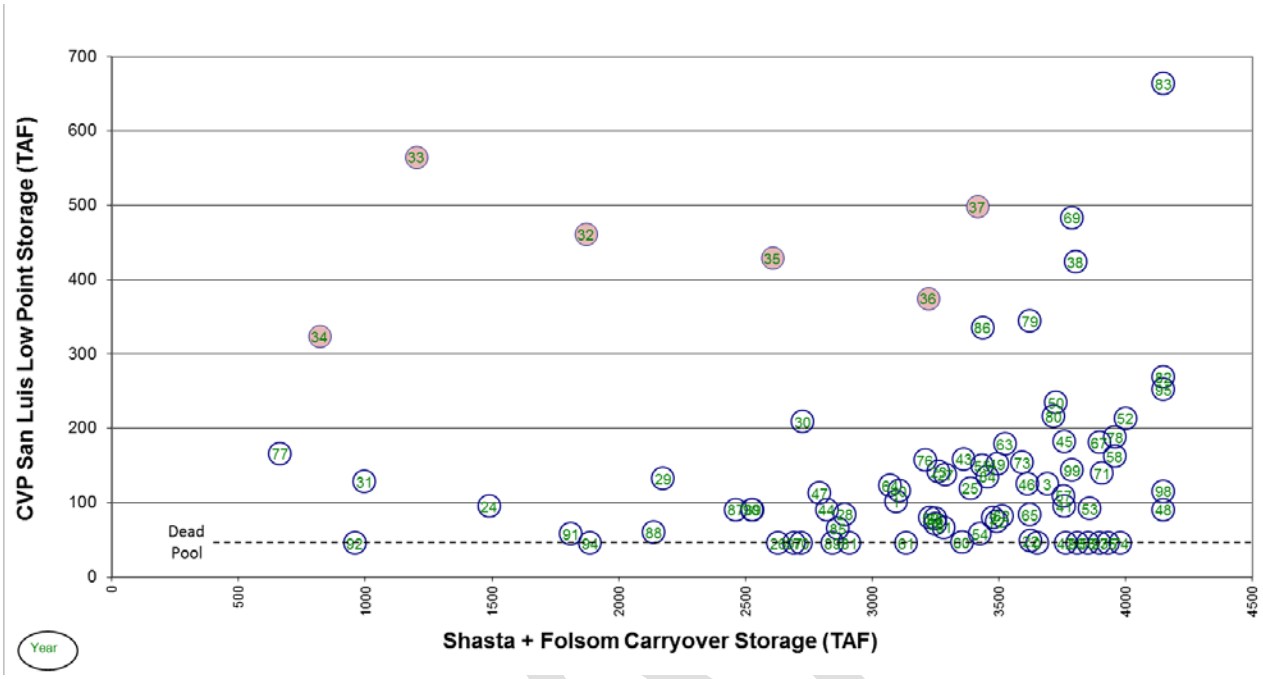


Figure 9. CVP San Luis low point storage versus combined Shasta and Folsom carryover in CalSim_27JAN2015 with contract year data label

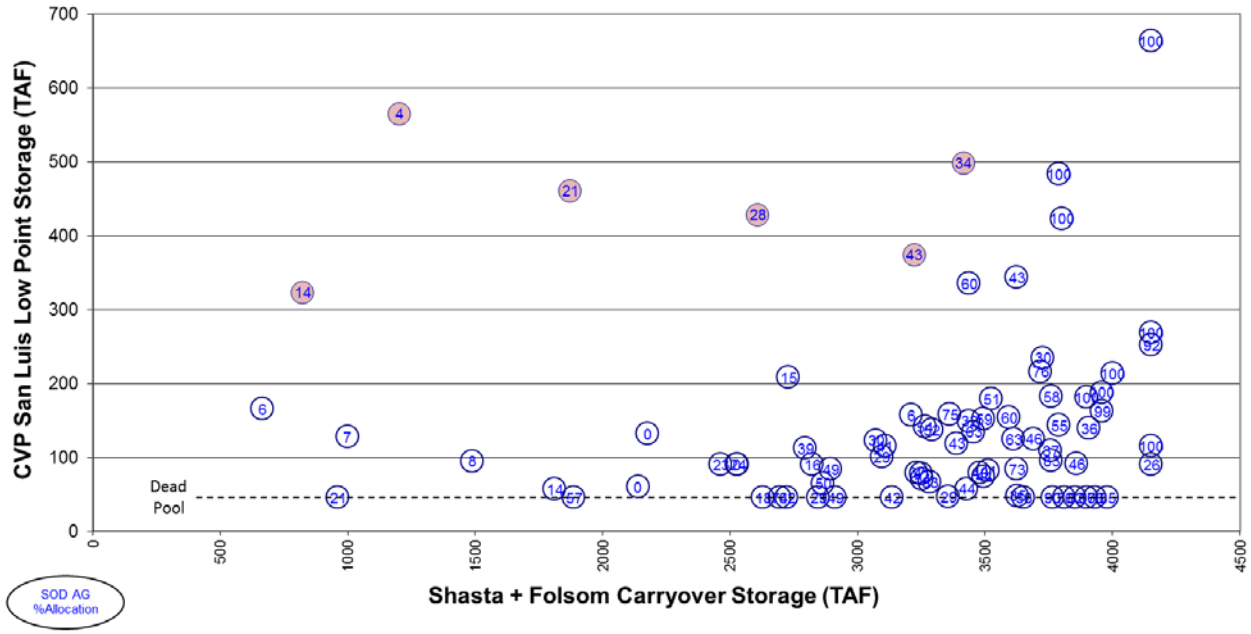


Figure 10. CVP San Luis low point storage versus combined Shasta and Folsom carryover in CalSim_27JAN2015 with SOD Ag Service allocation data label

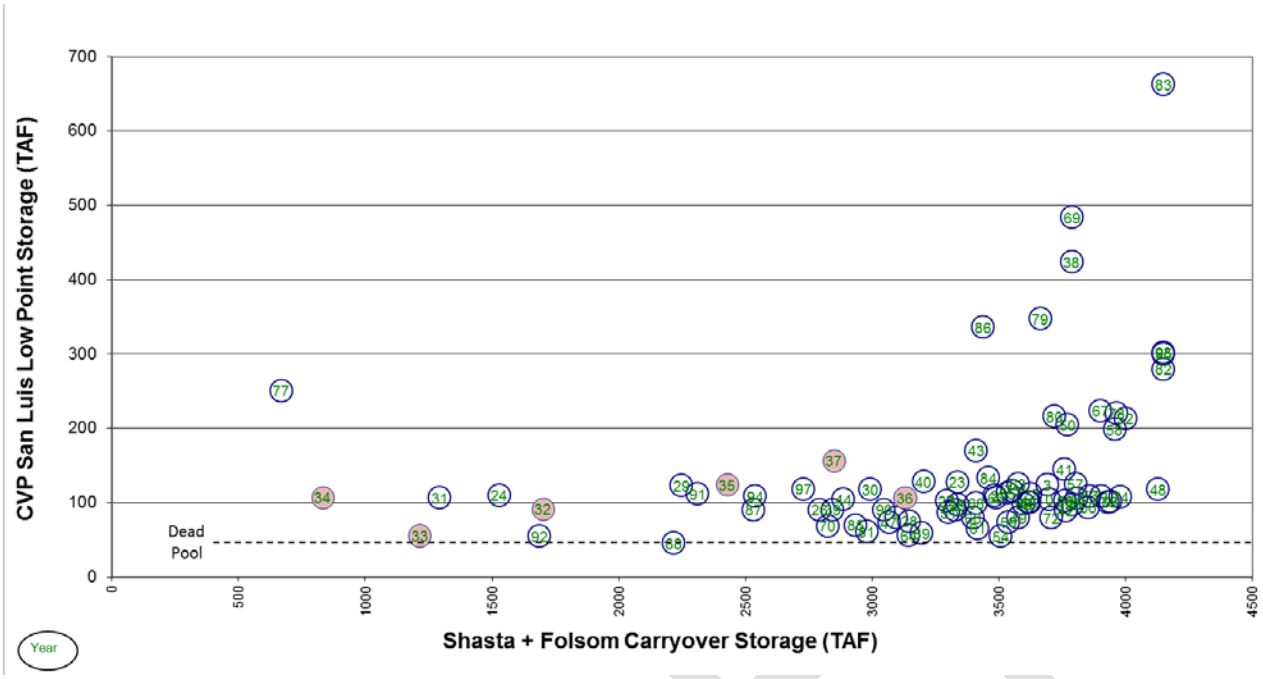


Figure 11. CVP San Luis low point storage versus combined Shasta and Folsom carryover in CalSim_27JAN2015_Revised with contract year data label

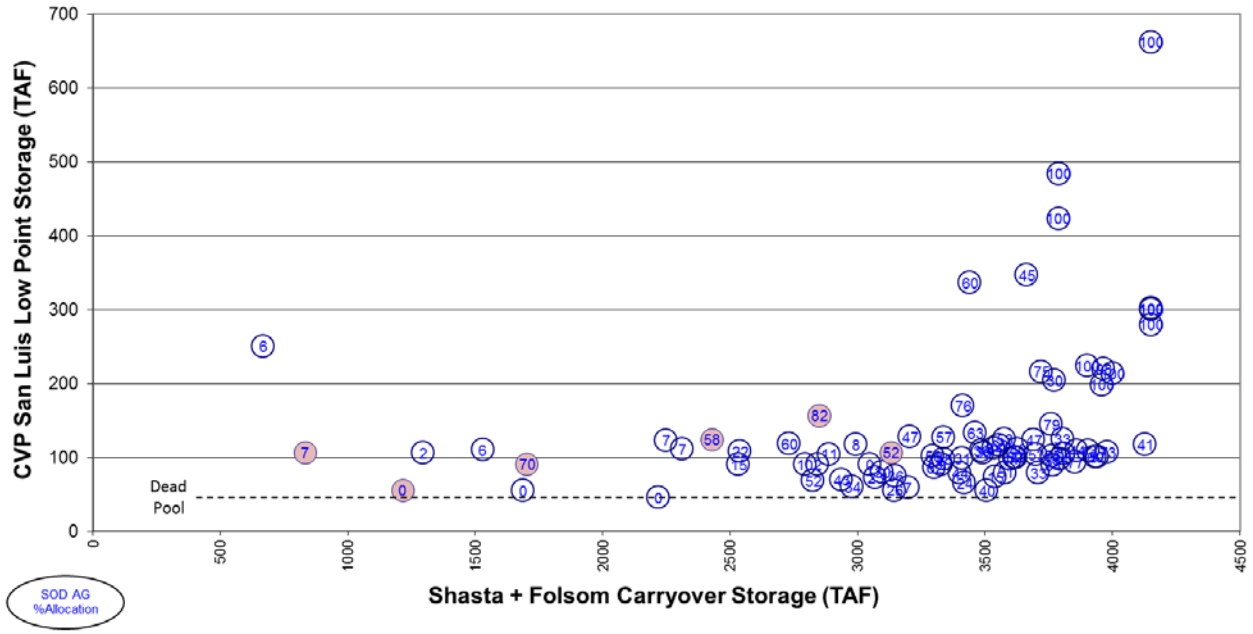


Figure 12. CVP San Luis low point storage versus combined Shasta and Folsom carryover in CalSim_27JAN2015_Revised with SOD Ag Service allocation data label

As discussed above, CalSim_27JAN2015_Revised results as plotted in Figure 5, Figure 6, Figure 7, Figure 8, Figure 11, and Figure 12 were significantly influenced by the revised export forecast used in CVP and SWP allocations and the reformulation of CVP allocation logic in 1932–1937. Two more changes were also made to CalSim_27JAN2015_Revised that affected results. However, while

important to NOD-SOD storage balance, these changes are less significant than those already discussed. The first of these additional edits is refinement of San Luis rulecurve for the SWP and CVP, and the second is an adjustment to operational logic under an ANN negative carriage constraint; these edits are detailed below.

RULECURVE

The purpose of rulecurve is to prioritize balance between NOD storage and San Luis for both the CVP and SWP. Rulecurve controls upstream release for export when there is a choice between storing water in upstream reservoirs and releasing water for export and storing it in San Luis. Operational constraints such as flood pool, minimum instream flow requirements, export regulations, H&S pumping requirements, and physical pump capacity override rulecurve; and when any of these control operations, choices for balancing NOD storage are limited.

During the winter, rulecurve is set to encourage the filling of San Luis though it rarely controls. Incidental Delta inflow typically drives San Luis filling during the rainy season. Upstream reservoir releases are often controlled by flood pool or minimum flow requirements, and exports are controlled by OMR flow requirements or maximum pumping capacity. Since rulecurve does not play a significant role in driving winter San Luis operations, there was no need to modify wintertime rulecurve logic.

Where rulecurve does make a difference (or should make a difference) is during irrigation season when there are windows of opportunity to coordinate upstream reservoir releases with Delta exports. During the summer, SOD project demand typically exceeds Delta exports. As such, SOD project demand is met with a combination of Delta exports and San Luis releases, and if rulecurve is controlling, it influences the balance between Delta exports and San Luis reservoir releases. If rulecurve is set lower, exports decrease and San Luis releases increase. When set higher, the opposite occurs. Ideally the combination of San Luis releases and project exports over the irrigation season is sufficient to satisfy project allocations and San Luis targeted carryover storage, and rulecurve should be set to encourage the appropriate balance.

Therefore, formulation of rulecurve during the irrigation season should boil down to an export scheduling problem, to be solved by determining how much to export within a season to achieve delivery and carryover goals, how to distribute these exports from month to month, and where to set SWP and CVP rulecurve to encourage those Delta exports and the supporting upstream releases. The problem with the current irrigation season rulecurve formulations in CalSim is that they do not consider the amount of exports needed over the season. In fact, for both the SWP and CVP, the rulecurve formulation assumes exports of 60 TAF per month whether that is sufficient to meet operational objectives or not. Rulecurve levels are driven by this export assumption.

The implemented fix to the irrigation season rulecurve formulation is to incorporate export scheduling in CalSim_27JAN2015_Revised; SWP and CVP formulations vary slightly. With the CVP, exports need to be scheduled to ensure the project can meet peak summer demand and prevent San Luis low point issues through the end of September. The SWP has similar concerns, but must also consider Article 56 carryover into the next calendar year with the added complication of Feather River flow limitations for half of October and all of November that can interfere with the

State's ability to make Oroville releases for export. So while the CVP's export scheduling formulation extends from May through September, the SWP's starts in April and extends through December. As an example, the SWP export schedule–based rulecurve formulation for the months of April–December is outlined below.

First, needed exports are calculated from the beginning of the current month of the simulation through the end of December (Required_Exports_NowtoDec (TAF)).

(1) Required_Exports_NowtoDec = max(0, remainDem_SOD + remain_evap + remain_loss + max(110, carryover_final + 55) – Beg_Month_SWP_San_Luis_Storage)

Where

- remainDem_SOD is the remaining Table A allocations to be delivered from now to the end of December (TAF)
- remain_evap is an estimate of total evaporation over the rest of the calendar year (TAF)
- remain_loss is an estimate of the total California Aqueduct losses over the rest of the calendar year (TAF)
- 110 is the SWP San Luis carryover target (TAF)
- carryover_final is the quantity of water needed in San Luis at the end of December to make Article 56 deliveries (TAF)
- 55 is SWP San Luis dead pool capacity (TAF)
- Beg_Month_SWP_San_Luis_Storage is SWP San Luis storage at the beginning of the current month of simulation (TAF)

Next, the amount that should be exported this month (Required_Exports (TAF)) in order to achieve the export goal for the remainder of the calendar year (Required_Exports_NowtoDec) is calculated. Assume exports will be scheduled uniformly over the remaining months of the calendar year, except for half of October and all of November due to Feather River flow restrictions. During the Feather River flow restrictions, we assume Banks pumping is held to the H&S level (300 cfs), which equals approximately 27 TAF over 1.5 months or 18 TAF over 1 month. So the formulation varies by month:

For the months April–September, the formulation is:

(2a) Required_Exports = (Required_Exports_NowtoDec - 27)/(remain_months - 1.5)

For the month of October, the formulation is:

(2b) Required_Exports = (Required_Exports_NowtoDec - 18)/(remain_months - 1)

And for the months of November–December the formulation is:

(2c) Required_Exports = Required_Exports_NowtoDec/remain_months

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Where

- remain_months is the number of months remaining in the calendar year starting from the beginning of this month of simulation to the end of December

At this point in the calculation, SWP exports could be prioritized up to Required_Exports such that Oroville releases would be made to support those exports. But that is not the modeling technique used in CalSim. As discussed, the balance of upstream storage and San Luis storage is guided with rulecurve; so to prioritize SWP exports up to Required_Exports, rulecurve must be appropriately set. Expected change in San Luis storage (Change_San_Luis_Storage (TAF)) if exports equal Required_Exports is now calculated. The formulation is:

(3) Change_San_Luis_Storage = Required_Exports – This_Month_Forecasted_Delivery – This_Month_Forecasted_Loss – This_Month_Forecasted_Evap

Where

- This_Month_Forecasted_Delivery is this month's estimated Table A deliveries (TAF)
- This_Month_Forecasted_Loss is this month's estimated California Aqueduct losses (TAF)
- This_Month_Forecasted_Evap is this month's estimated SWP San Luis evaporation (TAF)

Given the calculated Change_San_Luis_Storage, the rulecurve (SWP_Rulecurve (TAF)) that will encourage sufficient Oroville releases to support SWP exports at Required_Exports is determined as follows:

(4) SWP_Rulecurve = Beg_Month_SWP_San_Luis_Storage + Change_San_Luis_Storage

NEGATIVE CARRIAGE OPERATIONS

Delta carriage is the additional Delta outflow above minimum required Delta outflow (MRDO) necessary to meet D-1641 salinity standards. When salinity is controlling, an increase in exports requires an increase in release from upstream reservoirs to the Delta that equals the export increase plus carriage. In other words, carriage is the water cost of Delta exports when salinity standards are controlling. While higher exports typically result in higher carriage, there are times of the year when Rock Slough and Emmaton salinity standards can be met with higher exports and negative carriage. Essentially, when a negative carriage salinity constraint is controlling, a unit increase in Delta exports is supplied partially by a decrease in carriage (decrease in Delta outflow) and the remainder by an increase in upstream reservoir release. While negative carriage might be counterintuitive, it is an actual phenomenon observed in Delta operations.

Negative carriage in CalSim presents problems of prioritization. In CalSim, Delta outflow above MRDO, whether the outflow is surplus or carriage, is given a highly negative weight (low priority). The intent is to discourage any Delta outflow in excess of MRDO. So when a negative carriage salinity constraint is controlling operations, CalSim will operate to minimize Delta outflow even though it might cause an imbalance between NOD and SOD storage. Delta outflow is reduced through increased exports, but some water still has to be released from upstream reservoirs to

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support part of the increased export. If NOD reservoirs are relatively full, this could be a desirable operation, but if NOD reservoirs are low and further exports are not needed to support this year's allocation, minimizing Delta outflow at the expense of upstream storage is an unwarranted operational decision. During the critical periods, CalSim makes several of these decisions that result in the transfer of NOD storage to San Luis when the water would be better kept NOD.

The implemented negative carriage operation fix in CalSim_27JAN2015_Revised is to remove the model flexibility to make an unwarranted decision. In CalSim, SWP and CVP export estimates are made to guide operations when salinity standards are controlling (C400_MIF logic). This is used to ensure that needed exports are made even if positive carriage must be paid. In CalSim_27JAN2015_Revised, similar export estimates are now used to limit how much carriage can be reduced through increases in exports under a negative carriage constraint. Essentially, under an Emmaton or Rock Slough negative carriage constraint, the carriage is held at the level to support the estimated export – no more and no less. CalSim does not get an objective function benefit of releasing more water from upstream storage for a fractional reduction in Delta outflow.

COMPARISON OF CALSIM_27JAN2015 AND CALSIM_27JAN2015_REVISED RESULTS

The revisions in CalSim_27JAN2015_Revised change the storage balance between Oroville and SWP San Luis. Figure 13 and Figure 14 relate SWP San Luis low point storage to Oroville carryover in each year of the CalSim_27JAN2015 simulation. The only difference between the two figures is that data in Figure 13 is labeled by year and data in Figure 14 is labeled by Table A allocation. Note the years that SWP San Luis low point is at dead pool. This occurs over a wide spectrum of Oroville carryover and Table A allocations. Also note the four data points highlighted in red—1925, 1932, 1949, and 1955 with Table A allocations of 37%, 28%, 29%, and 38%, respectively. Ideally, higher allocations would have been made in these years, reducing San Luis low point storage. Figure 15 and Figure 16 relate SWP San Luis low point storage to Oroville carryover storage in each year of the CalSim_27JAN2015_Revised simulation. Compare Figure 15 and Figure 16 to Figure 13 and Figure 14, respectively to see the effect of the model edits (export forecast, rulecurve, and negative carriage) on the overall San Luis-Oroville storage balance. Note that the San Luis low point has been largely lifted above dead pool in CalSim_27JAN2015_Revised. Also note the red highlighted data points in Figure 15 and Figure 16, which correspond to the same years highlighted in red in Figure 13 and Figure 14. The combined effect of the model edits creates a more ideal balance between Oroville storage, SWP San Luis storage, and Table A allocations.

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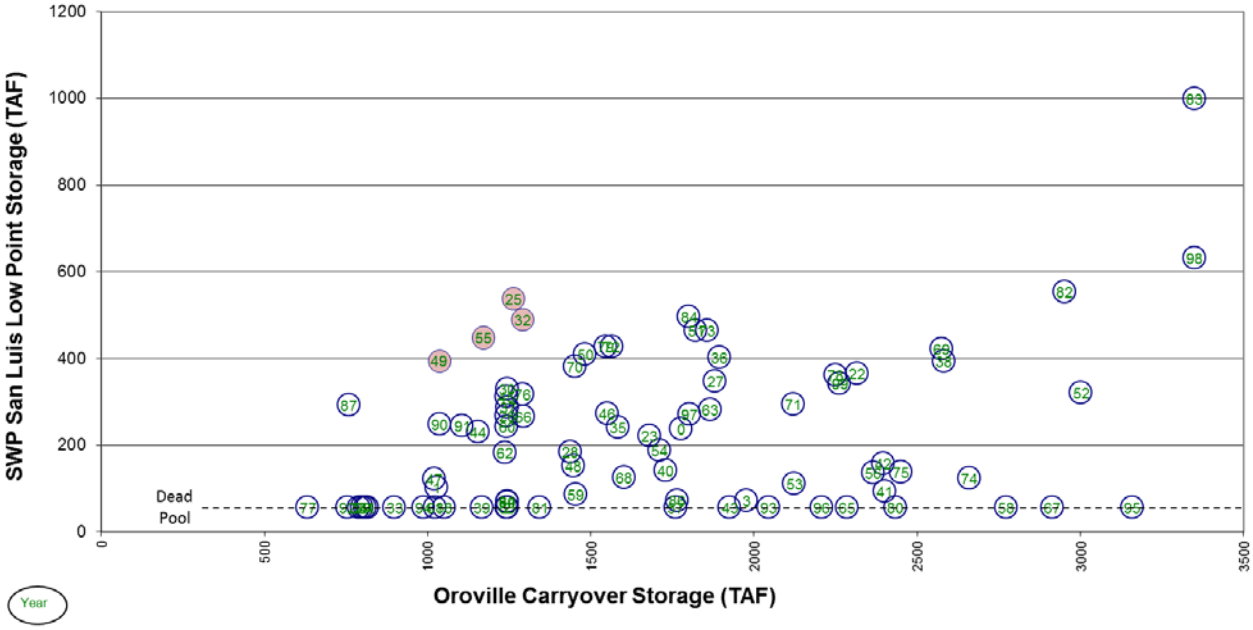


Figure 13. SWP San Luis low point storage versus Oroville carryover in CalSim_27JAN2015 with contract year data label

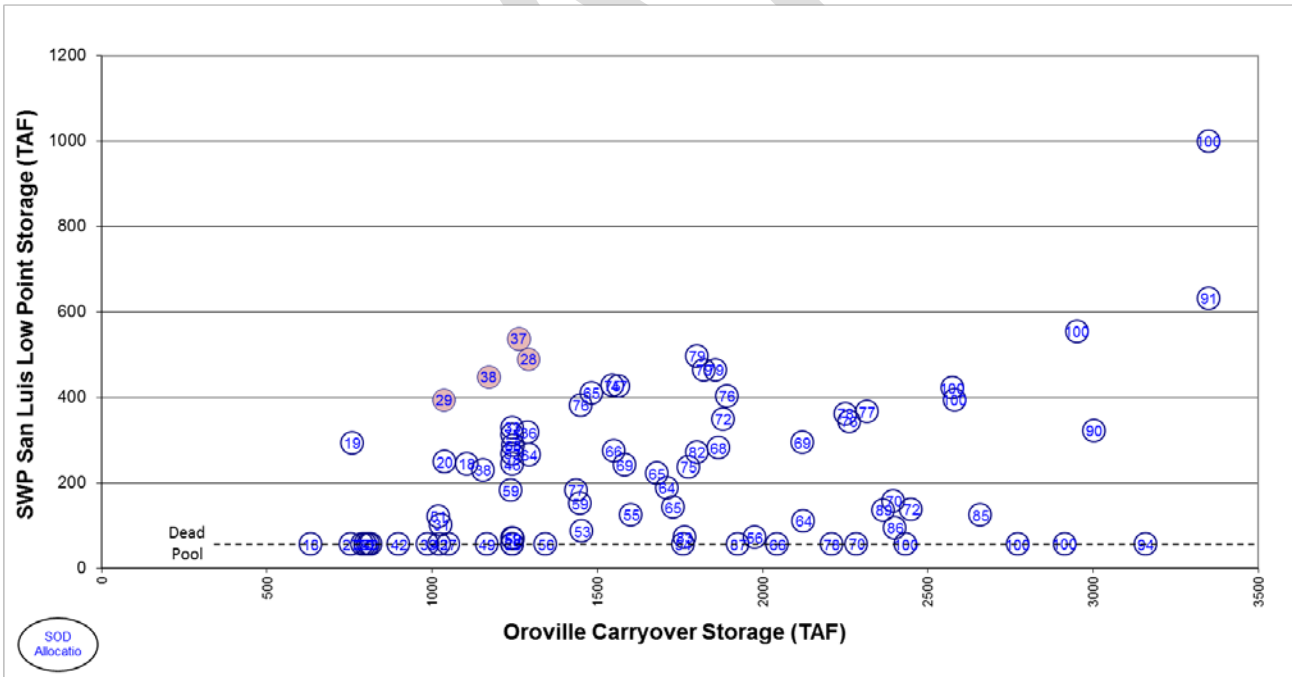


Figure 14. SWP San Luis low point storage versus Oroville carryover in CalSim_27JAN2015 with Table A allocation data label

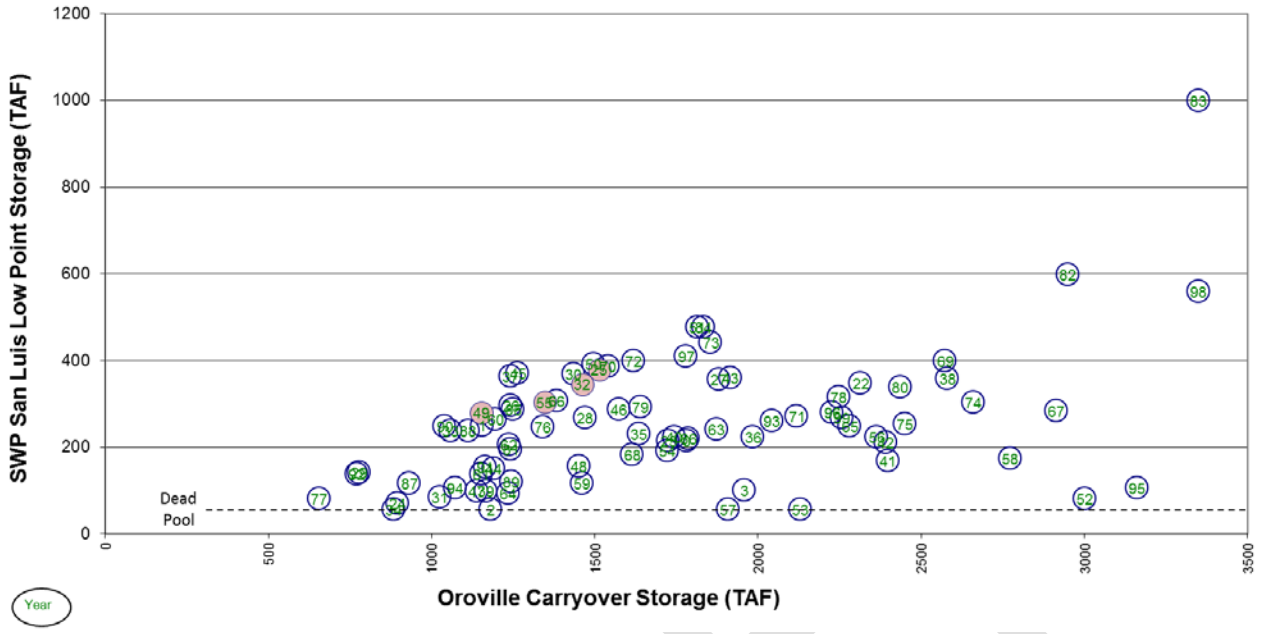


Figure 15. SWP San Luis low point storage versus Oroville carryover in CalSim_27JAN2015_Refined with contract year data label

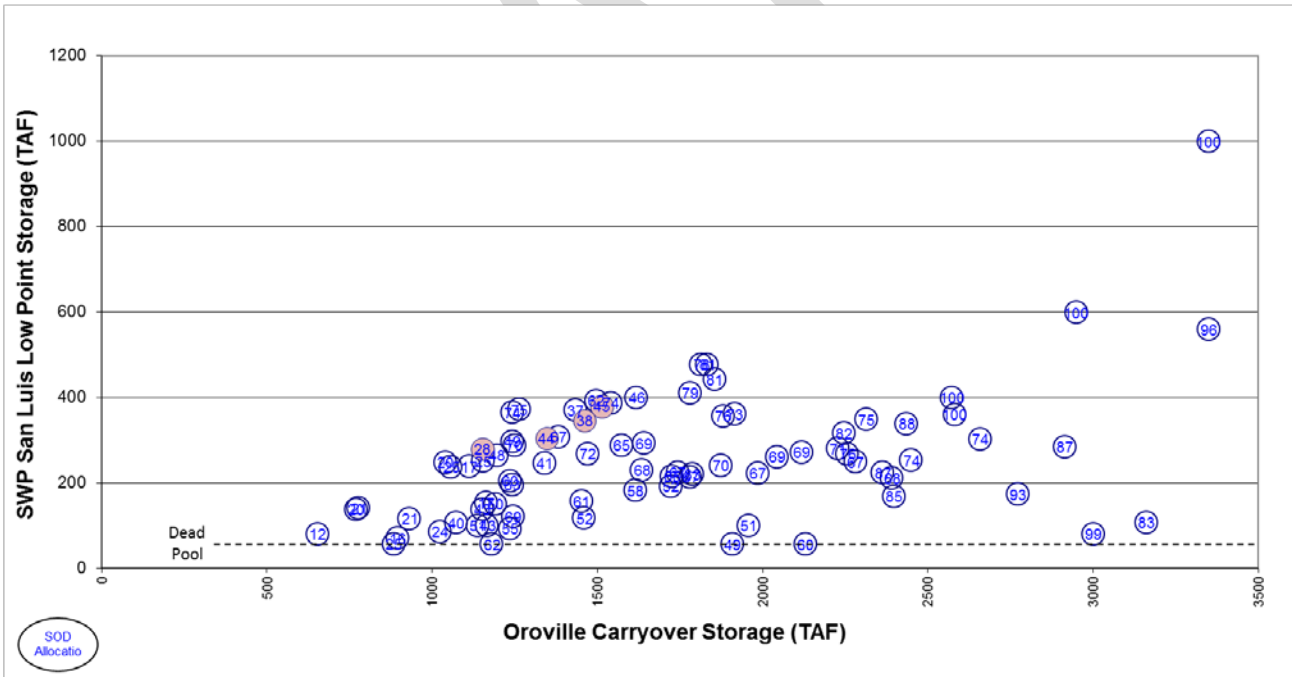


Figure 16. SWP San Luis low point storage versus Oroville carryover in CalSim_27JAN2015_Revised with Table A allocation data label

CVP San Luis storage often hits its annual low point in August. Figure 17 compares CVP San Luis end of August storage probability of exceedance curves for CalSim_27JAN2015 and CalSim_27JAN2015_Revised. In CalSim_27JAN2015, there is an almost 20% chance that end of August CVP San Luis storage is at dead pool; there is only slightly more than a 1% chance in

CalSim_27JAN2015_Revised. Also, in CalSim_27JAN2015_Revised, CVP San Luis is consistently drawn down to the 90 TAF low point target used in the CVP SOD export forecast allocation logic, whereas CalSim_27JAN2015 tends to diverge from this target.

SWP San Luis storage often hits its annual low point in October. Figure 18 compares SWP San Luis end-of-October storage probability of exceedance curves for CalSim_27JAN2015 and CalSim_27JAN2015_Revised. In CalSim_27JAN2015, there is a greater than 16% chance that end-of-October SWP San Luis storage is at dead pool; there is only a 3% chance in CalSim_27JAN2015_Revised. The low point target used in SWP export forecast allocation logic is 110 TAF. There is no obvious drawdown to this target in Figure 18 because of Article 56 carryover. CalSim_27JAN2015_Revised does a better job of preserving Article 56 requested by contractors. This is more evident when comparing CalSim_27JAN2015_Revised and CalSim_27JAN2015 Article 56 deliveries.

Model revisions also affect NOD carryover storage (end of September). Figure 19 through Figure 22 show the CalSim_27JAN2015 and CalSim_27JAN2015_Revised carryover storage probability exceedance curves for Trinity, Shasta, Folsom, and Oroville reservoirs, respectively. As shown, the model revisions had a largely positive effect on upstream carryover storage.

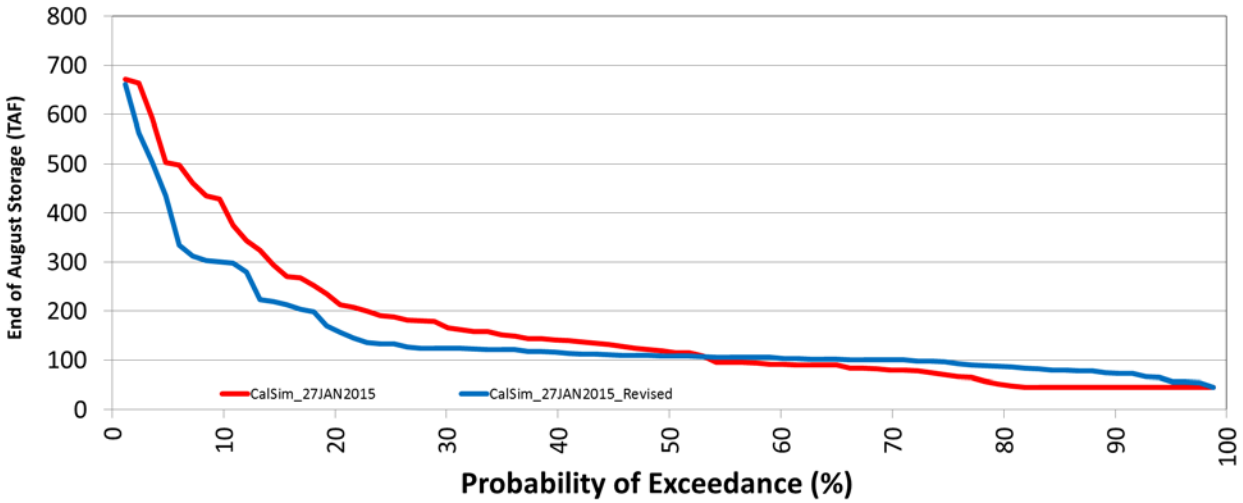


Figure 17. CVP San Luis end of August storage probability of exceedance for CalSim_27JAN2015 and CalSim_27JAN2015_Revised

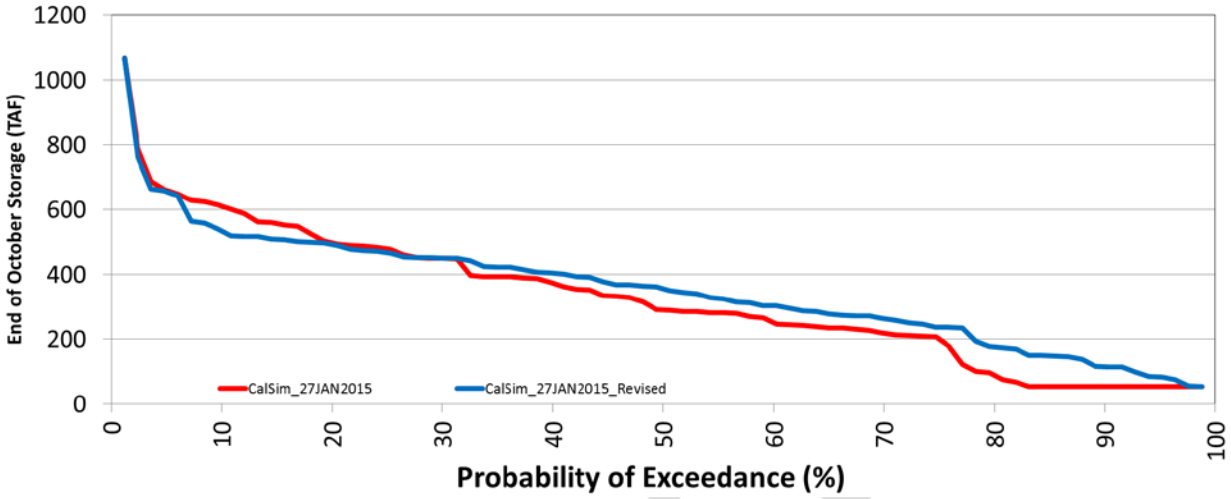


Figure 18. SWP San Luis end of October storage probability of exceedance for CalSim_27JAN2015 and CalSim_27JAN2015_Revised

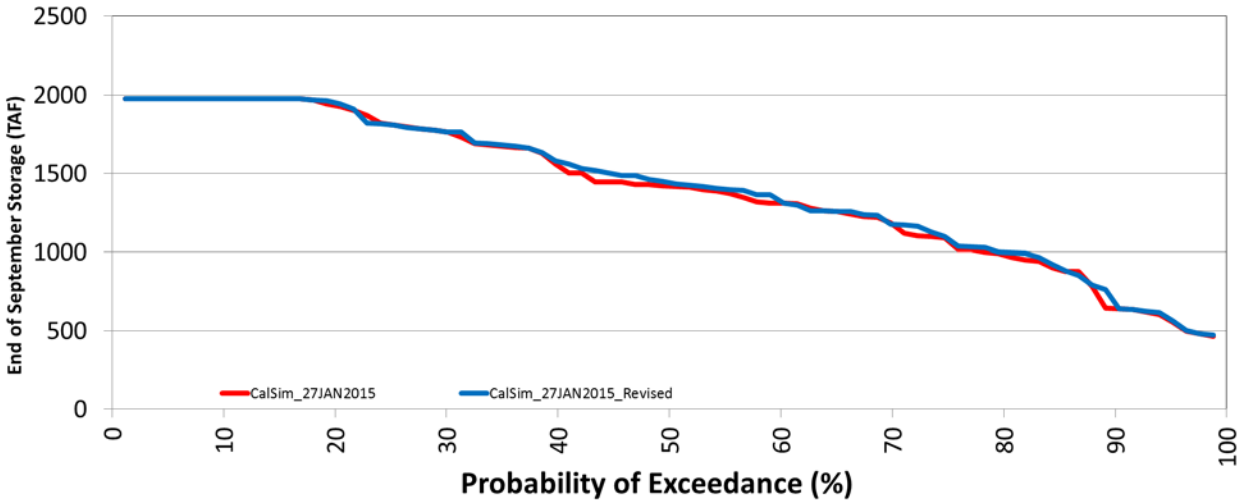


Figure 19. Trinity carryover storage probability of exceedance for CalSim_27JAN2015 and CalSim_27JAN2015_Revised

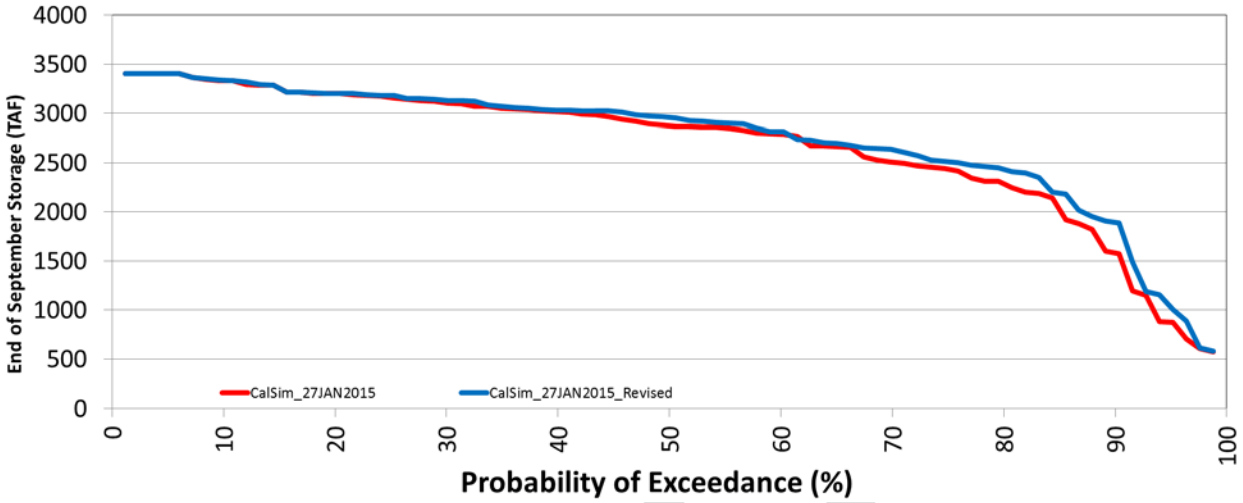


Figure 20. Shasta carryover storage probability of exceedance for CalSim_27JAN2015 and CalSim_27JAN2015_Revised

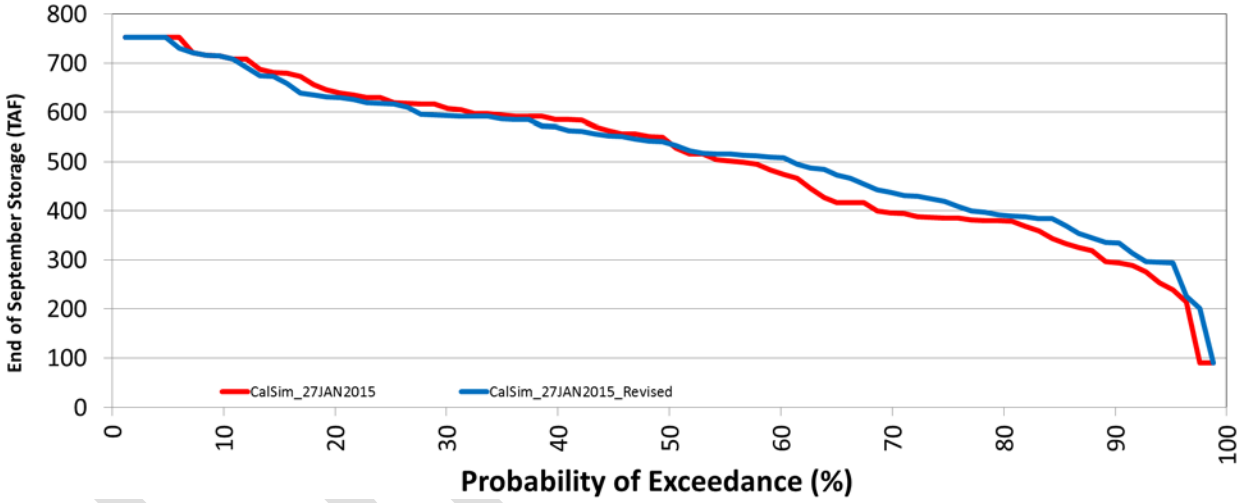


Figure 21. Folsom carryover storage probability of exceedance for CalSim_27JAN2015 and CalSim_27JAN2015_Revised

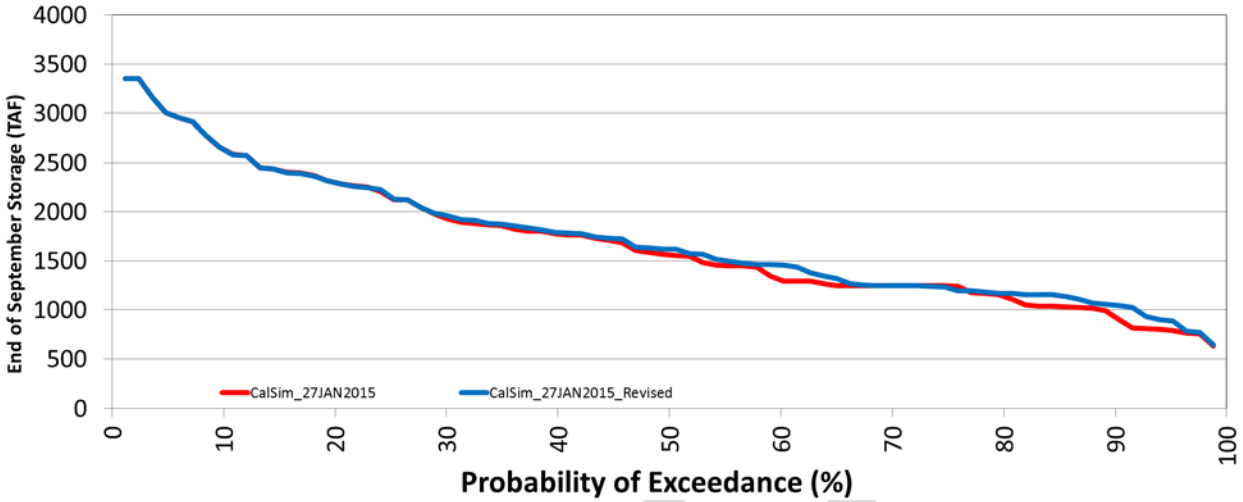


Figure 22. Oroville carryover storage probability of exceedance for CalSim_27JAN2015 and CalSim_27JAN2015_Revised

Significant changes in project reservoir operations necessarily affect project deliveries. Table 5 and Table 6 quantify the difference in CVP NOD and SOD project deliveries by month and water year type. Overall, CVP NOD project deliveries increased by 13 TAF, whereas CVP SOD project deliveries decreased by 25 TAF.

Table 5. Change in total CVP NOD project deliveries between CalSim_27JAN2015_Revised and CalSim_27JAN2015 (TAF)

Indx	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0	0	0	0	0	0	0	0	0	0	0	0	2
AN	0	0	0	0	0	0	1	1	2	2	2	1	8
BN	0	0	0	0	0	0	2	5	7	8	7	3	34
D	0	0	0	0	0	0	2	2	3	4	3	1	16
C	1	0	0	0	0	0	1	1	1	2	1	1	10
All	0	0	0	0	0	0	1	2	2	3	2	1	13

Table 6. Change in total CVP SOD project deliveries between CalSim_27JAN2015_Revised and CalSim_27JAN2015 (TAF)

Indx	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-2	-1	-2	-3	-4	2	-3	-3	-5	-6	11	-2	-18
AN	-3	-2	-3	-5	-5	4	-4	-5	-8	-10	3	-2	-41
BN	0	0	0	-1	-1	9	8	9	14	18	13	4	73
D	0	0	0	0	0	1	-6	-8	-13	-16	-9	-4	-57
C	-1	-1	-1	-2	-2	-4	-7	-12	-17	-22	-13	-6	-89
All	-1	-1	-1	-2	-2	2	-2	-4	-6	-7	2	-2	-25

Table 7 through Table 9 quantify the difference in SWP Table A, Article 56, and Article 21 project deliveries by month and water year type. Overall, Table A deliveries decreased 44 TAF, Article 56 deliveries increased 7 TAF, and Article 21 deliveries decreased 11 TAF. It is expected that reduced Table A allocations would result in fewer Article 56 requests. The reason for higher Article 56 deliveries is that the improved San Luis operation results in fewer Article 56 shortages.

Table 7. Change in SWP Table A deliveries between CalSim_27JAN2015_Revised and CalSim_27JAN2015 (TAF)

Indx	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-2	6	-2	1	-3	11	-10	-11	-11	-8	-7	-6	-41
AN	21	-10	-25	1	0	1	-12	-13	-15	-16	-16	-12	-97
BN	0	-3	-14	8	-6	-6	-4	-3	-1	0	0	0	-30
D	-9	-6	-40	1	1	2	15	9	7	6	14	14	13
C	10	7	-6	0	0	-1	-1	-18	-30	-39	-38	17	-97
All	2	0	-16	2	-2	3	-3	-6	-9	-9	-7	2	-44

Table 8. Change in SWP Article 56 deliveries between CalSim_27JAN2015_Revised and CalSim_27JAN2015 (TAF)

Indx	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0	0	0	6	4	2	0	0	0	0	0	0	11
AN	0	0	0	-4	-2	-1	0	0	0	0	0	0	-7
BN	0	0	0	3	2	2	0	0	0	0	0	0	7
D	0	0	0	3	3	2	0	0	0	0	0	0	9
C	0	0	0	4	4	1	0	0	0	0	0	0	9
All	0	0	0	3	2	1	0	0	0	0	0	0	7

Table 9. Change in SWP Article 21 deliveries between CalSim_27JAN2015_Revised and CalSim_27JAN2015 (TAF)

Indx	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0	0	0	-7	-6	7	-2	0	0	0	1	0	-7
AN	0	0	-1	-2	-1	-1	0	0	0	0	1	0	-4
BN	0	0	0	0	-1	-25	0	0	0	0	0	0	-25
D	0	0	0	0	-4	-2	0	0	0	0	1	0	-6
C	0	0	0	0	-14	-7	0	0	0	0	0	0	-20
All	0	0	0	-2	-5	-4	-1	0	0	0	1	0	-11

Table 10 quantifies the difference in Feather River Settlement Contractor fall rice decomposition deliveries by month and water year type. The annual average difference between the CalSim_27JAN2015_Revised and CalSim_27JAN2015 is 8 TAF. CalSim meets less than the rice decomposition demand when Oroville storage drops below 1.2 MAF. Since CalSim_27JAN2015_Revised maintains higher Oroville storage than CalSim_27JAN2015, the revised study is able to meet more of the rice decomposition demand annually.

Table 10. Change in Feather River Settlement Contractor rice decomposition deliveries between CalSim_27JAN2015_Revised and CalSim_27JAN2015 (TAF)

Indx	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	2	2	1	0	0	0	0	0	0	0	0	0	5
AN	-2	-2	-1	-1	0	0	0	0	0	0	0	0	-6
BN	4	6	4	2	0	0	0	0	0	0	0	0	16
D	4	4	2	1	0	0	0	0	0	0	0	0	12
C	4	5	3	1	0	0	0	0	0	0	0	0	12
All	2	3	2	1	0	0	0	0	0	0	0	0	8

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Attachment A
CalSim II Assumptions for Future No Action Conditions

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	Period of Simulation: 82 years (1922-2003)
	Future Level Study
HYDROLOGY	
Level of Development	2020 Level, *DWR Bulletin 160-98*[1]
Sacramento River Region Demands	
CVP	Land use based, limited by full contract
SWP (FRSA)	Land use based, limited by full contract
Non-Project	Land use based
Woodland-Davis Clean Water Agency	Included
Antioch	Pre-1914 water right
CVP Refuges	Firm Level 2 water needs
American River Basin Demands	
Water rights	2020 Level
CVP	2020 Level, full contracts including Freeport Regional Water Project and Sacramento River Water Reliability Project
San Joaquin River Basin Demands	
Friant Unit	Limited by contract amounts, based on current allocation policy
Lower Basin	Land use based with district level operations and constraints
Stanislaus River Basin[2]	Land use based, with New Melones Interim Operations Plan and NMFS biological opinion (June 2009), Actions 3.1.2 and 3.1.3[5]
South of Delta Demands	
CVP	Full contract
Contra Costa Water District	195 taf/yr
SWP (with North Bay Aqueduct)	4.1 maf/yr
SWP Article 21 Demand	Metropolitan Water District of Southern California up to 200 taf/month (Dec-Mar), KCWA demand up to 180 taf/month and others up to 34 taf/month
FACILITIES	
Red Bluff Diversion Dam	Fish Passage Improvement Project in place with 2,500 cfs capacity
Freeport Regional Water Project	Included with diversions to EBMUD
Banks Pumping Capacity	Physical capacity is 10,300 cfs, 6,680 cfs permitted capacity up to 8,500 cfs (Dec 15th–Mar 15th) depending on Vernalis flow conditions[3] additional capacity of 500 cfs (up to 7,180 cfs) allowed for Jul–Sep for reducing impact of NMFS biological opinion on SWP (Jun 2009), Action 4.2.1[5]
Jones Pumping Capacity	Exports up to 4,600 cfs permit capacity in all months
Delta-Mendota Canal-California Aqueduct Intertie	Included with 400 cfs capacity
Los Vaqueros Reservoir Capacity	160 taf
South Bay Aqueduct	South Bay Aqueduct Enlargement to 430 cfs
REGULATORY STANDARDS	
Trinity River	
Minimum Flow below Lewiston Dam	Trinity EIS Preferred Alternative (369-815 taf/yr)
Trinity Reservoir End-of-September Minimum Storage	Trinity EIS Preferred Alternative (600 taf as able)

	Period of Simulation: 82 years (1922-2003)
	Future Level Study
Clear Creek	
Minimum Flow below Whiskeytown Dam	Downstream water rights, 1963 Reclamation Proposal to USFWS and NPS, predetermined Central Valley Project Improvement Act 3406(b)(2) flows and NMFS biological opinion (June 2009) Action I.1.1[5]
Upper Sacramento River	
Shasta Lake End-of-September Minimum Storage	NMFS 2004 Winter-run biological opinion (1900 taf), predetermined Central Valley Project Improvement Act 3406(b)(2) flows, and NMFS biological opinion (Jun 2009) Action I.2.1[5]
Minimum Flow below Keswick Dam	Flows for SWRCB Water Rights Order 90-5 and 1993 Winter-run biological opinion temperature control, predetermined Central Valley Project Improvement Act 3406(b)(2) flows, and NMFS biological opinion (Jun 2009), Action I.2.2[5]
Feather River	
Minimum Flow below Thermalito Diversion Dam	2006 Settlement Agreement (700/800 cfs)
Minimum Flow below Thermalito Afterbay outlet	1983 DWR, DFG Agreement (750-1700 cfs)
Yuba River	
Minimum flow below Daguerre Point Dam	D-1644 Operations (Lower Yuba River Accord)[4]
American River	
Minimum Flow below Nimbus Dam	American River Flow Management as required by NMFS biological opinion (Jun 2009), Action 2.1[5]
Minimum Flow at H Street Bridge	SWRCB D-893
Lower Sacramento River	
Minimum Flow near Rio Vista	SWRCB D-1641
Mokelumne River	
Minimum Flow below Camanche Dam	Federal Energy Regulatory Commission 2916-029, 1996 Joint Settlement Agreement (100 – 325 cfs)
Minimum Flow below Woodbridge Diversion Dam	Federal Energy Regulatory Commission 2916-029, 1996 Joint Settlement Agreement (25 – 300 cfs)
Stanislaus River	
Minimum Flow below Goodwin Dam	1987 Reclamation, DFG agreement, and flows required for NMFS biological opinion (Jun 2009) Actions III.1.2 and III.1.3[5]
Minimum Dissolved Oxygen	SWRCB D-1422
REGULATORY STANDARDS	
Merced River	
Minimum Flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180 – 220 cfs, Nov – Mar) and Cowell Agreement
Minimum Flow at Shaffer Bridge	Federal Energy Regulatory Commission 2179 (25-100 cfs)
Tuolumne River	
Minimum Flow at Lagrange Bridge	Federal Energy Regulatory Commission 2299-024, 1995 Settlement Agreement (94-301 taf/yr)
San Joaquin River	
San Joaquin River Restoration	Full flows
Maximum Salinity near Vernalis	SWRCB D-1641
Minimum Flow near Vernalis	SWRCB D-1641, NMFS biological opinion (Jun 2009), Action 4.2.1[5]

	Period of Simulation: 82 years (1922-2003)
	Future Level Study
Sacramento River-San Joaquin River Delta	
Delta Outflow Index (Flow and Salinity)	SWRCB D-1641, USFWS biological opinion (Dec 2008), Action 4[5]
Delta Cross Channel Gates	SWRCB D-1641, NMFS biological opinion (Jun 2009) Action 4.1.2[5]
Delta Exports	SWRCB D-1641, NMFS biological opinion (Jun 2009) Action 4.2.1[5]
Combined Flow in Old and Middle River	USFWS biological opinion (Dec 2008), Actions 1–3 and NMFS biological opinion (Jun 2009), Action 4.2.3[5]
OPERATIONS CRITERIA	
Subsystem	
Upper Sacramento River	
Flow Objective for Navigation (Wilkins Slough)	NMFS biological opinion (Jun 2009) Action I.4[5]; 3,250 – 5,000 cfs based on CVP water supply condition
American River	
Folsom Dam Flood Control	Variable 400/670 without outlet modifications
Feather River	
Flow at Mouth	Maintain DFG/DWR flow target above Verona or 2800 cfs Apr-Sep, dependent on Oroville inflow and FRSA allocation
System-wide	
CVP Water Allocation	
CVP Settlement and Exchange	100% (75% in Shasta Critical years)
CVP Refuges	100% (75% in Shasta Critical years)
CVP Agriculture	100% - 0% based on supply; additionally limited due to D-1641, USFWS biological opinion (Dec 2008) and NMFS biological opinion (Jun 2009) export restrictions[5]
CVP Municipal & Industrial	100% - 0% based on supply; additionally limited due to D-1641, USFWS biological opinion (Dec 2008) and NMFS biological opinion (Jun 2009) export restrictions[5]
OPERATIONS CRITERIA	
SWP Water Allocation	
North of Delta (FRSA)	Contract specific
South of Delta	Based on supply, Monterey Agreement; allocations limited due to D-1641, USFWS biological opinion (Dec2008) and NMFS biological opinion (Jun 2009) export restrictions[5]
CVP/SWP Coordinated Operations	
Sharing of Responsibility for In Basin Use	1986 Coordinated Operations Agreement
Sharing of Surplus Flows	1986 Coordinated Operations Agreement
Sharing of Restricted Export Capacity	Equal sharing of export capacity under SWRCB D-1641, USFWS biological opinion (Dec 2008) and NMFS biological opinion (Jun 2009) export restrictions[5]
Transfers	
Lower Yuba River Accord[6]	Yuba River acquisitions for reducing impact of NMFS biological opinion export restrictions on SWP

[1] The Sacramento Valley hydrology used in the Future Conditions CalSim II model reflects 2020 land-use assumptions associated with Bulletin 160-98. The San Joaquin Valley hydrology reflects draft 2030 land-use assumptions developed by Reclamation. Development of future-level projected land-use assumptions are being coordinated with the California Water Plan Update for future models.

[2] The CalSim II model representation for the Stanislaus River does not necessarily represent Reclamation's current or future operational policies. A suitable plan for supporting flows has not been developed for NMFS biological opinion (Jun 2009), Action 3.1.3.

[3] Current US Army Corps of Engineers permit for Harvey O. Banks Pumping Plant allows for an average diversion rate of 6,680 cfs in all months. Diversion rate can increase up to 1/3 of the rate of San Joaquin River flow at Vernalis during Dec 15th–Mar 15th up to a maximum diversion of 8,500 cfs, if Vernalis flow exceeds 1,000 cfs.

[4] D-1644 and the Lower Yuba River Accord are assumed to be implemented for Future Conditions. The Yuba River is not dynamically modeled in CalSim II. Yuba River hydrology and availability of water acquisitions under the Lower Yuba River Accord are based on modeling performed and provided by the Lower Yuba River Accord EIS/EIR study team.

[5] In cooperation with USBR, NMFS, USFWS, and DGF, the DWR has developed assumptions for implementation of the USFWS biological opinion (December 15, 2008) and NMFS biological opinion (June 4, 2009) in CalSim II.

[6] Acquisitions of Component 1 water under the Lower Yuba River Accord, and use of 500 cfs dedicated capacity at Banks Pumping Plant during Jul–Sep, are assumed to be used to reduce as much of the effect of the April–May Delta export actions on SWP contractors as possible.

San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix B: Attachment B, Comparison of Future No Action Conditions and Project Alternatives at Future LOD

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Figure 1: Comparison of Trinity Storage for Lower San Felipe Intake Alternative

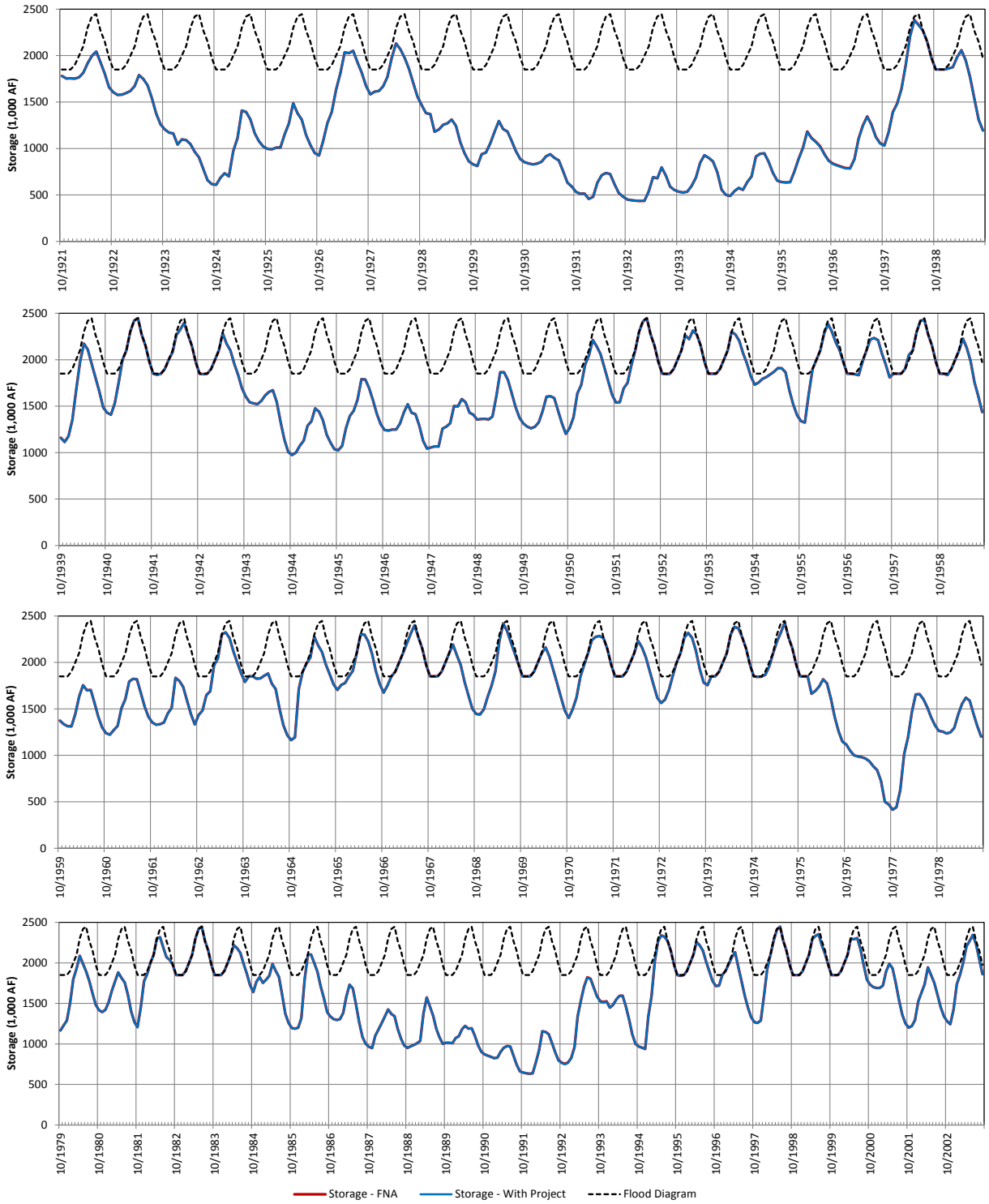


Figure 2: Comparison of Shasta Storage for Lower San Felipe Intake Alternative

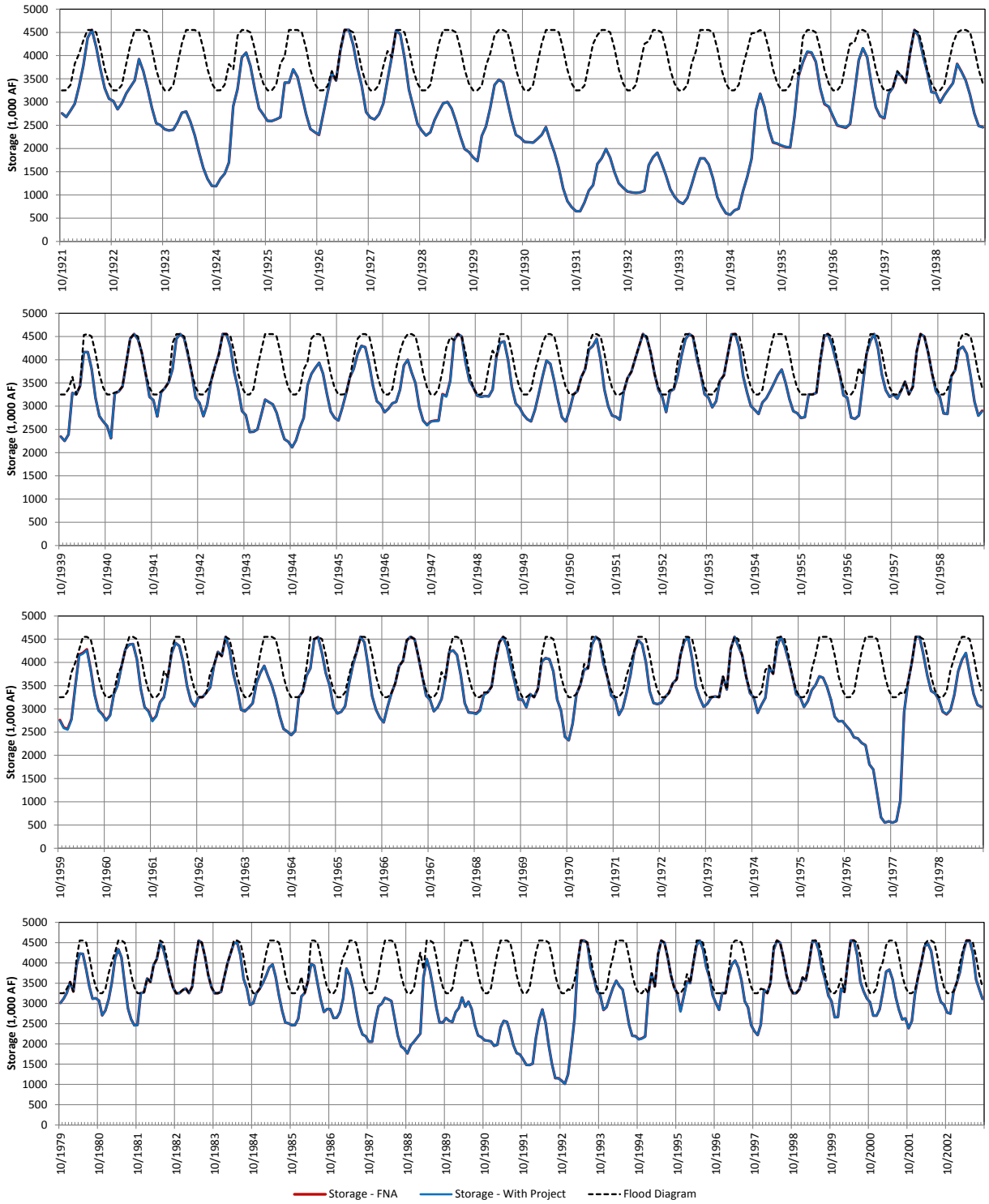


Figure 3: Comparison of Folsom Storage for Lower San Felipe Intake Alternative

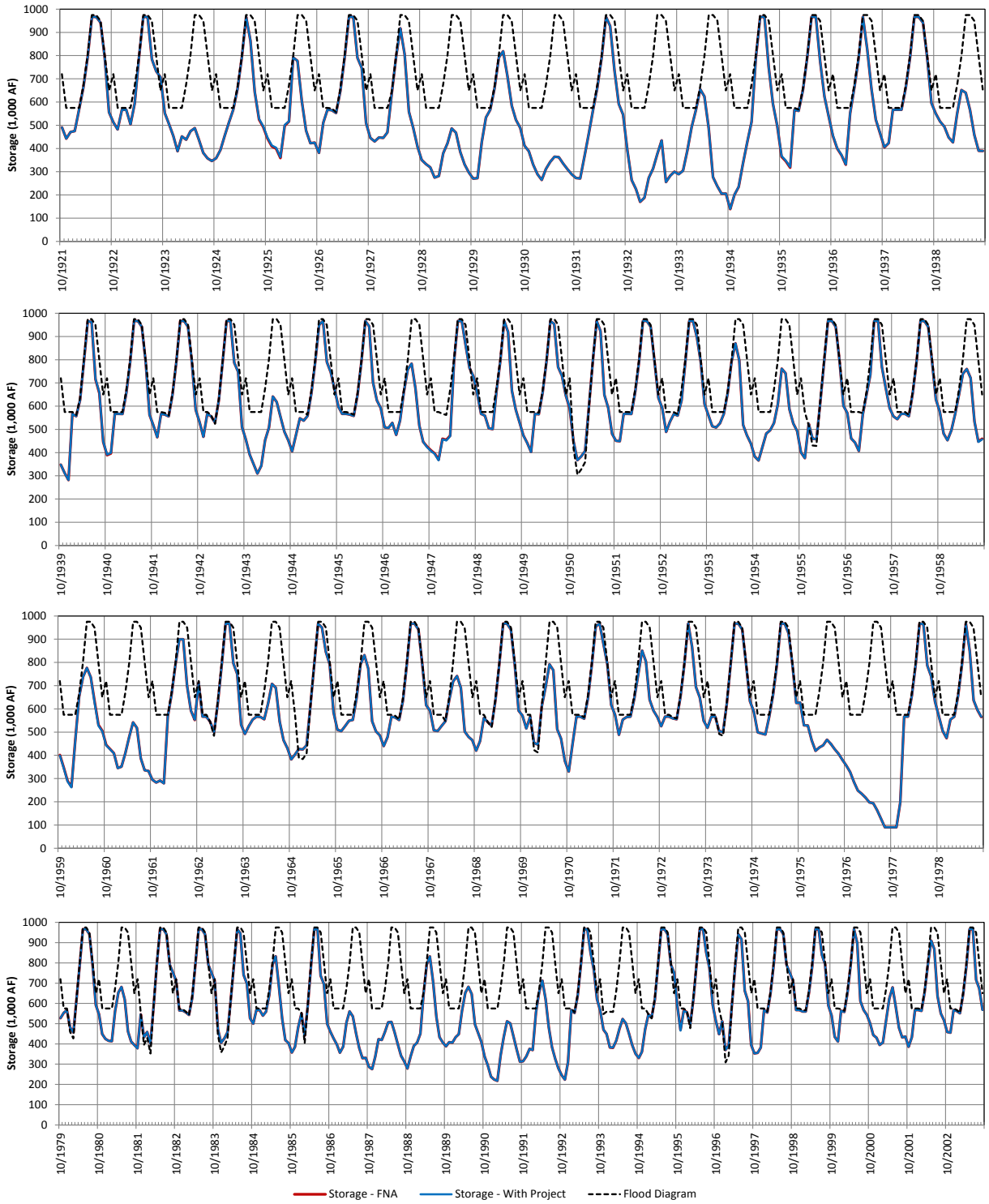


Figure 4: Comparison of Oroville Storage for Lower San Felipe Intake Alternative

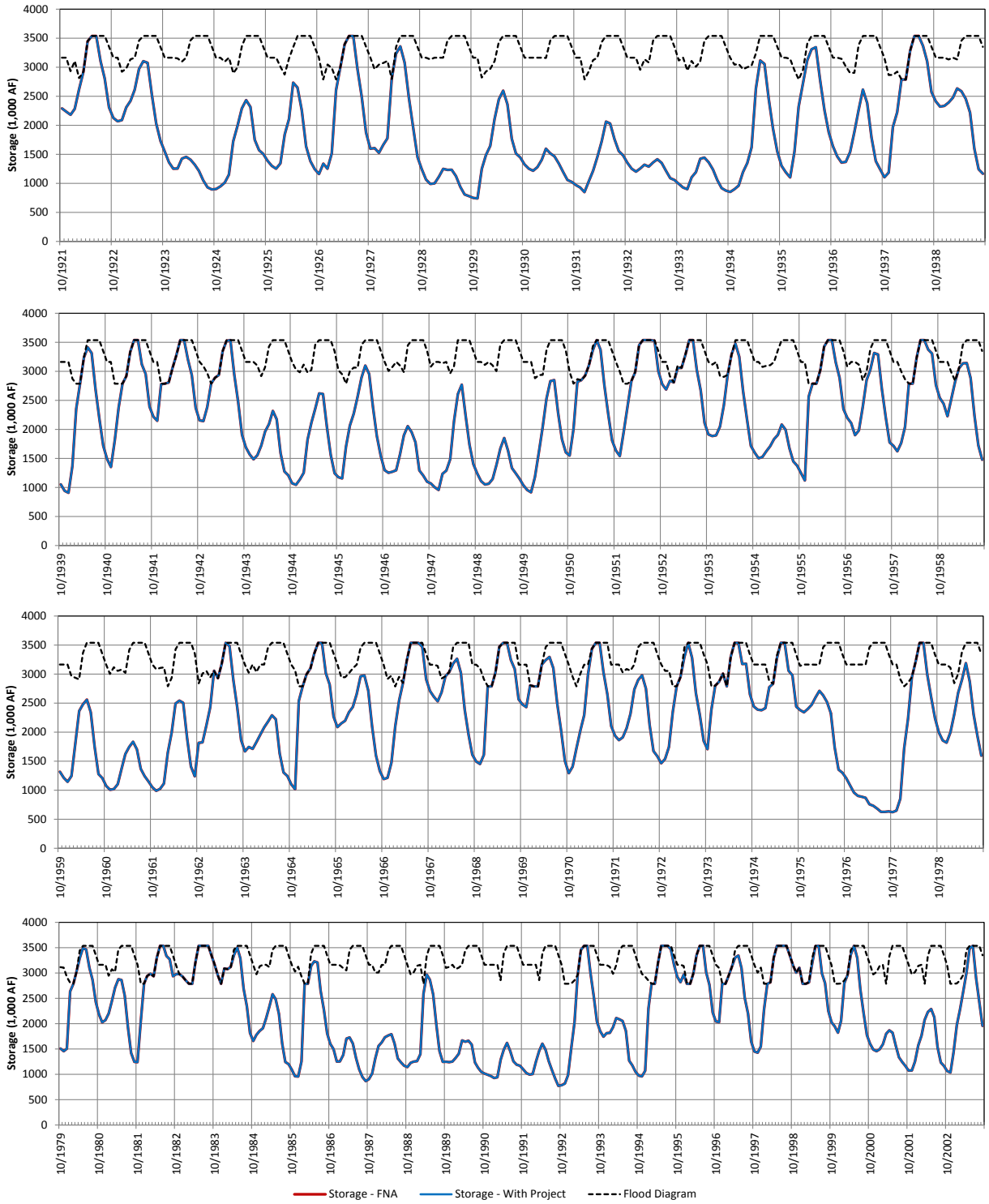


Figure 5: Comparison of Sacramento River below Keswick Flow for Lower San Felipe Intake Alternative

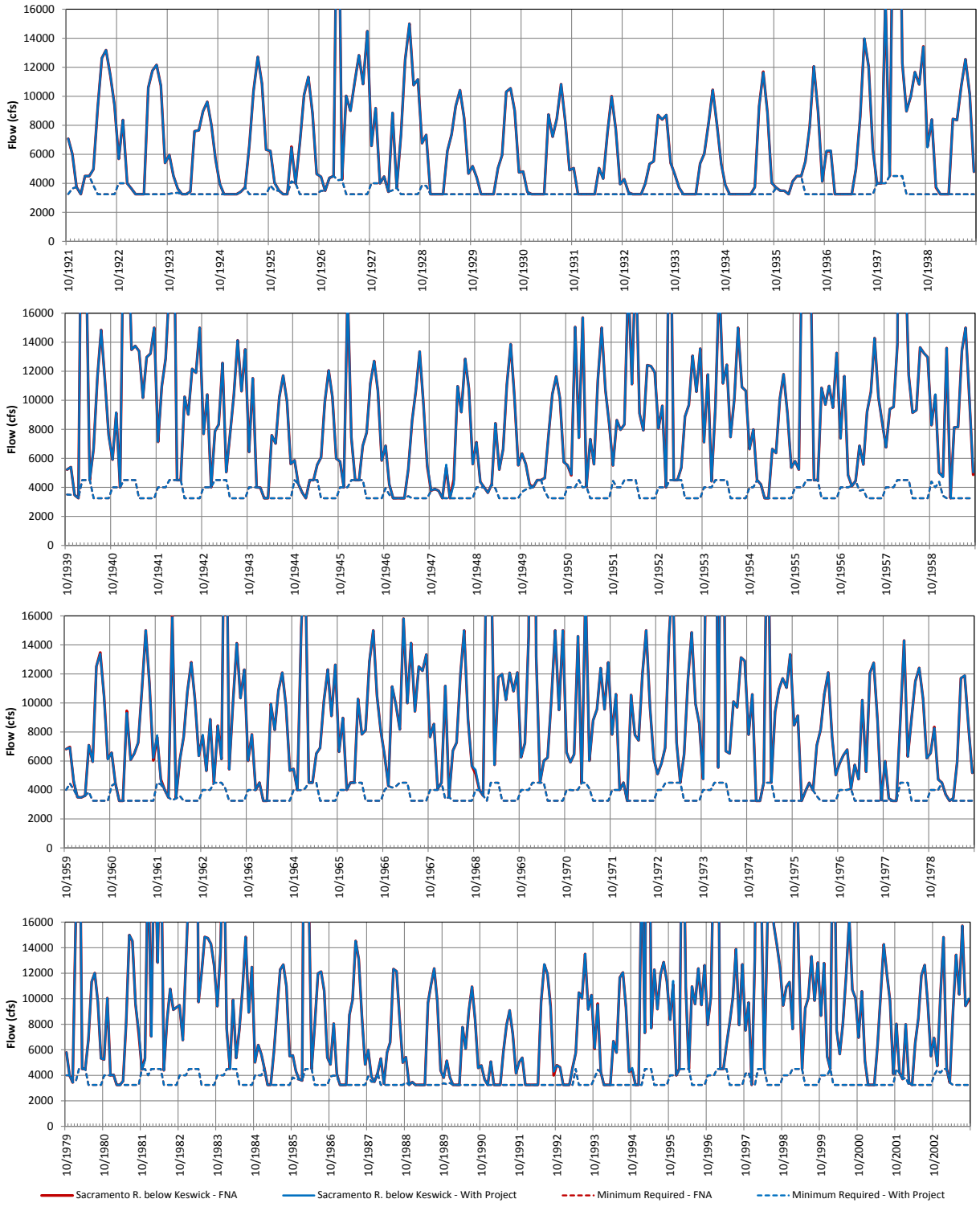


Figure 6: Comparison of Sacramento River at Wilkins Slough Flow for Lower San Felipe Intake Alternative

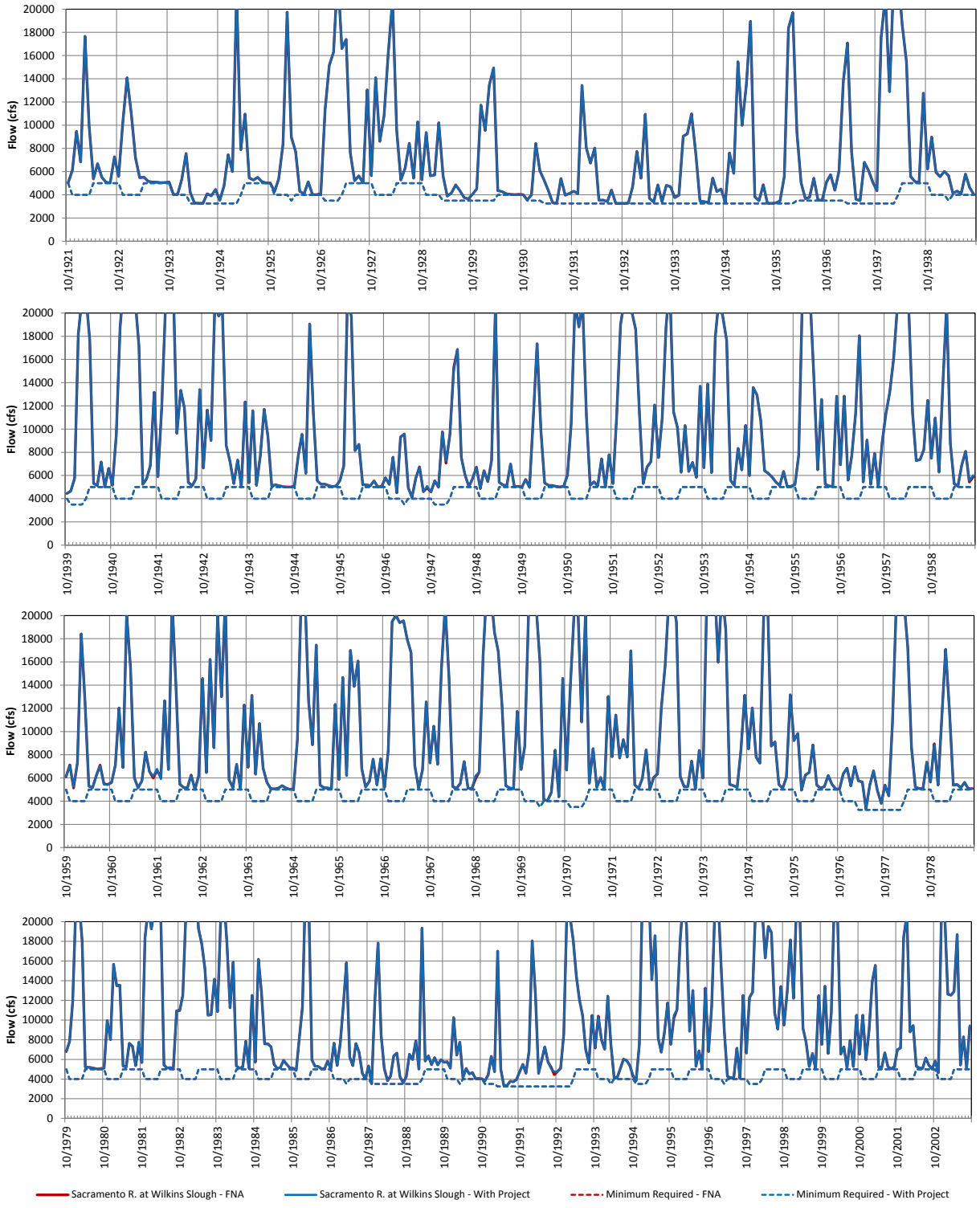


Figure 7: Comparison of American River below Nimbus Flow for Lower San Felipe Intake Alternative

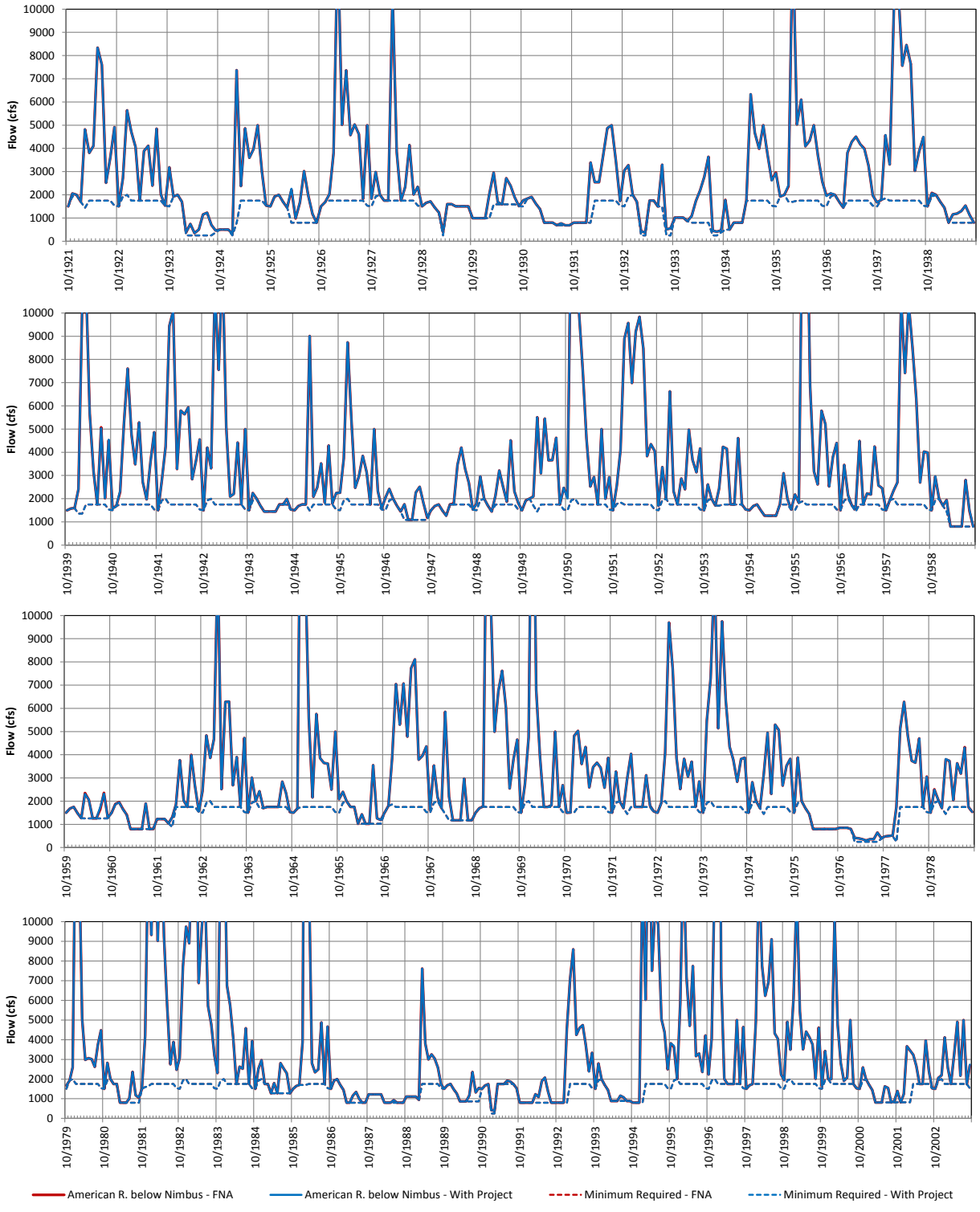


Figure 8: Comparison of Lower Feather River Flow for Lower San Felipe Intake Alternative

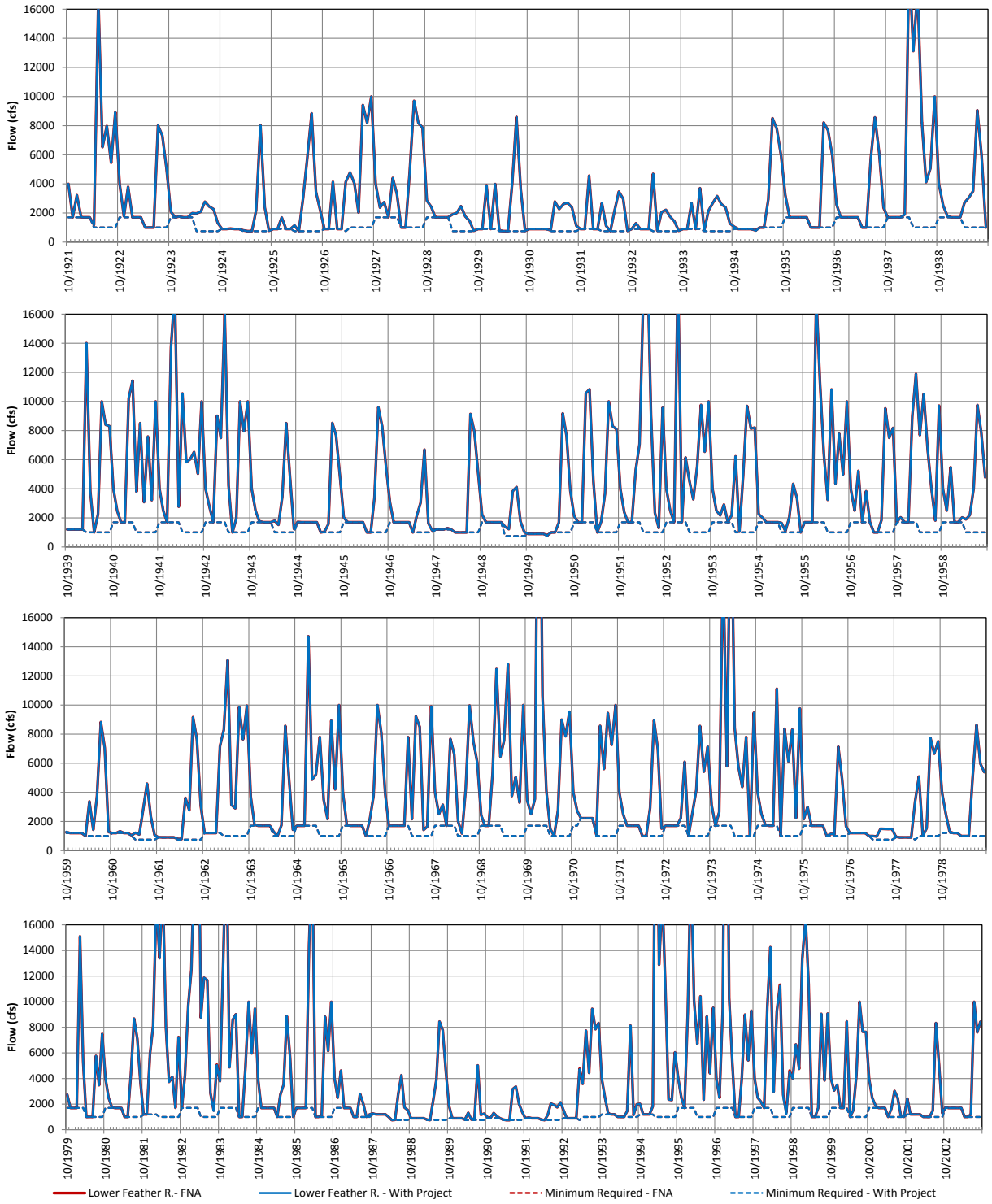


Figure 9: Comparison of Delta Inflow for Lower San Felipe Intake Alternative

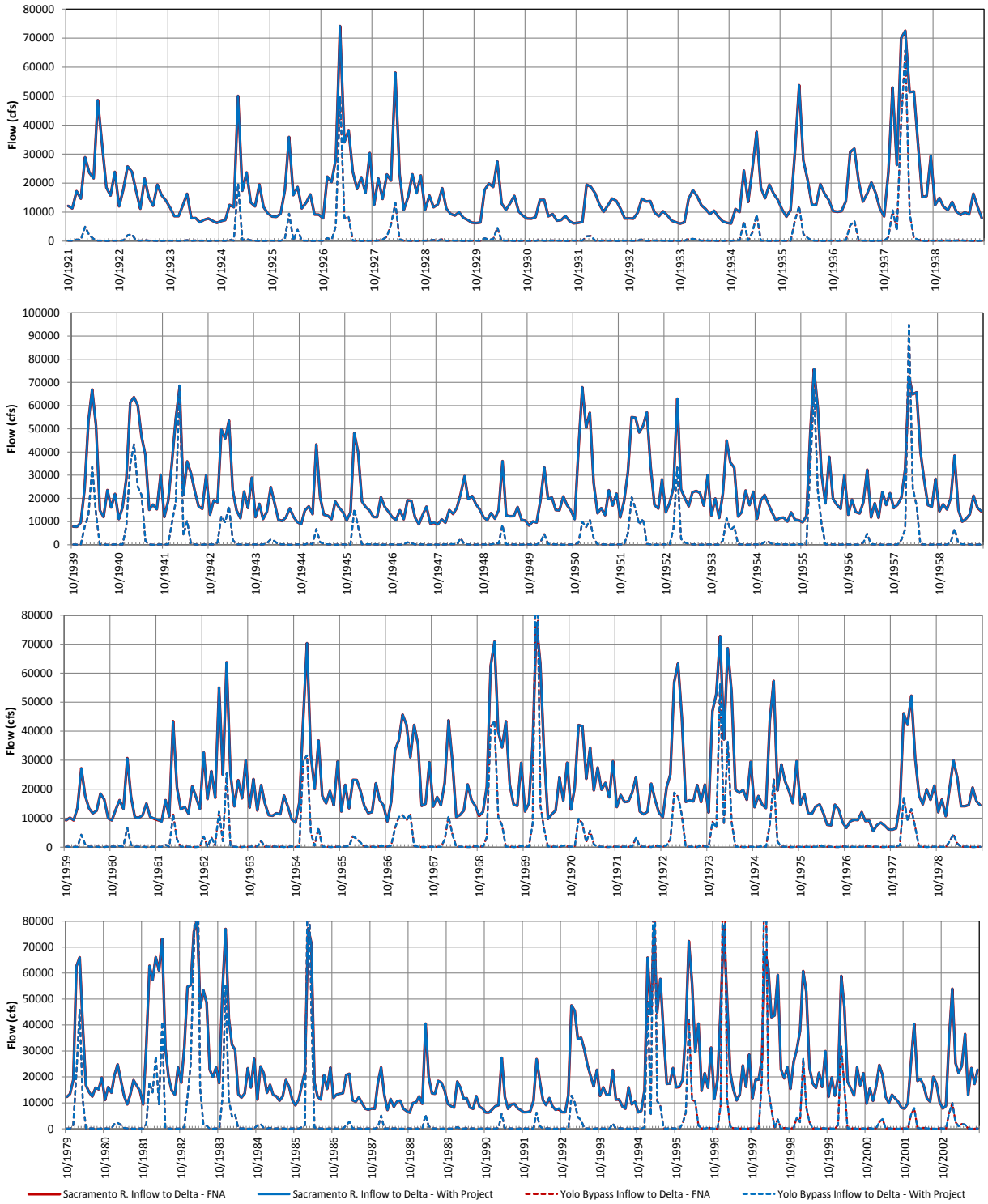


Figure 10: Comparison of Delta Outflow for Lower San Felipe Intake Alternative

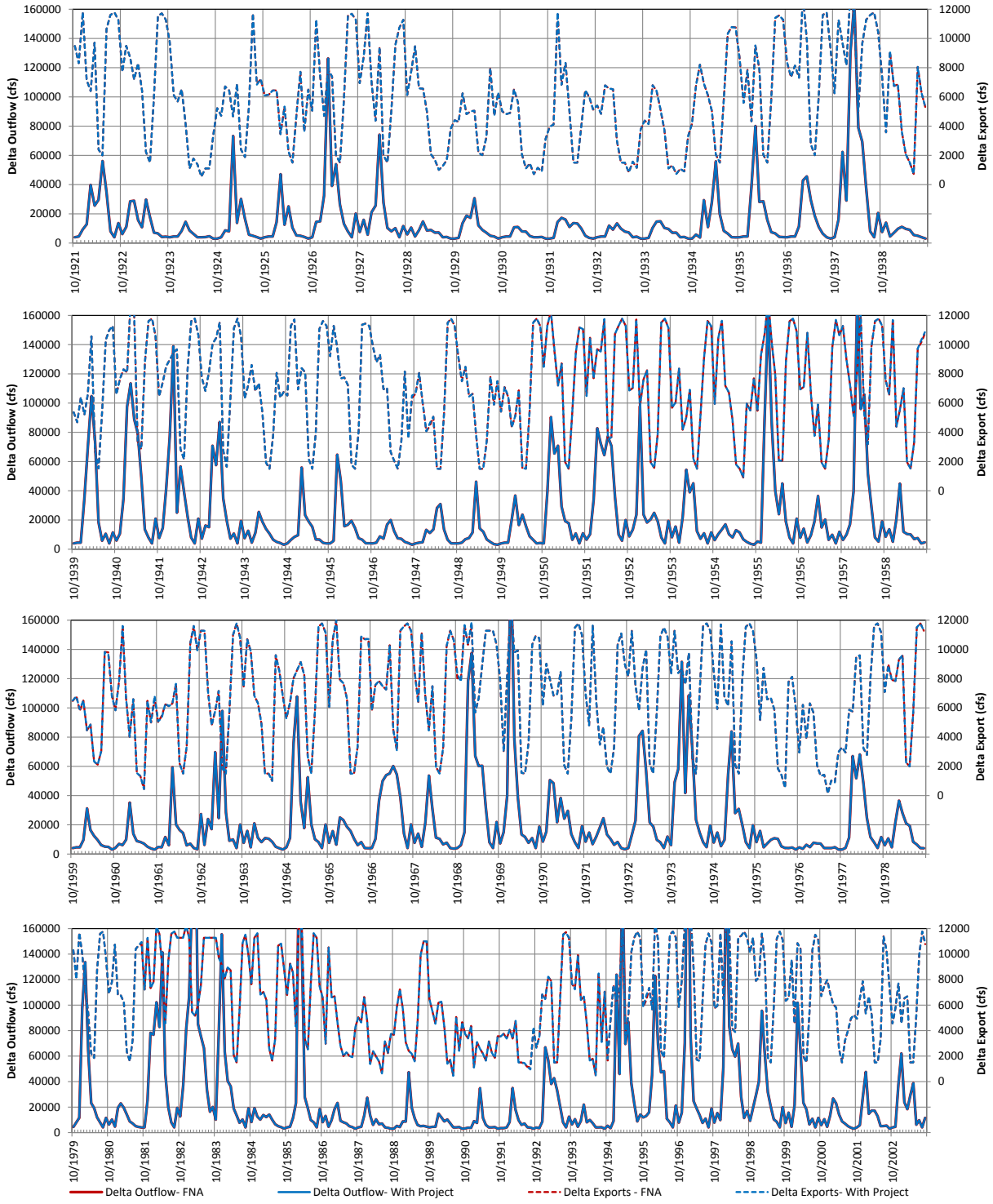


Figure 11: Comparison of San Luis Reservoir Storage for Lower San Felipe Intake Alternative

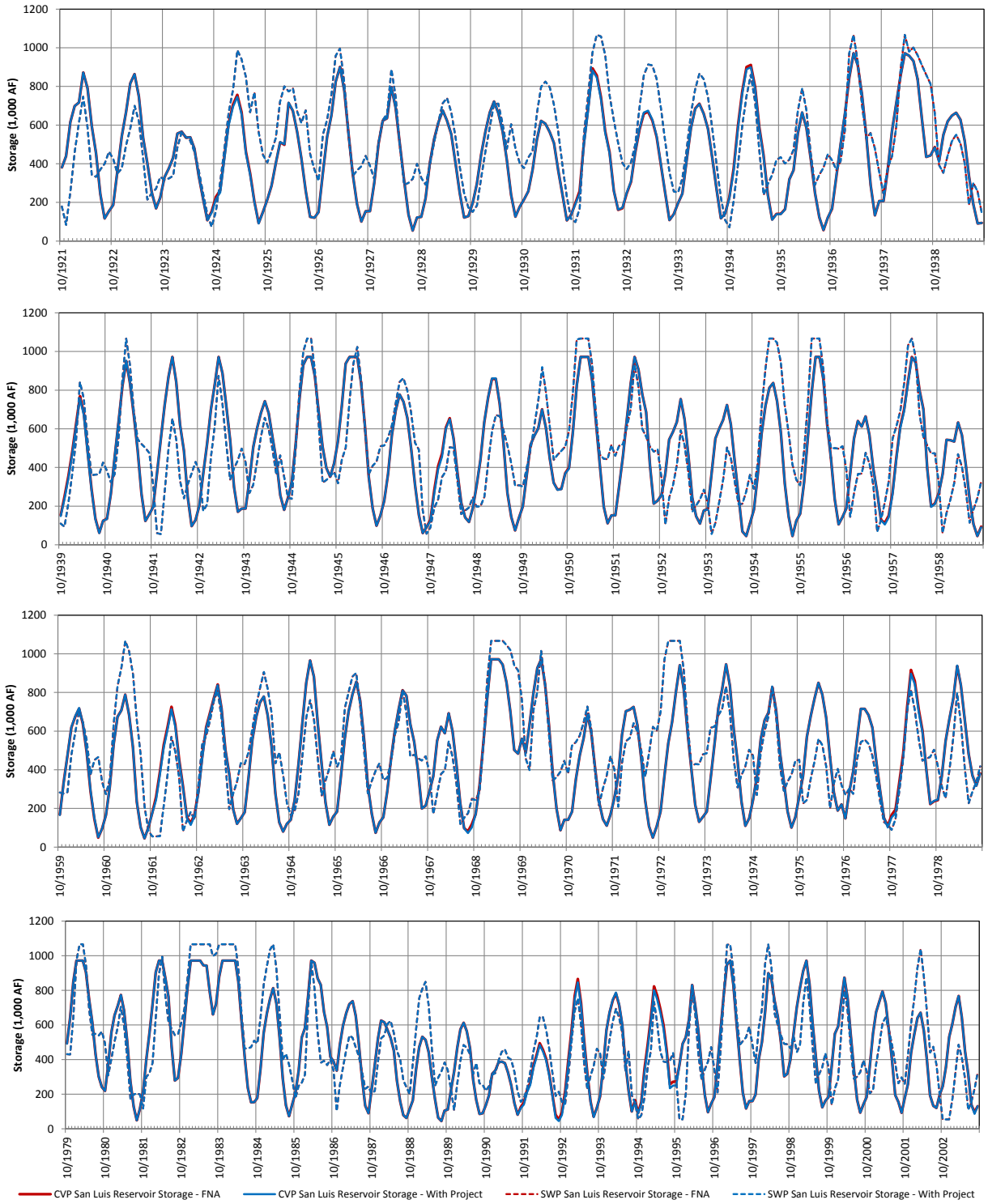


Figure 12: Comparison of Trinity Storage for San Luis Reservoir Expansion Alternative

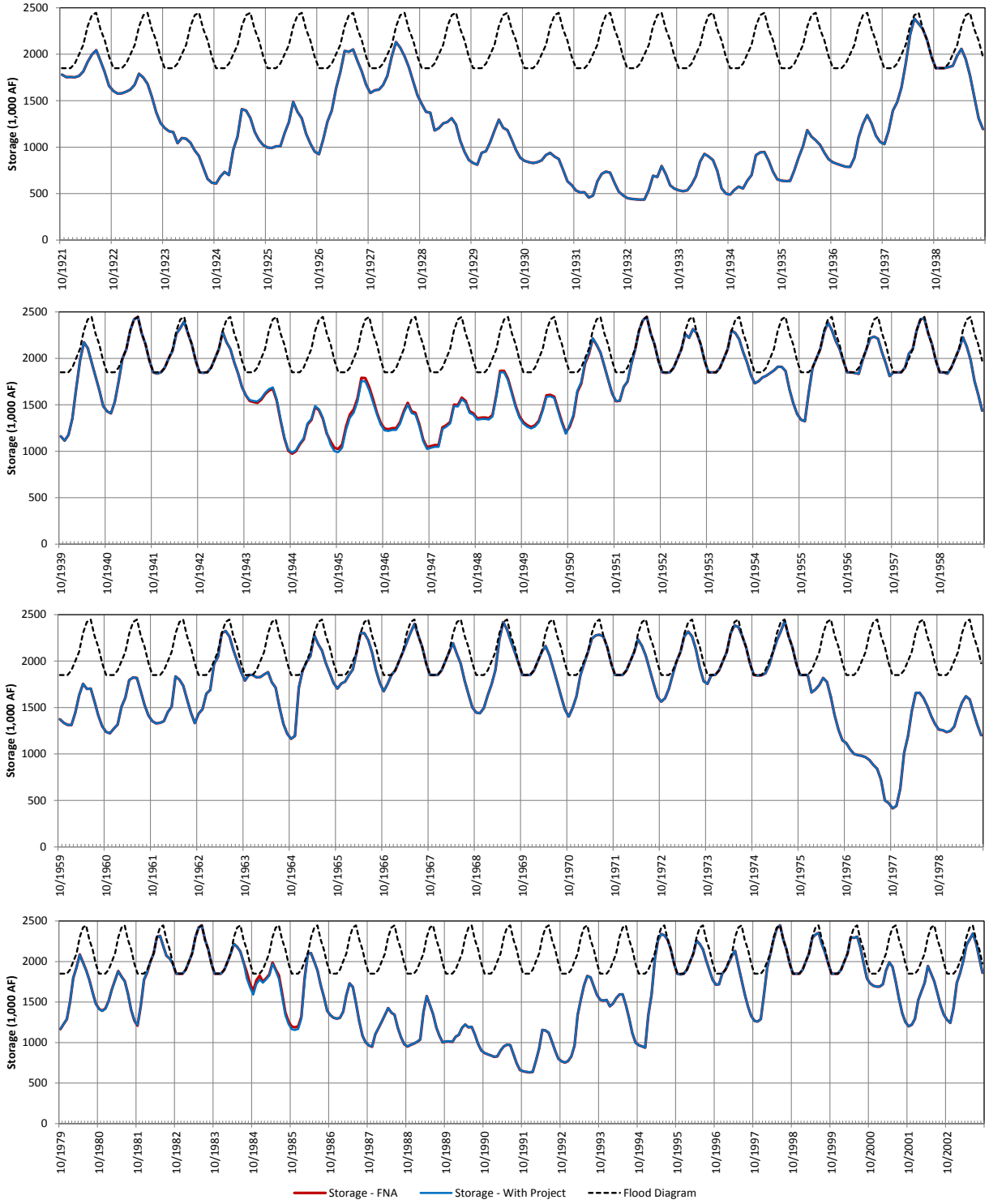


Figure 13: Comparison of Shasta Storage for San Luis Reservoir Expansion Alternative

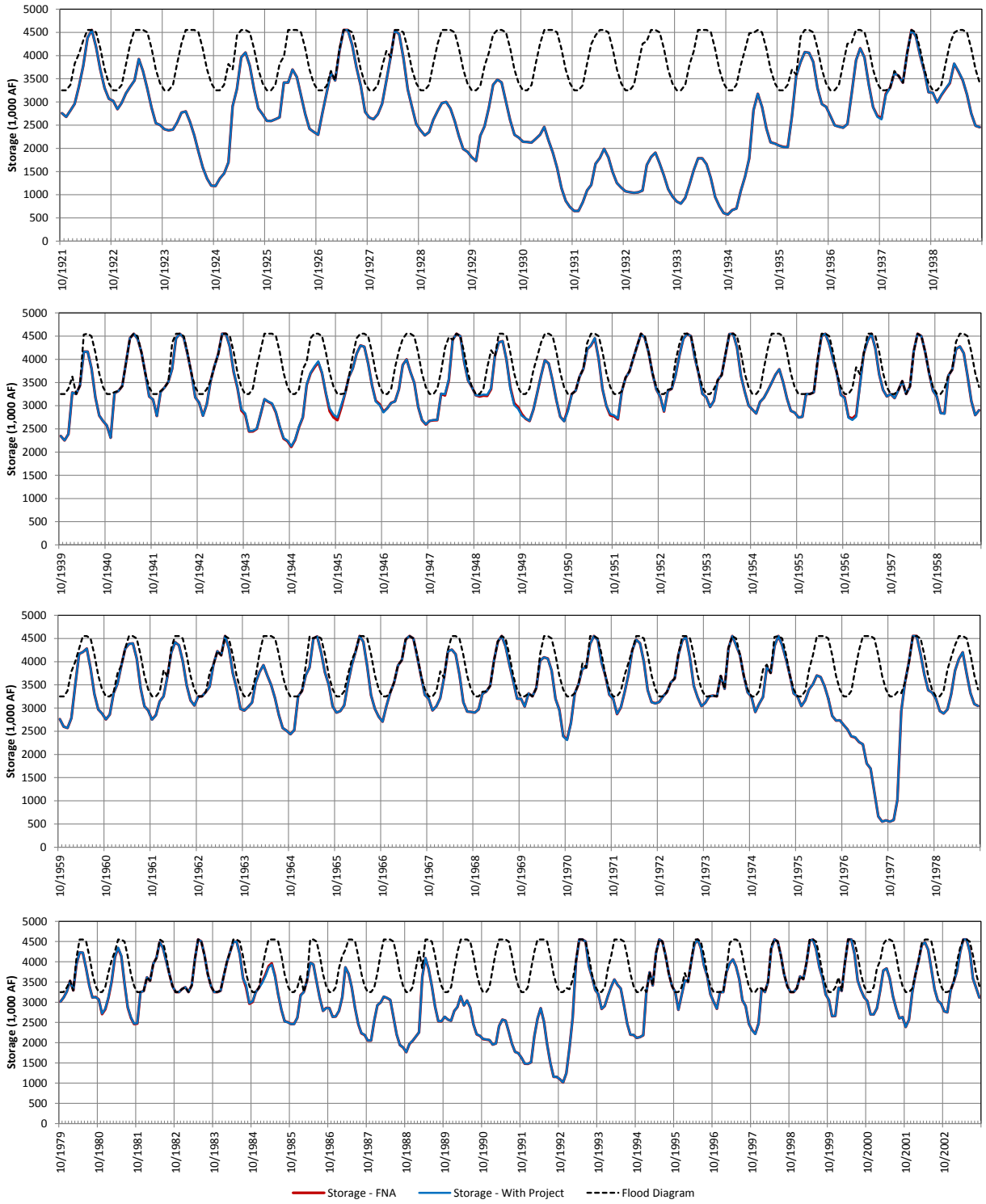


Figure 14: Comparison of Folsom Storage for San Luis Reservoir Expansion Alternative

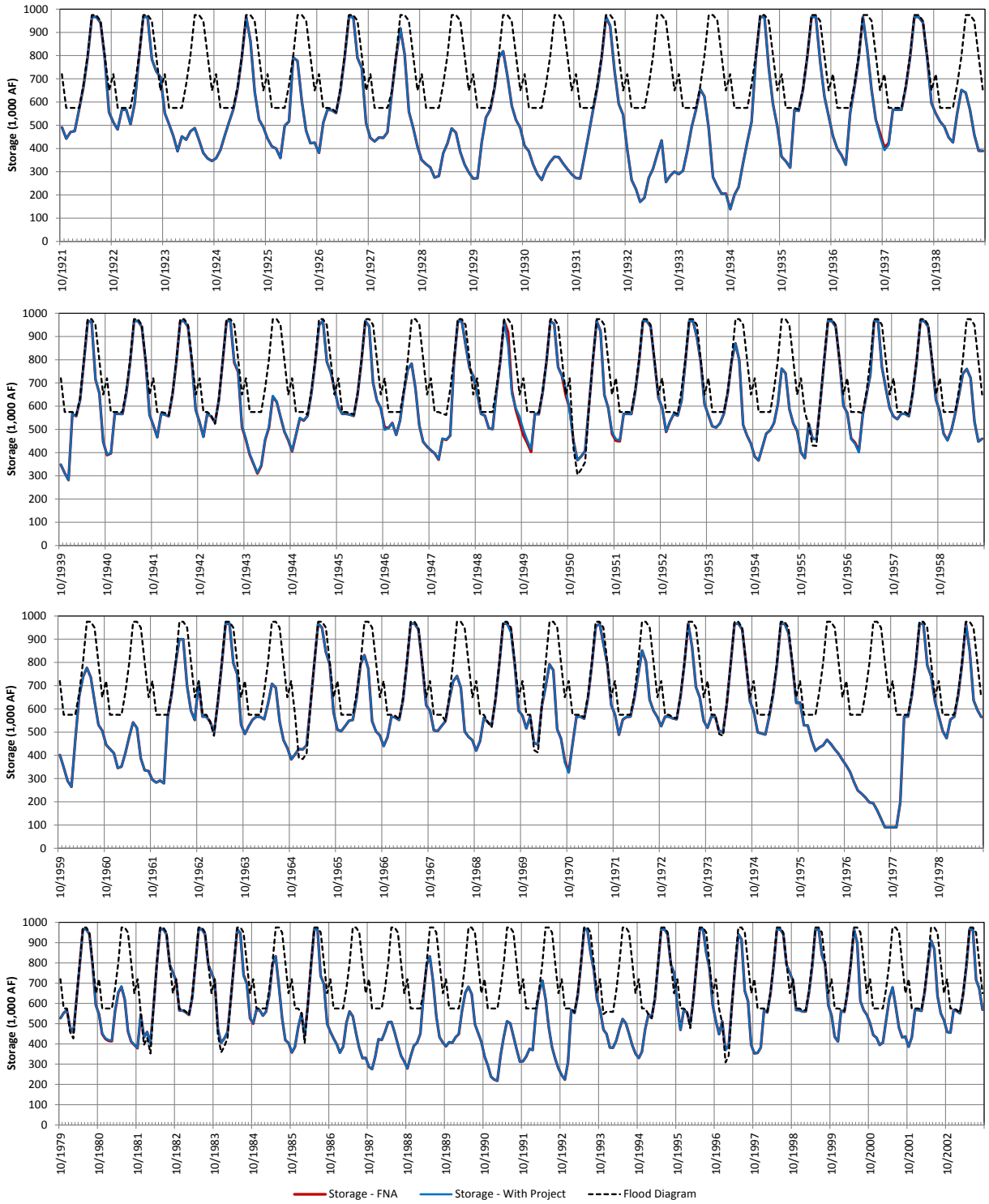


Figure 15: Comparison of Oroville Storage for San Luis Reservoir Expansion Alternative

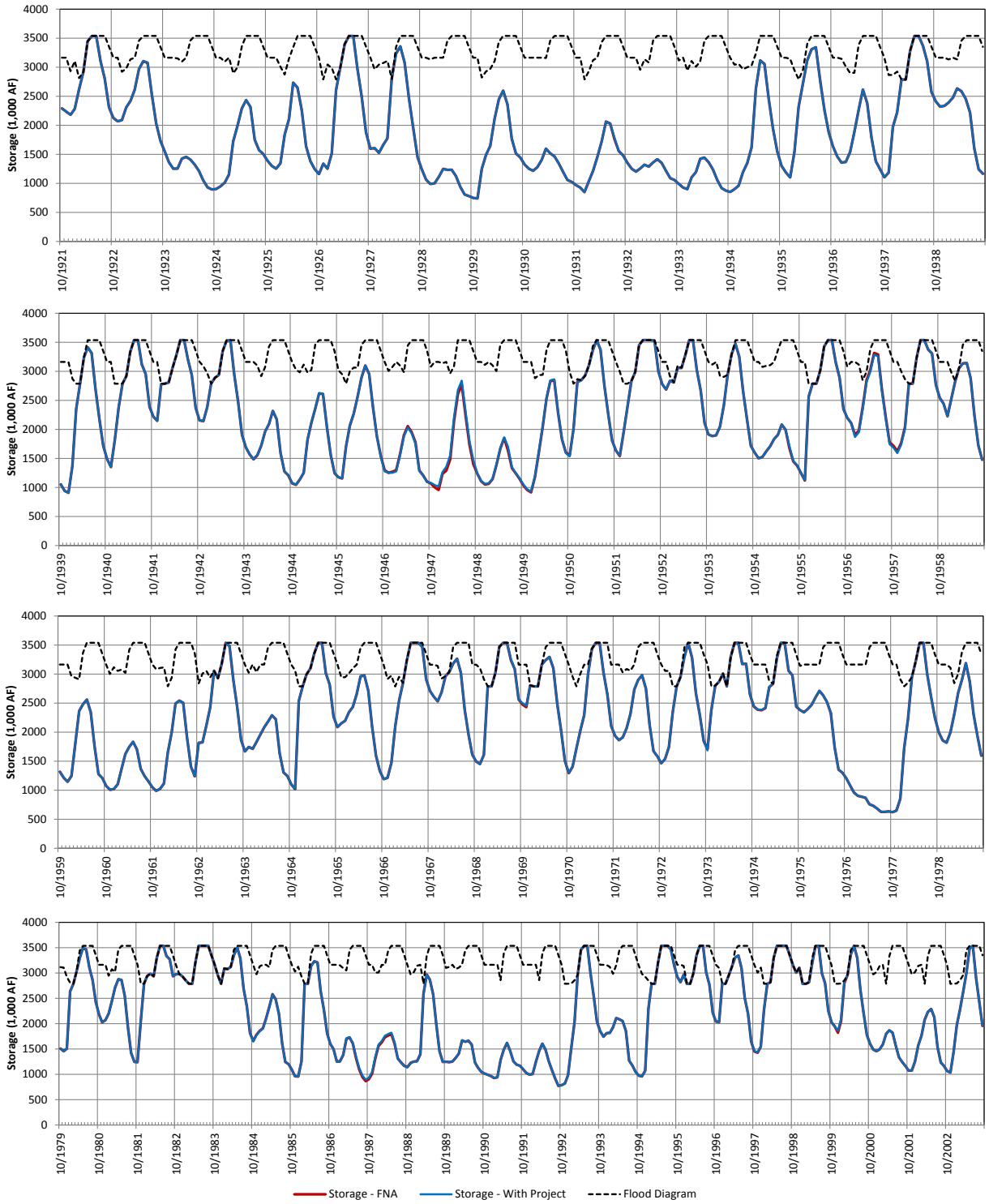


Figure 16: Comparison of Sacramento River below Keswick Flow for San Luis Reservoir Expansion Alternative

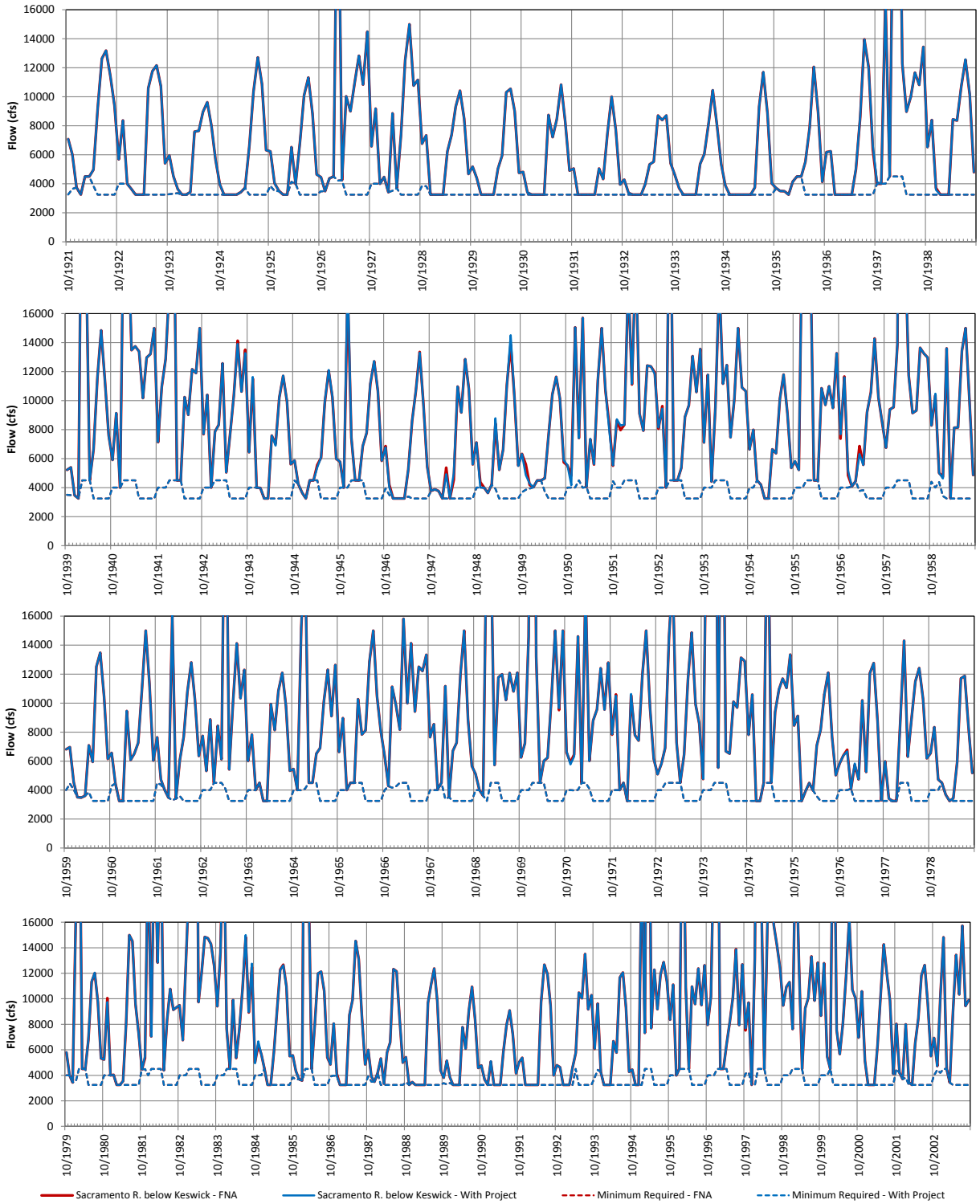


Figure 17: Comparison of Sacramento River at Wilkins Slough Flow for San Luis Reservoir Expansion Alternative

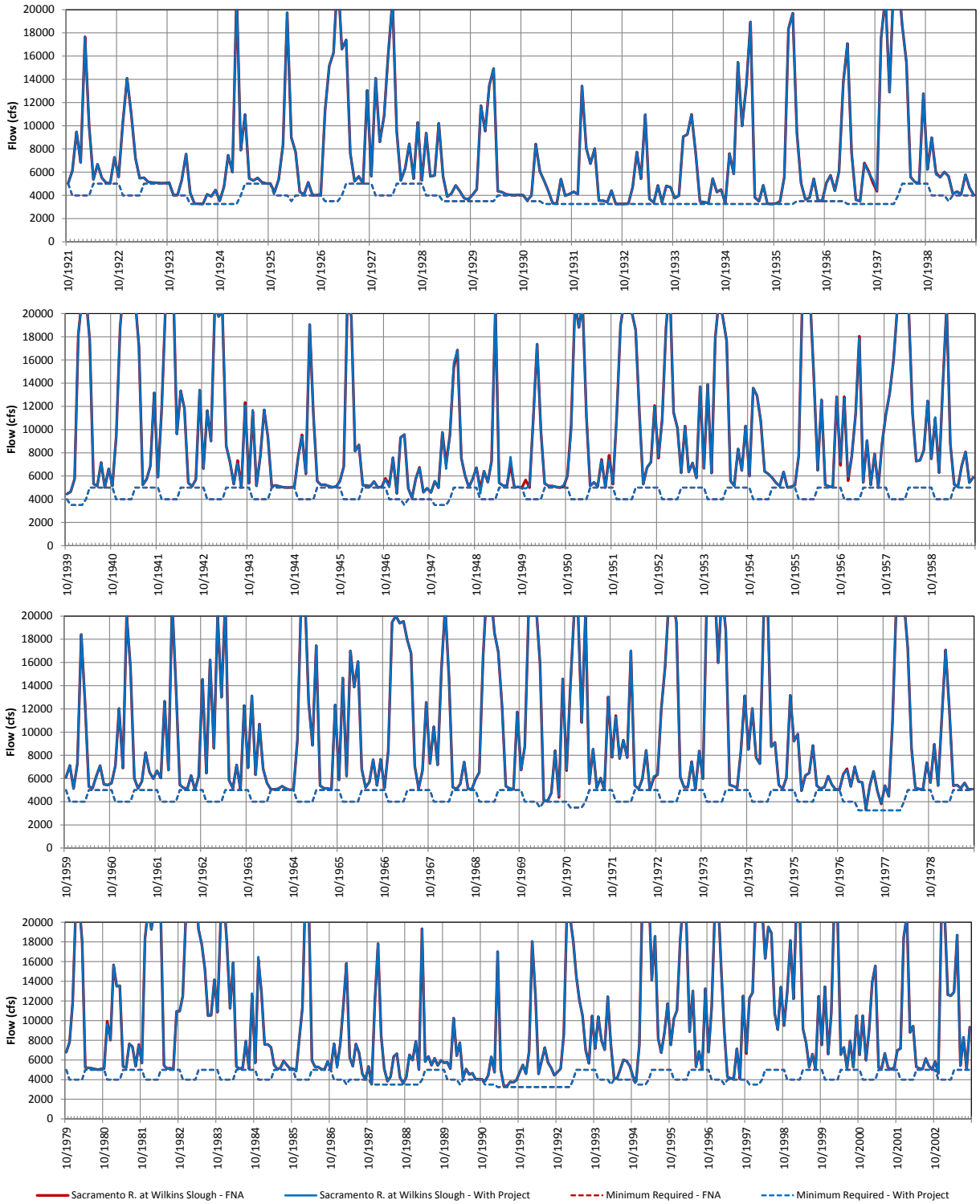


Figure 18: Comparison of American River below Nimbus Flow for San Luis Reservoir Expansion Alternative

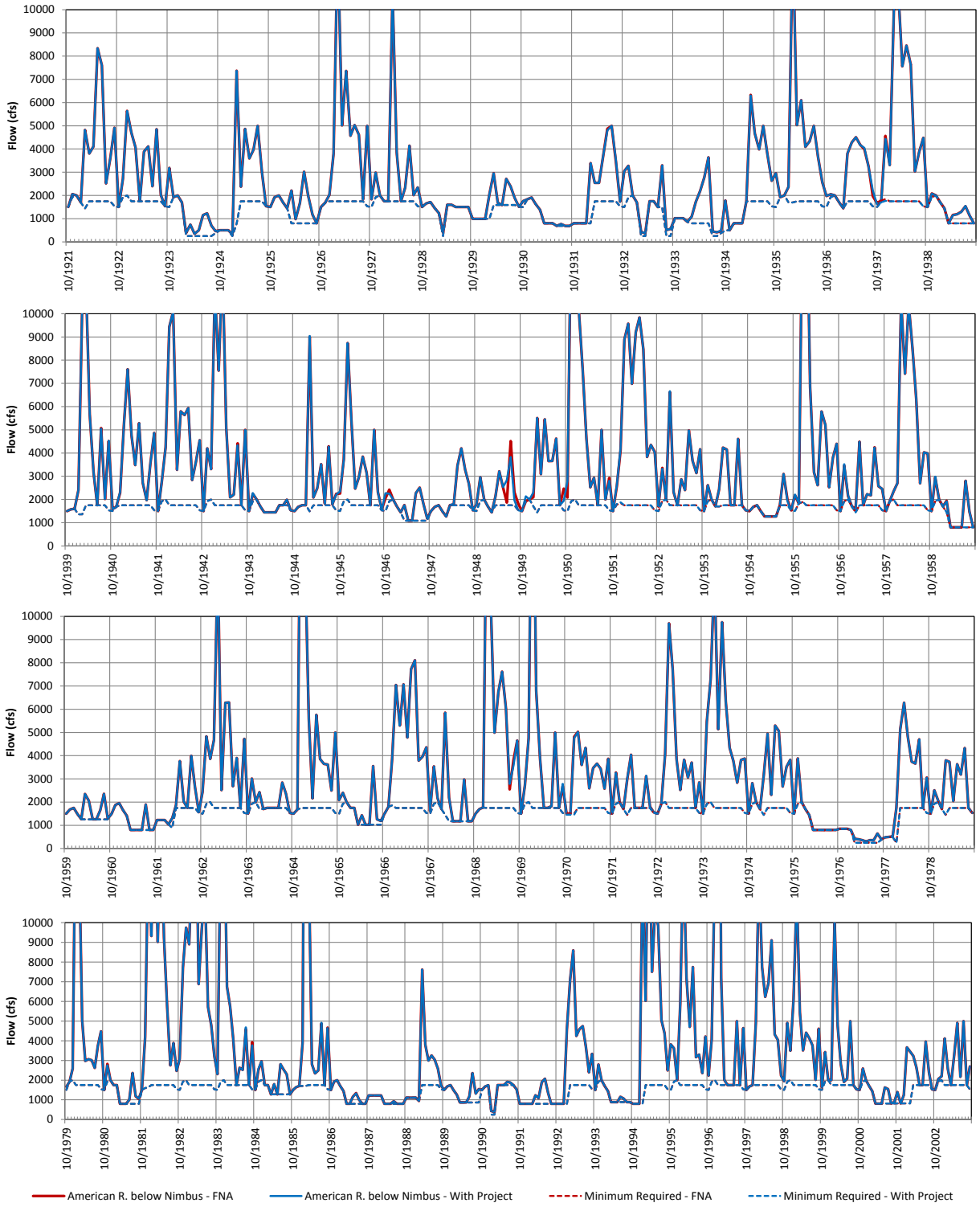


Figure 19: Comparison of Lower Feather River Flow for San Luis Reservoir Expansion Alternative

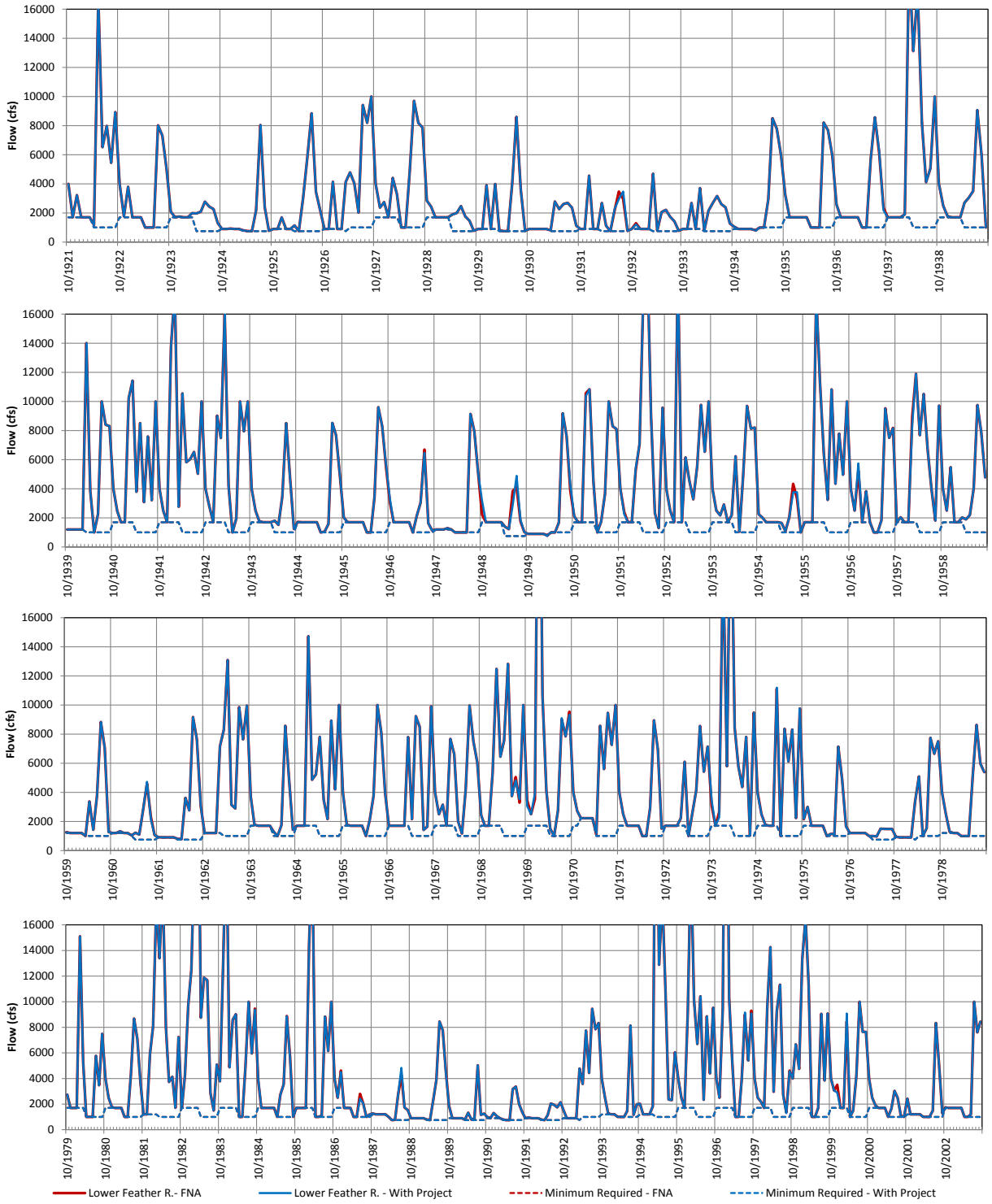


Figure 20: Comparison of Delta Inflow for San Luis Reservoir Expansion Alternative

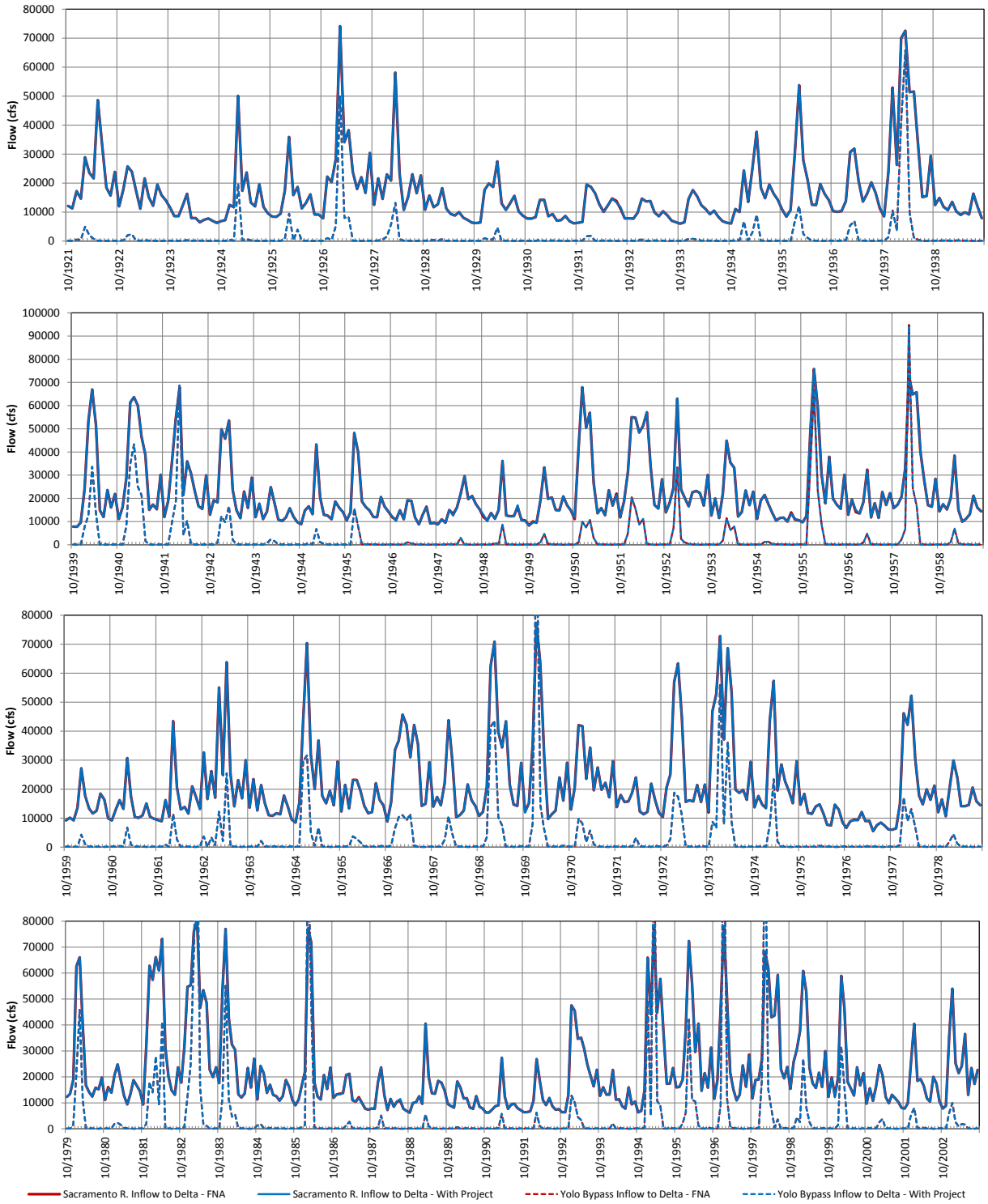


Figure 21: Comparison of Delta Outflow for San Luis Reservoir Expansion Alternative

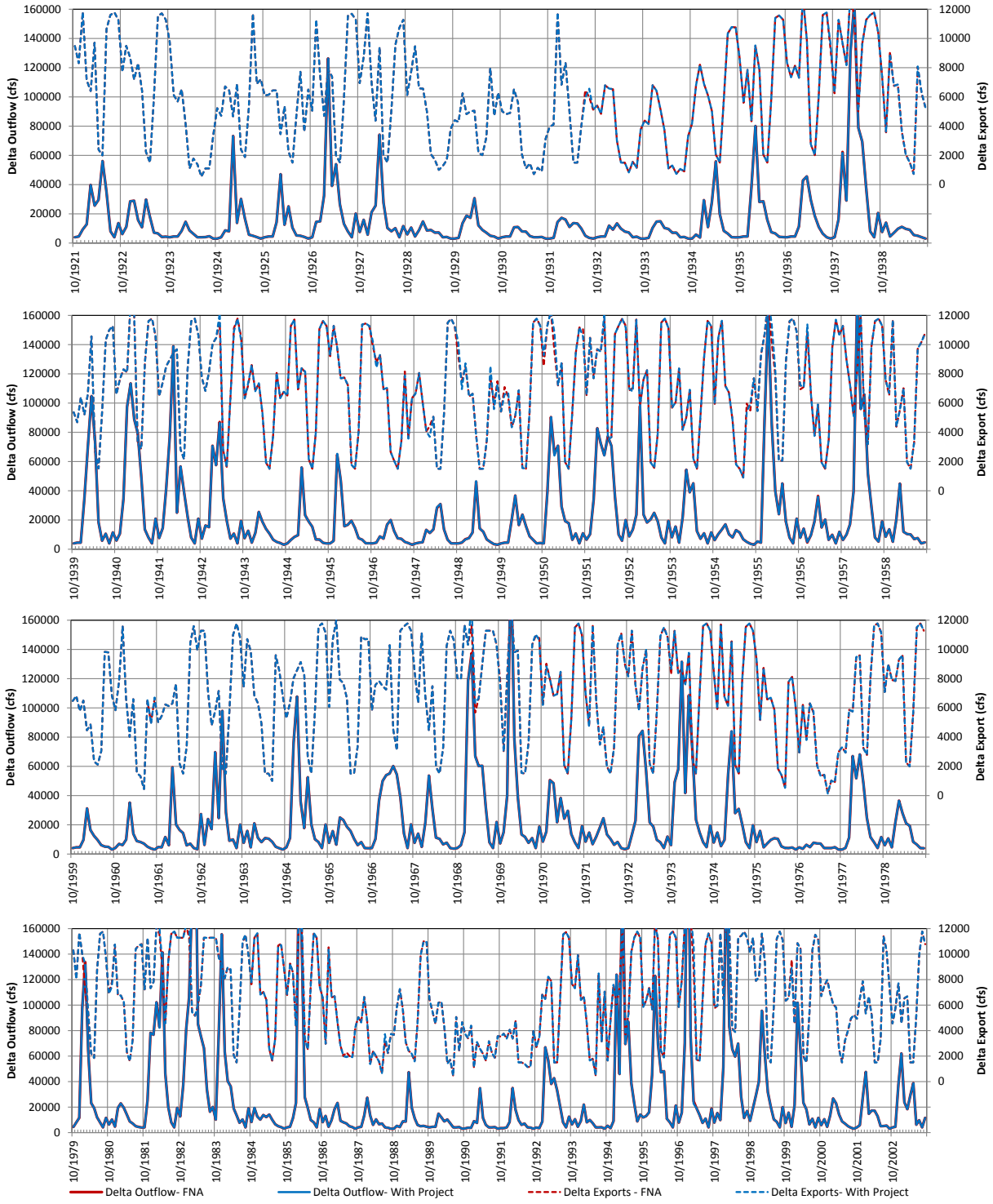


Figure 22: Comparison of San Luis Reservoir Storage for San Luis Reservoir Expansion Alternative

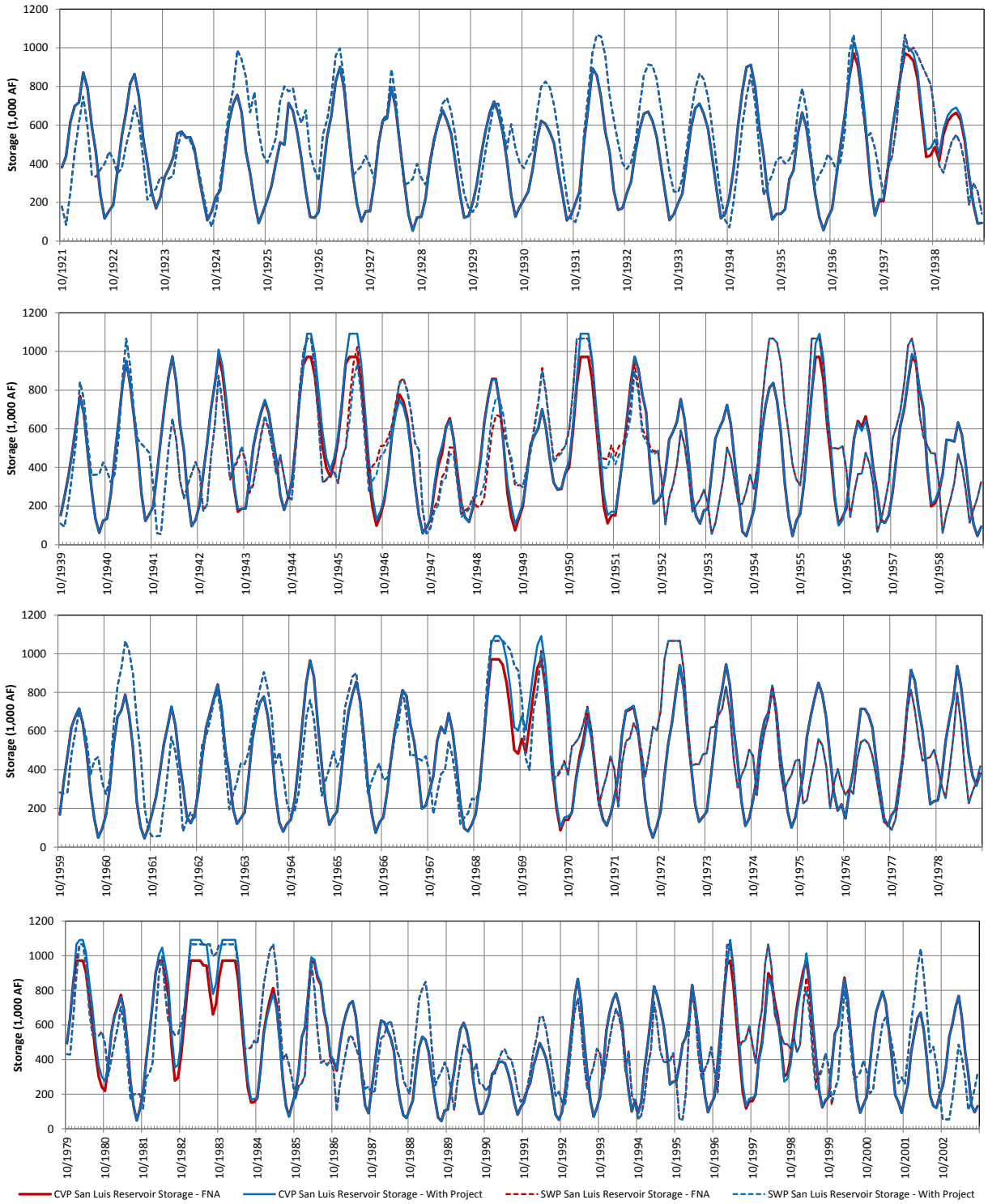


Figure 23: Comparison of Trinity Storage for Pacheco Reservoir Expansion Alternative

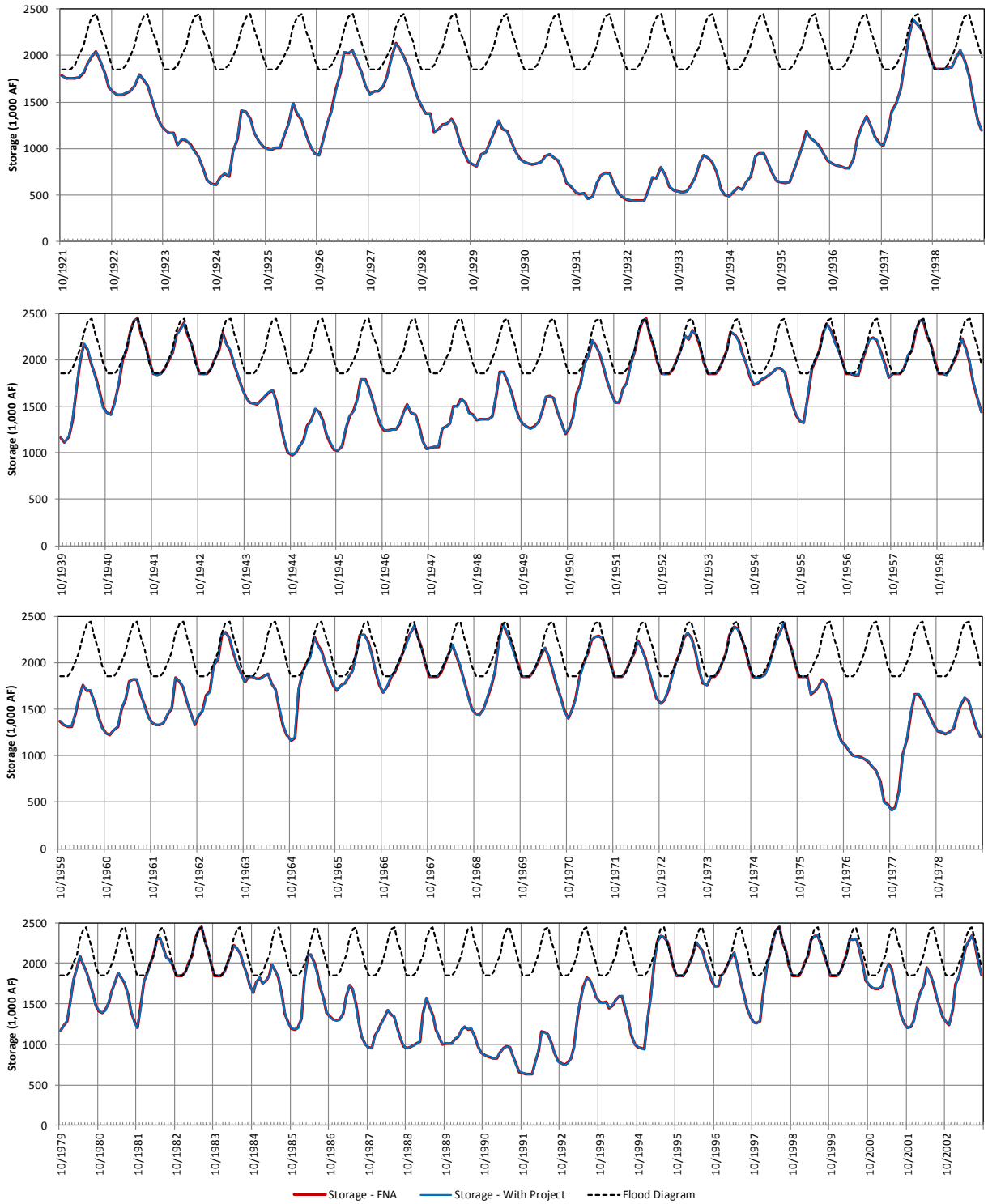


Figure 24: Comparison of Shasta Storage for Pacheco Reservoir Expansion Alternative

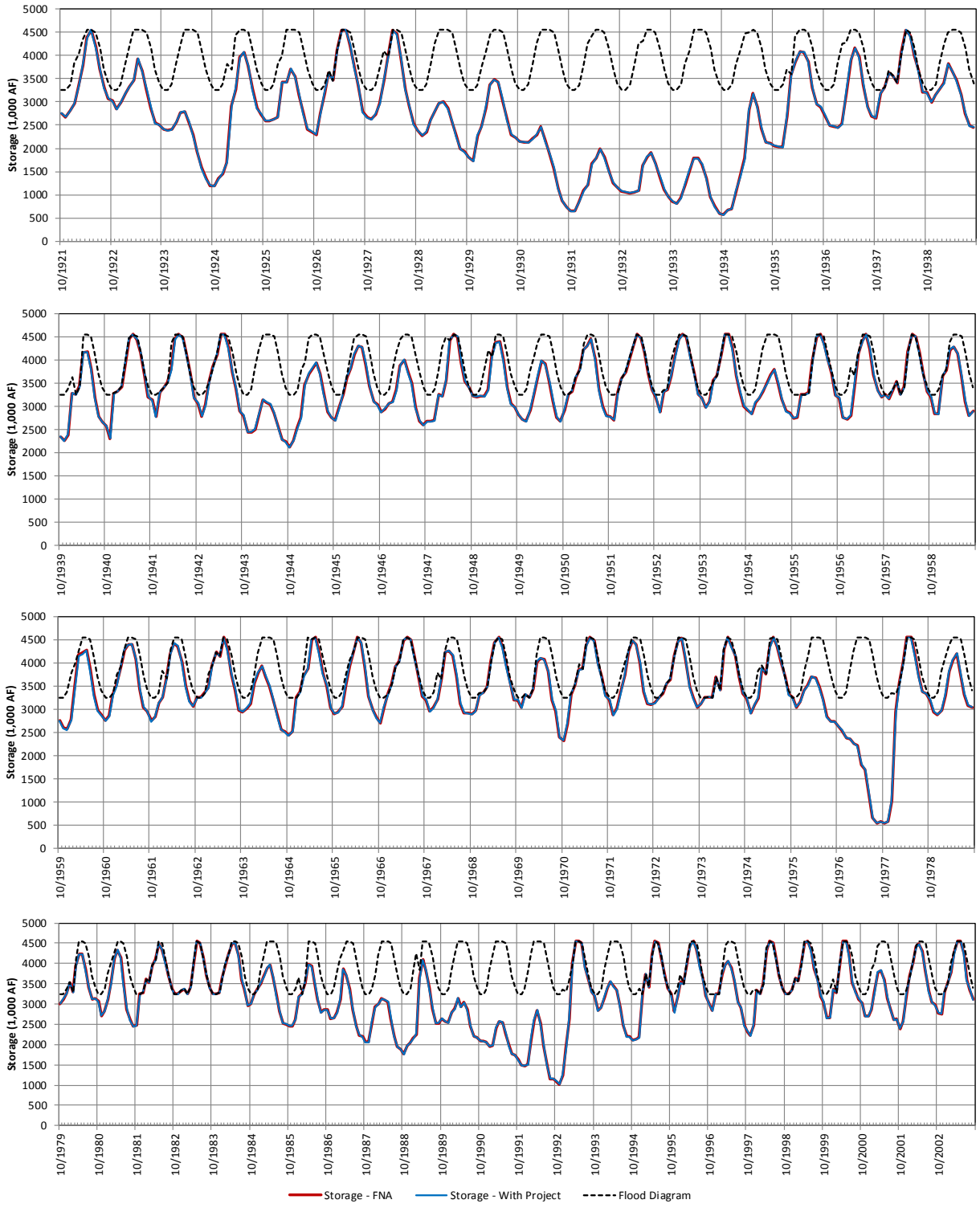


Figure 25: Comparison of Folsom Storage for Pacheco Reservoir Expansion Alternative

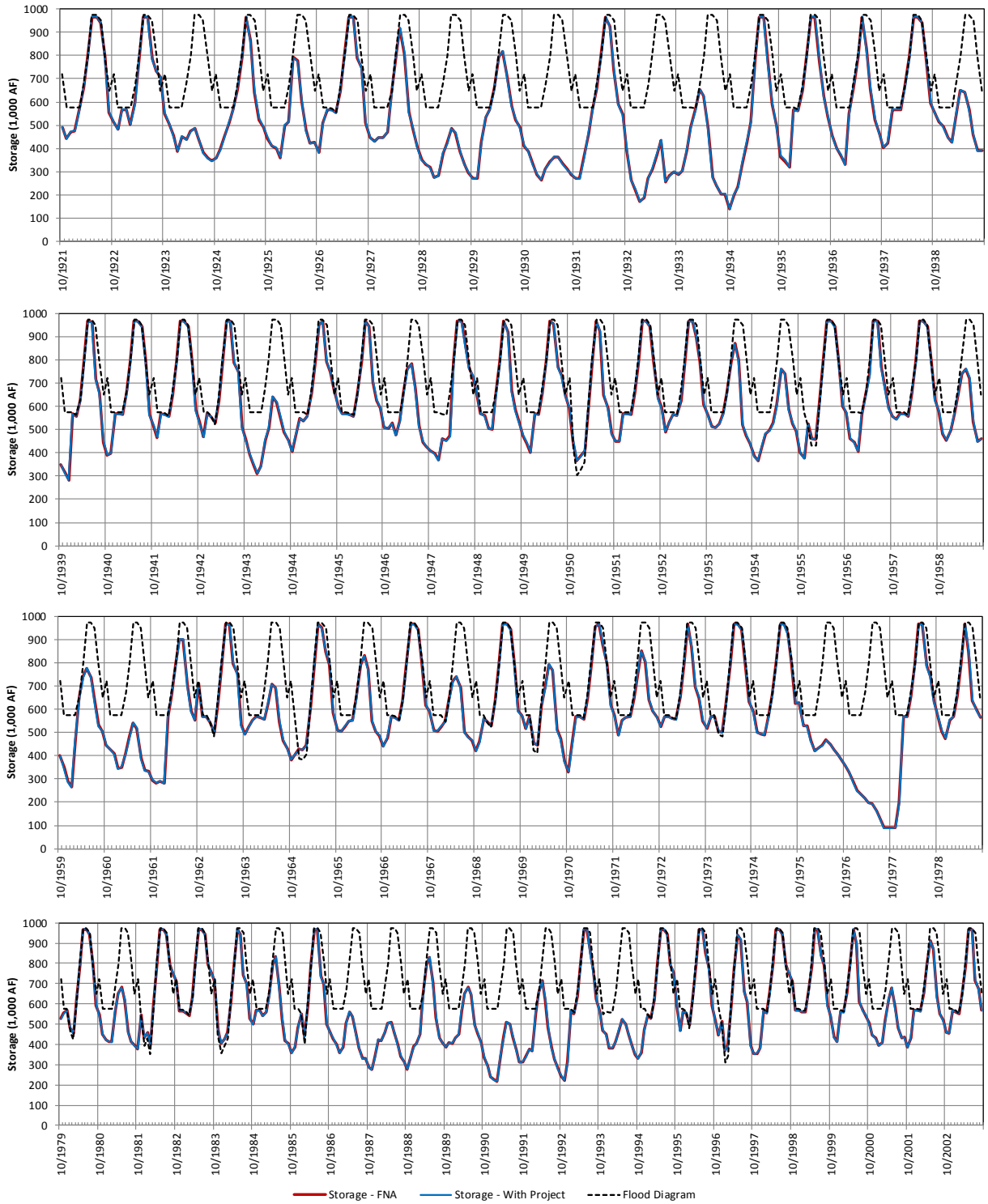


Figure 26: Comparison of Oroville Storage for Pacheco Reservoir Expansion Alternative

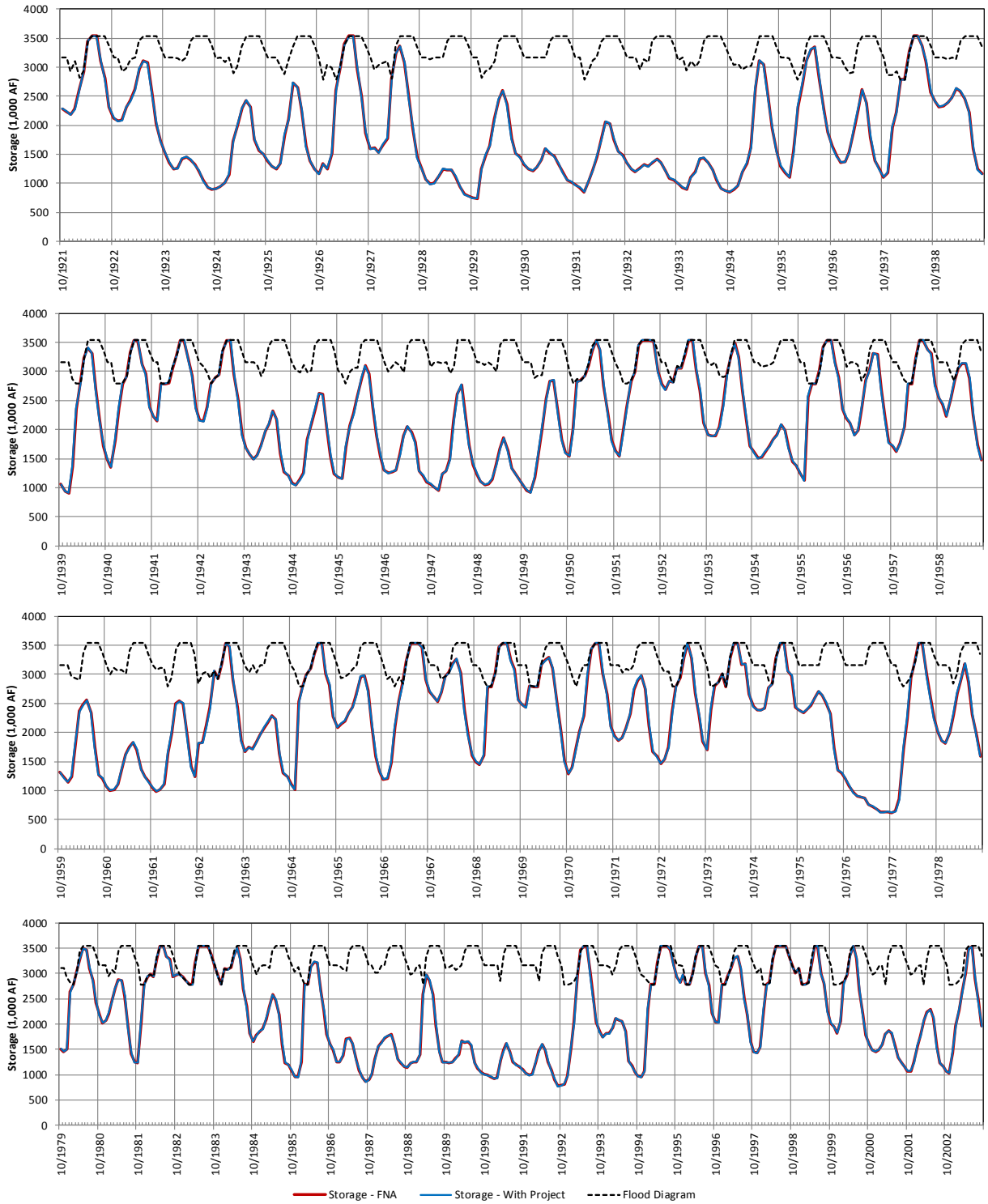


Figure 27: Comparison of Sacramento River below Keswick Flow for Pacheco Reservoir Expansion Alternative

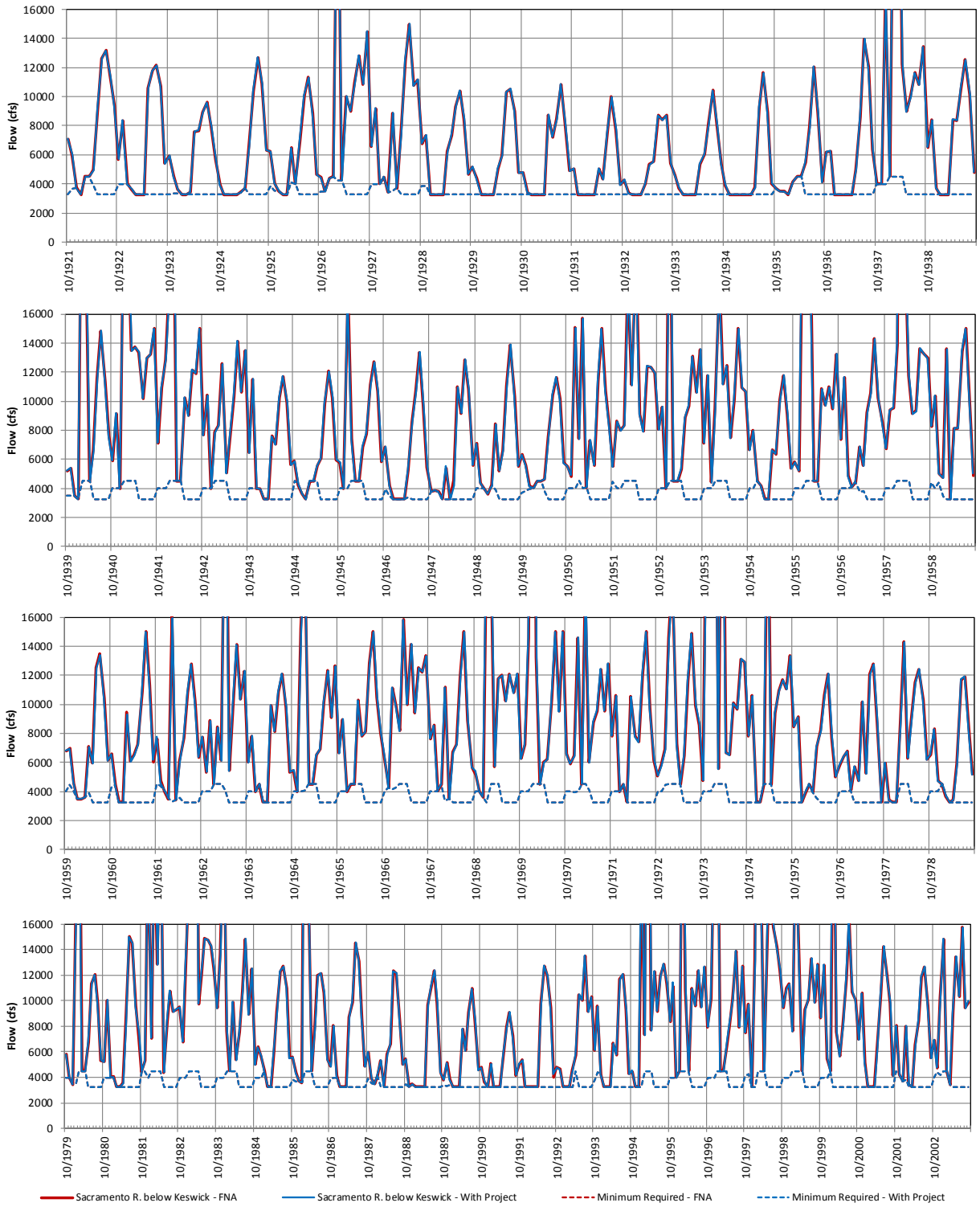


Figure 28: Comparison of Sacramento River at Wilkins Slough Flow for Pacheco Reservoir Expansion Alternative

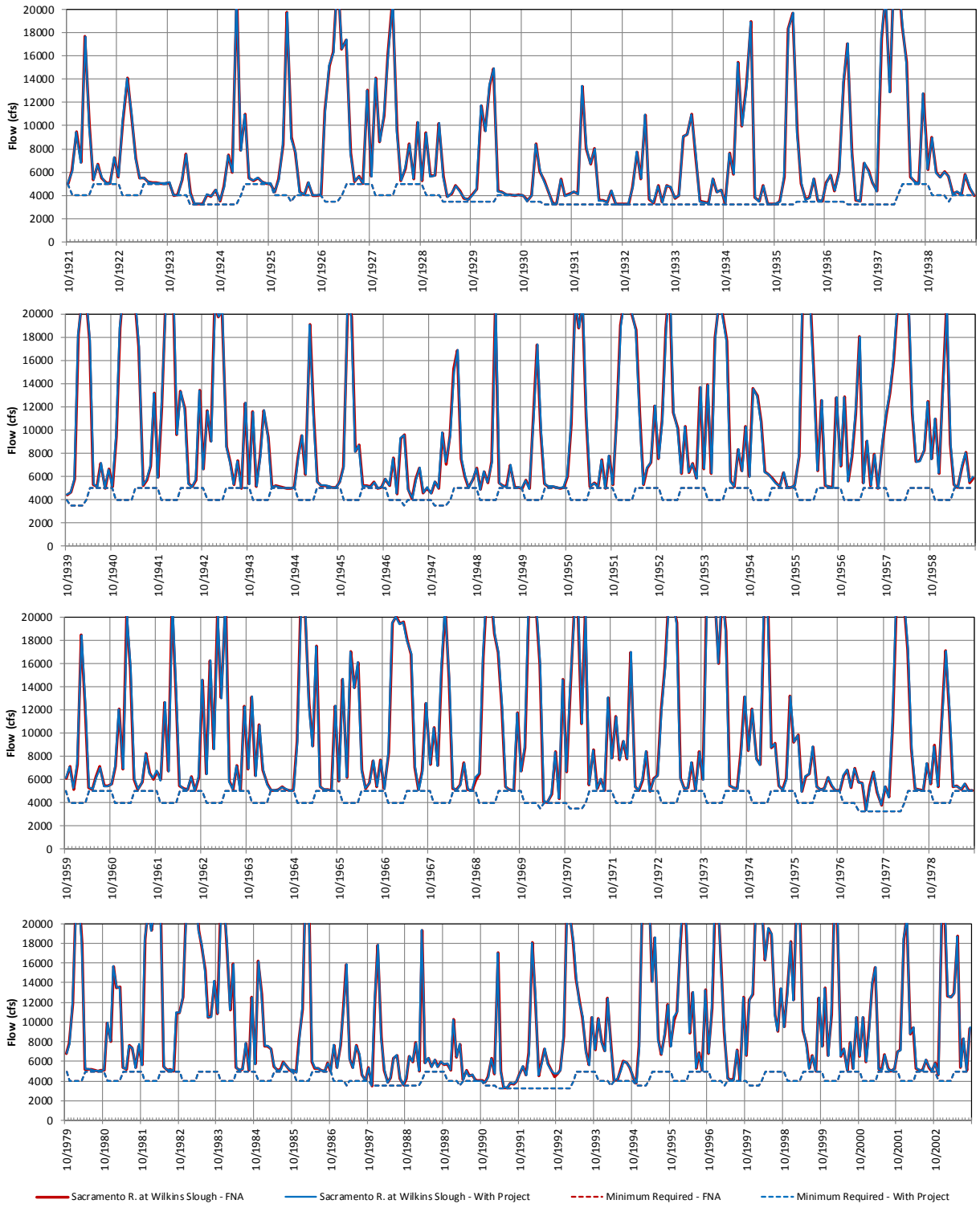


Figure 29: Comparison of American River below Nimbus Flow for Pacheco Reservoir Expansion Alternative

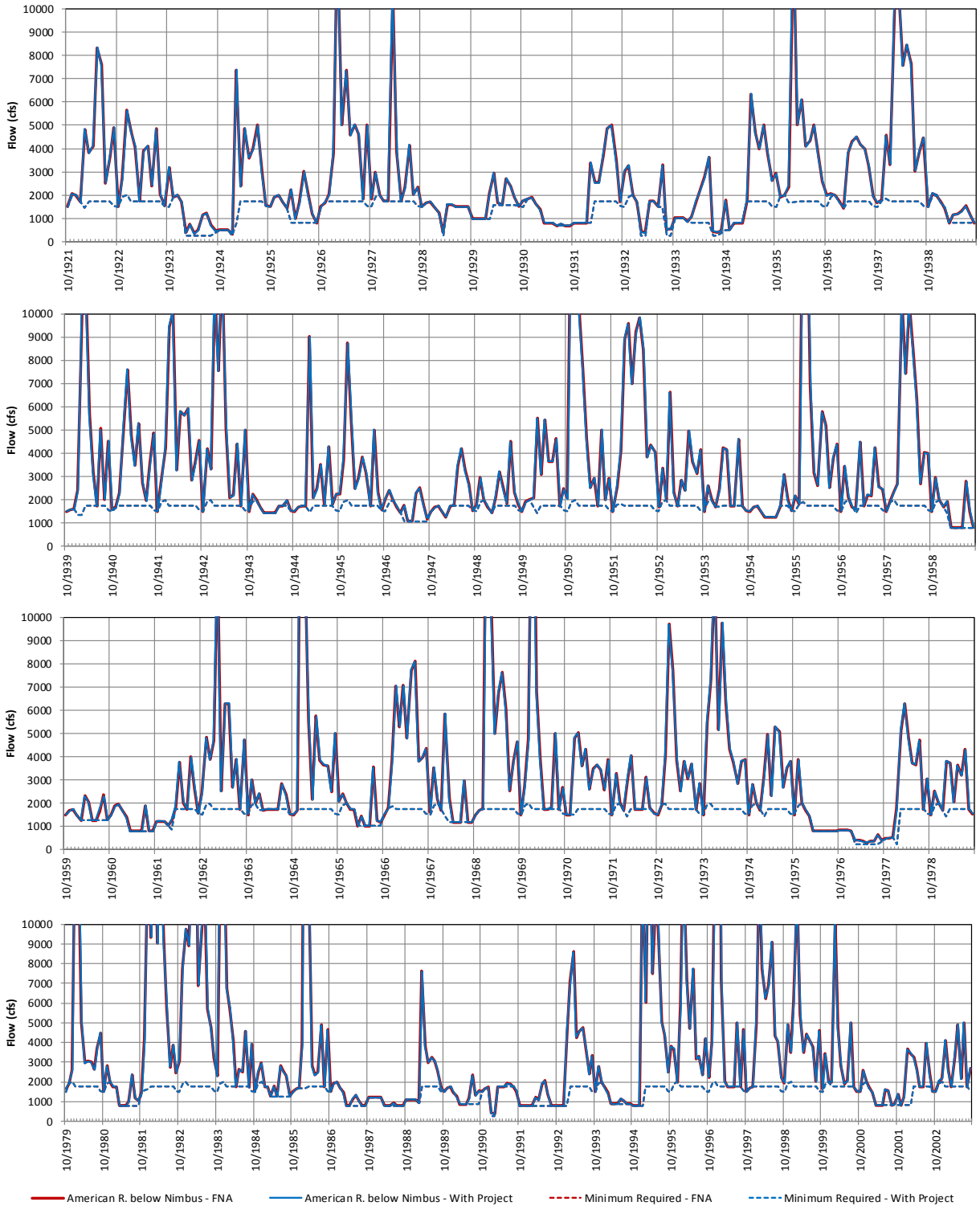


Figure 30: Comparison of Lower Feather River Flow for Pacheco Reservoir Expansion Alternative

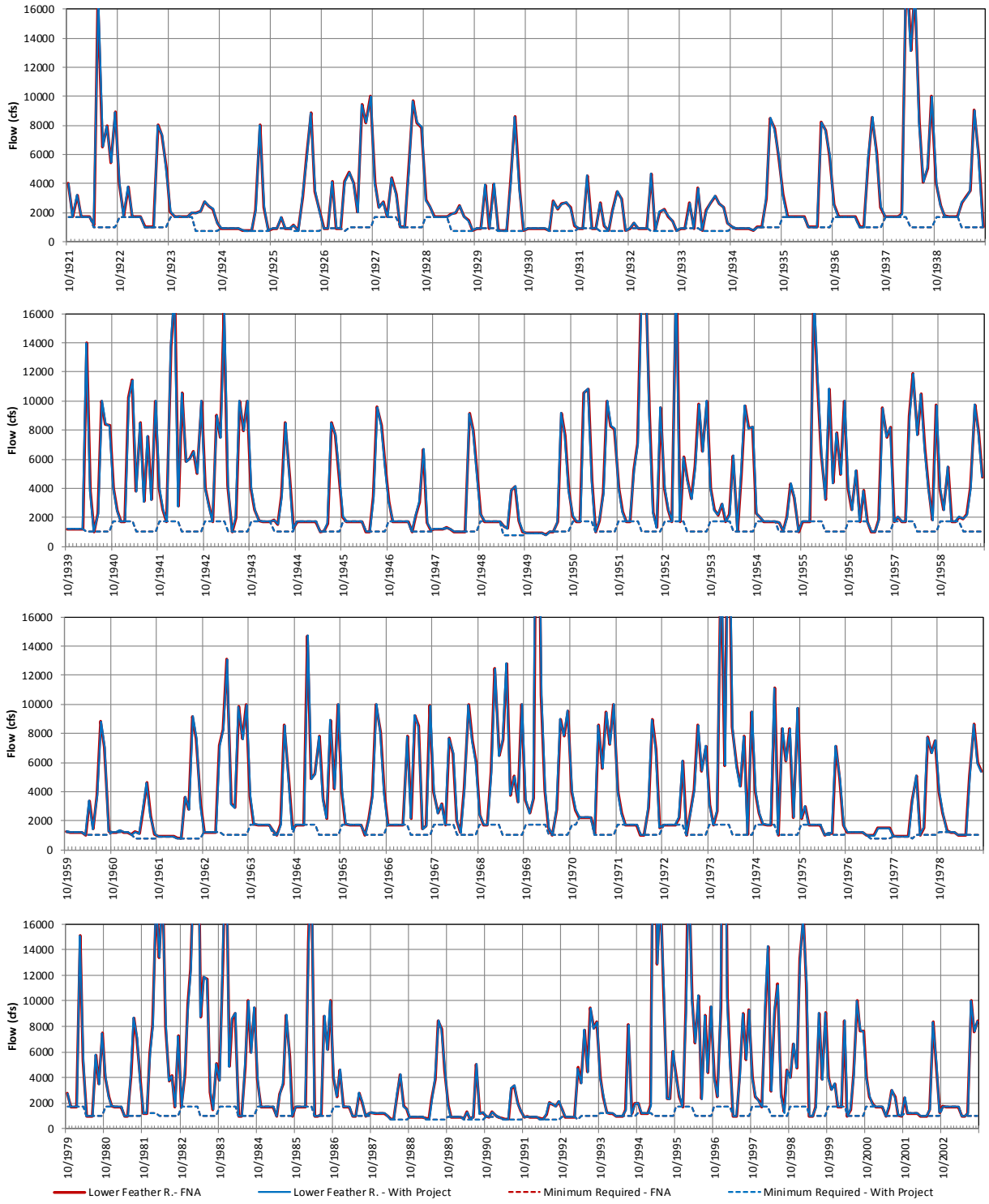


Figure 31: Comparison of Delta Inflow for Pacheco Reservoir Expansion Alternative

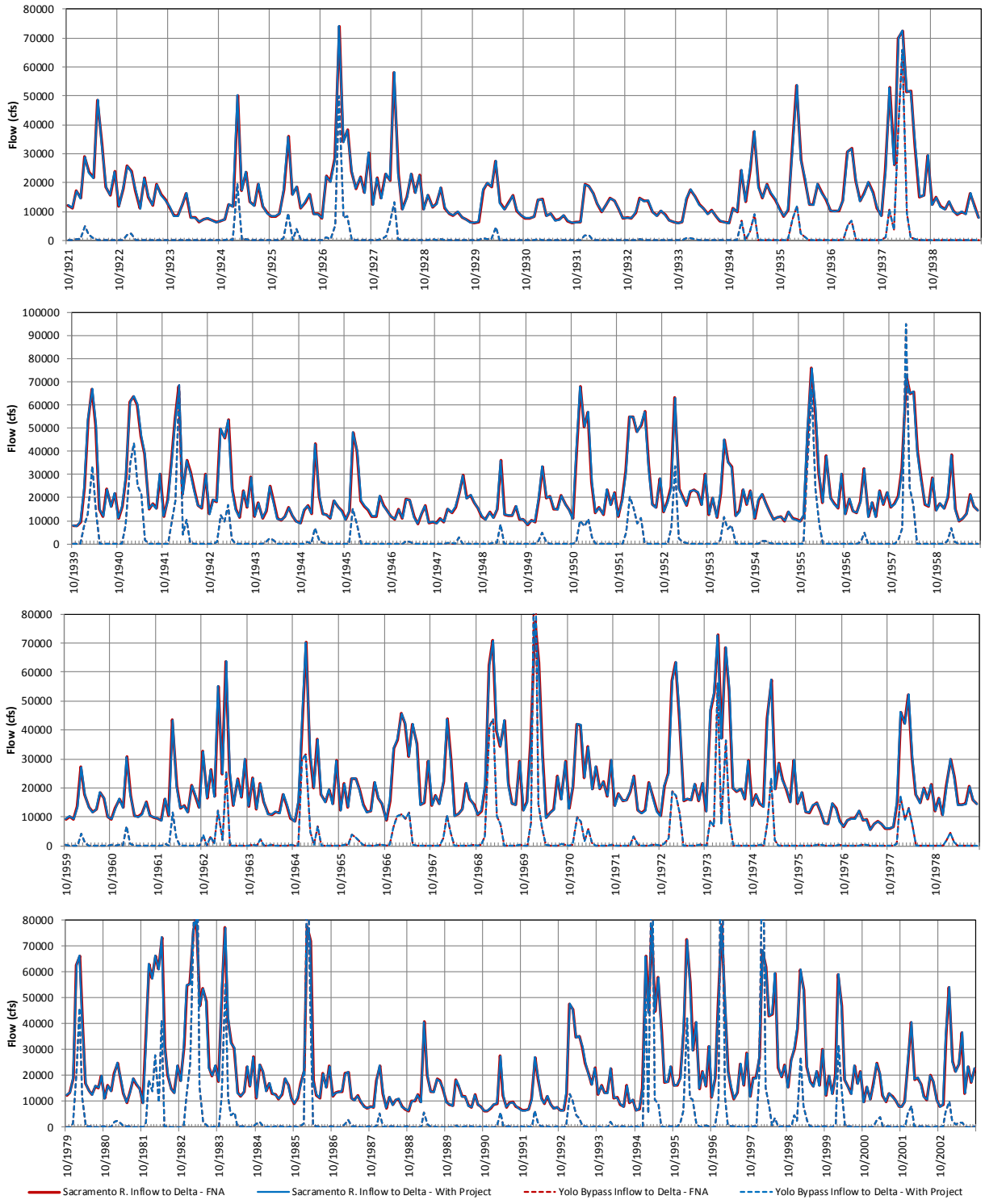


Figure 32: Comparison of Delta Outflow for Pacheco Reservoir Expansion Alternative

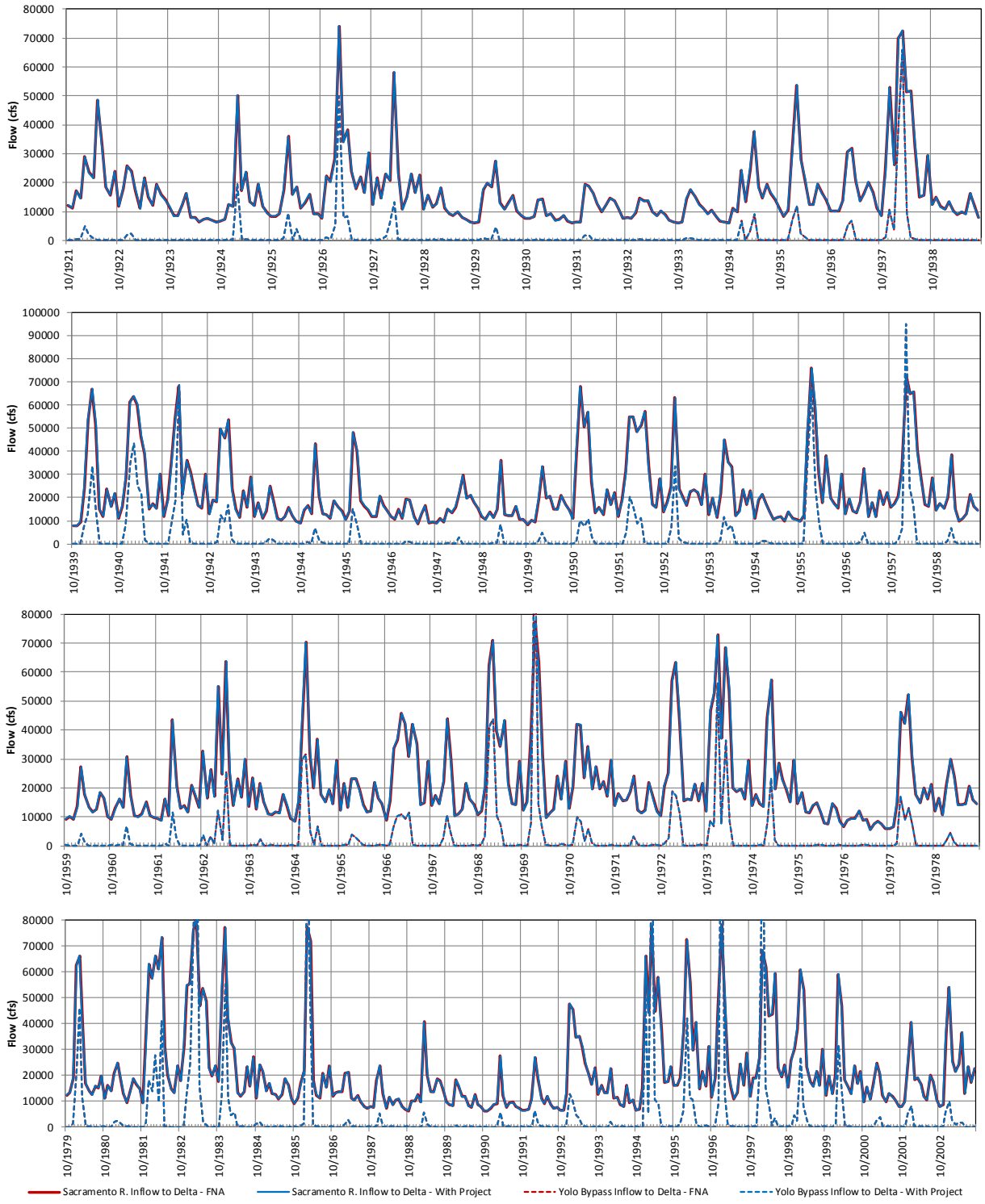
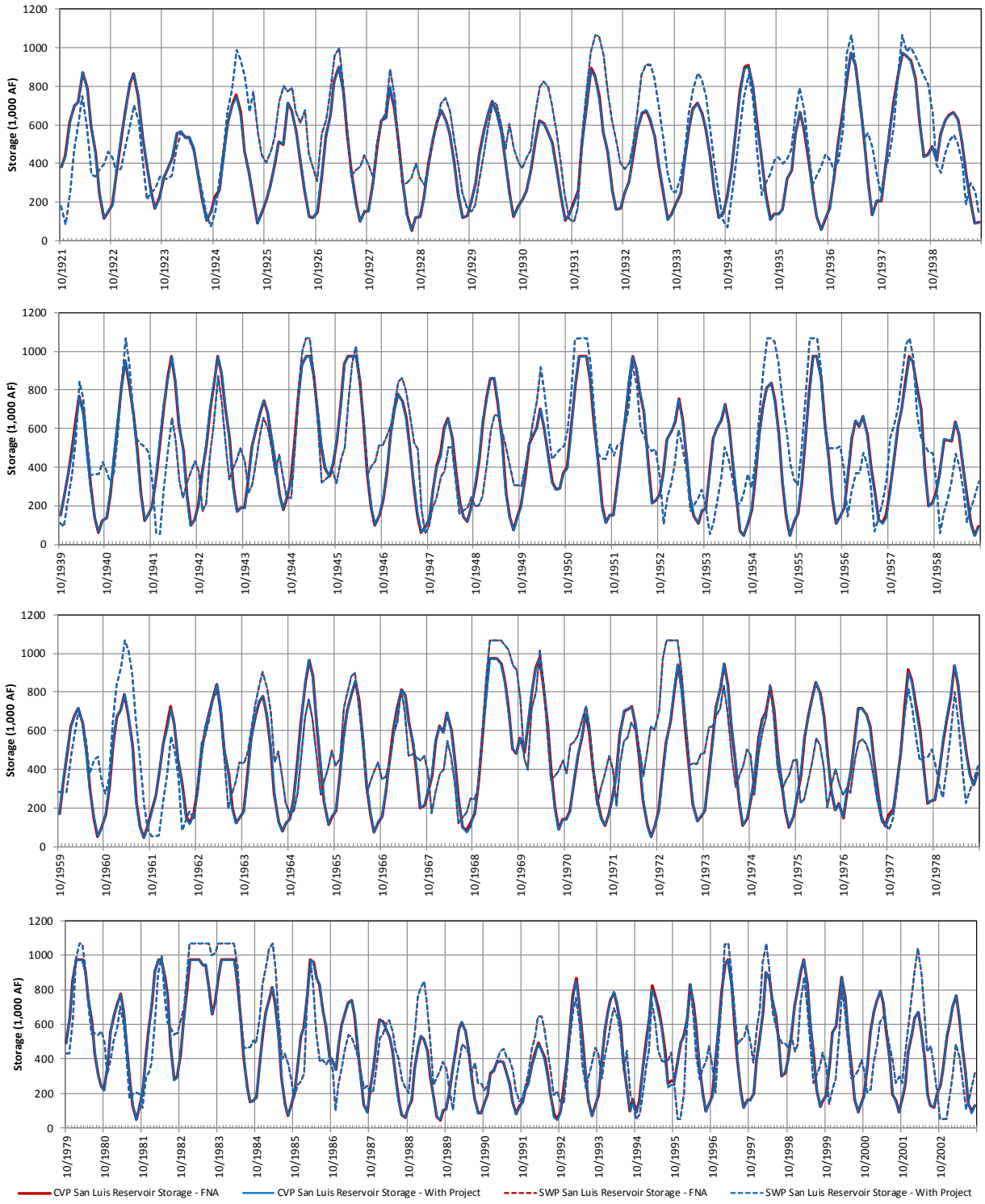


Figure 33: Comparison of San Luis Reservoir Storage for Pacheco Reservoir Expansion Alternative



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Attachment C
Improvements to CalSim San Luis Operations Technical Memorandum

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MBK ENGINEERS

Water Resources ◆ Flood Control ◆ Water Rights

TECHNICAL MEMORANDUM

DATE: July 16, 2015

SUBJECT: Improvements to CalSim San Luis Operations

PREPARED BY: Dan Easton

REVIEWED BY: Walter Bourez and Jennifer Wilson

MBK Engineers was tasked with improving San Luis operations in CalSim. At the December 2014 scoping meeting with CalSim modelers and Central Valley Project (CVP) and State Water Project (SWP) operators, issues with CalSim San Luis operations were outlined, and it was decided that there was not sufficient budget to resolve all issues under this task order. As such, the three key items listed below were selected for MBK to address and determine whether significant improvements could be made.

1. Reduce frequency of drawing San Luis to dead pool and shorting South-of-Delta (SOD) contract deliveries by improving the export forecasts used in SWP and CVP allocations.
2. Reduce excessive carryover in CVP San Luis during the critical period (particularly the 1930's) through reasonable increases in service contractor allocations.
3. Refine rulecurve formulations used to balance storage between North-of-Delta (NOD) project reservoirs and San Luis Reservoir.

While the problems outlined at the meeting have been present in CalSim for years, MBK used Reclamation's latest CalSim baseline generated on January 27, 2015 as a starting point. For the rest of this document, this baseline will be referred to as CalSim_27JAN2015, and the model edited to address the above three issues will be referred to as CalSim_27JAN2015_Revised. Any reference to CalSim in general includes CalSim_27JAN2015 and preceding versions.

REFINEMENT OF CVP AND SWP EXPORT FORECASTS USED IN CALSIM ALLOCATION LOGIC TO REDUCE SOD CONTRACT DELIVERY SHORTAGES

Since implementation of the smelt and salmon biological opinions, CalSim tended to over-allocate water to SOD CVP and SWP contractors in many years of the simulation. Although this does not occur in every year, it happens enough to skew results in water supply planning analysis. Over-allocation can result in breaking San Luis (drawing San Luis down to dead pool) and shorting project contractors. Figure 1 and Figure 2 relate annual SOD contractor shortages and San Luis low point for both the CVP and SWP, respectively, as simulated by CalSim_27JAN2015. CVP San Luis storage is drawn to dead pool (dashed line) in 15 years of the 82-year simulation; SWP San Luis storage is drawn to dead pool in 21 years of the simulation. Annual shortages to CVP contractors range as

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high as 100 thousand acre-feet (TAF). Running debt to SWP contractors reaches higher than 400 TAF in year 1995 of the simulation and greater than 100 TAF in several other years.

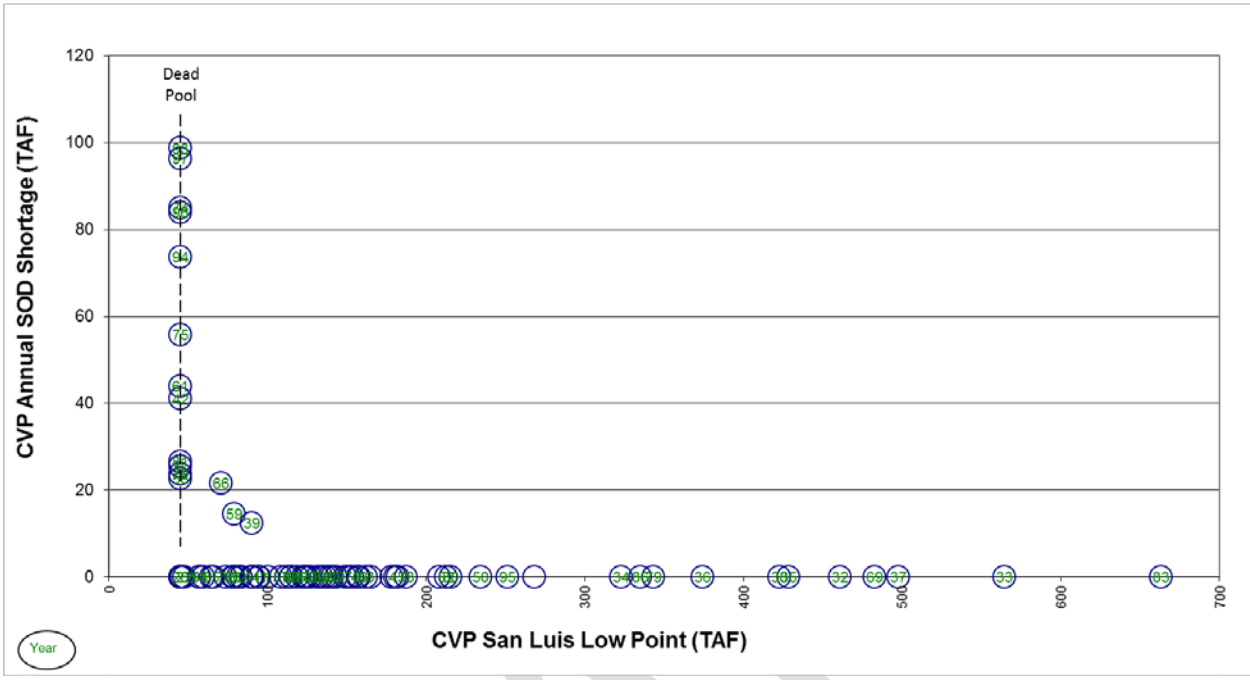


Figure 1. CVP annual SOD shortage versus CVP San Luis storage low point as simulated in CalSim_27JAN2015

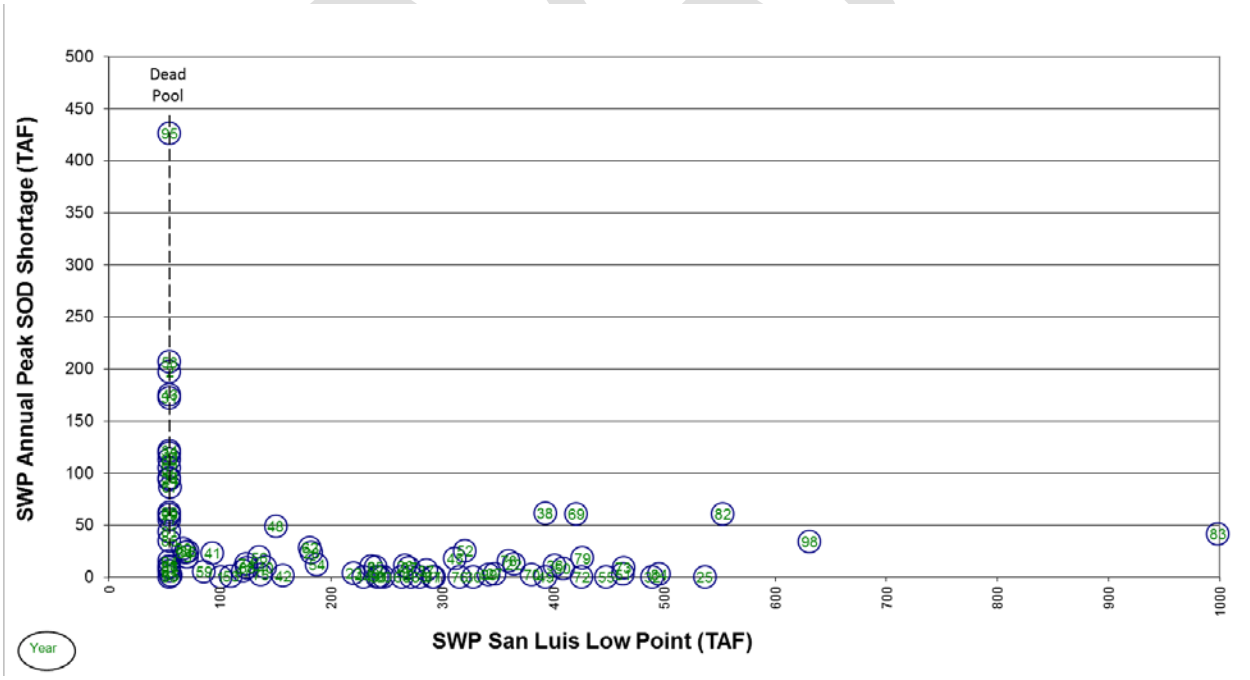


Figure 2. SWP annual maximum SOD shortage versus SWP San Luis storage low point as simulated in CalSim_27JAN2015

Over-allocation in CalSim can be traced back to the model methodology used for both the SWP Table A allocations and CVP SOD Agriculture (Ag) and Municipal and Industrial (M&I) allocations.

The CalSim allocation methodology (used for both the CVP and SWP) combines the Water Supply Index – Delivery Index (WSI-DI)–based allocation with an export forecast–based allocation. The minimum of the two is the final allocation for each project in each contract year. (Note that the CalSim model allocation methodology bears minimal resemblance to the methodology used in real-time allocations.)

The WSI-DI–based allocation assesses aggregate supply (forecasted inflow plus storage), but it does not adequately address limitations of available export capacity necessary to move the NOD supply to SOD contractors. Conversely, the export forecast–based allocation is intended to address export capacity limitations, but the current implementation has limited accuracy. Also, the export forecast–based allocation does not consider demand for export capacity. In other words, the export estimate does not consider whether or not the projects would release stored water from upstream reservoirs to make use of the available export capacity. If NOD storage is low, the projects will not want to release stored water to support exports. This should be explicitly incorporated into the allocation decisions, and it currently is not in CalSim.

The purpose of combining the WSI-DI allocation with an export forecast–based allocation was to have each allocation method cover the weaknesses of the other. However, as seen in current CalSim results (Figure 1 and Figure 2), this has not been accomplished. Ideally, the allocation methodology used in CalSim should better reflect real-time operations methodologies where consideration of supply, demand, conveyance capacity, and carryover in upstream reservoirs are physically integrated. This has been attempted by the Department of Water Resources (DWR) in the form of its Forecast Allocation Model (FAM), but it is beyond the scope of this contract.

The objective is to improve allocation decisions with the current methodology thereby preventing drawing San Luis to dead pool and shorting contractors. The most appropriate improvement is to create a more accurate export forecast—one that takes into account both the availability of and the demand for export capacity. However, before potential improvements are discussed, it is important to examine the CVP and SWP export forecast currently used in CalSim.

During the CVP allocation season (March–May), the current version of CalSim has only two possible export forecasts: one when it is a wet year as classified by the San Joaquin River (SJR) 60-20-20 index; and another when it is critical, dry, below normal, or above normal year classification. Table 1 shows the export estimates for each month from March to August. The export forecast–based allocation sums the export estimates from the current month through August.

In Table 1, only April, May, and June are conditioned on the SJR 60-20-20 index because those are the months where exports are most likely controlled by either the SJR inflow-export (IE) ratio or Old and Middle River (OMR) flow requirements. The sum total of the export estimates from April to June in a wet year is 516 TAF (2,000 cubic feet per second [cfs], 2,000 cfs, and 4,600 cfs); in a non-wet year the sum total is 240 TAF (1,000 cfs, 1,000 cfs, and 2,000 cfs). Such a coarse export estimate does not adequately account for the variability in SJR hydrology or in the conditionality of the SJR IE ratio or OMR flow regulations. It also does not reflect the information that operators have at hand to refine their forecasts, which include current SJR flows at Vernalis, forecasted operations on the SJR and its tributaries, and ongoing discussions with the U.S. Fish and Wildlife Service (FWS) about fish take, trawl data and expected OMR flow requirements.

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Table 1. Monthly CVP export estimates found in the CalSim_27JAN2015 lookup table ExportEstimate_CVP

CalSim Baseline CVP Export Forecast for SOD Ag and M&I Allocation			
Month	Export Estimate (cfs)	Wet SJR Export Estimate (cfs)	Delivery Pattern Fraction
MAR	2500	0	0.68
APR	1000	2000	0.622
MAY	1000	2000	0.553
JUN	2000	4600	0
JUL	4600	0	0
AUG	4600	0	0

The July and August export estimates for the CVP are listed in Table 1 at 4,600 cfs, which is Jones Pumping Plant's full capacity. Obviously this will never be an underestimate of simulated Jones pumping in July and August, but it is often an overestimate. Even though 4,600 cfs capacity is available, the CVP does not always want to release water from upstream reservoirs to fill that capacity. CalSim overestimates exports in these months with the expectation that the WSI-DI–based allocation will prevent an over-allocation. The WSI-DI does serve as a backstop in many years, but there are many years when it does not limit the export estimate based on available supply.

Figure 3 compares annual CVP SOD delivery shortage with the error in the CVP export forecast used in the export forecast–based allocation. The CVP export forecast error is calculated as the April–August CVP export forecast minus the modeled total April–August CVP Jones Pumping Plant exports. As shown in Figure 3, the error is both negative and positive but skews positive. There are no shortages when the export forecast is an underestimate of exports (negative error). There are 15 years with shortages when the forecast is an overestimate. However, the shortages in three of those years — 1939, 1959, and 1966, the three lowest shortages not equal to zero — have nothing to do with over-allocation but a quirk in the SJR model formulation. The remaining 12 are all due to over-allocation, both from the WSI-DI–based approach and the export forecast approach.

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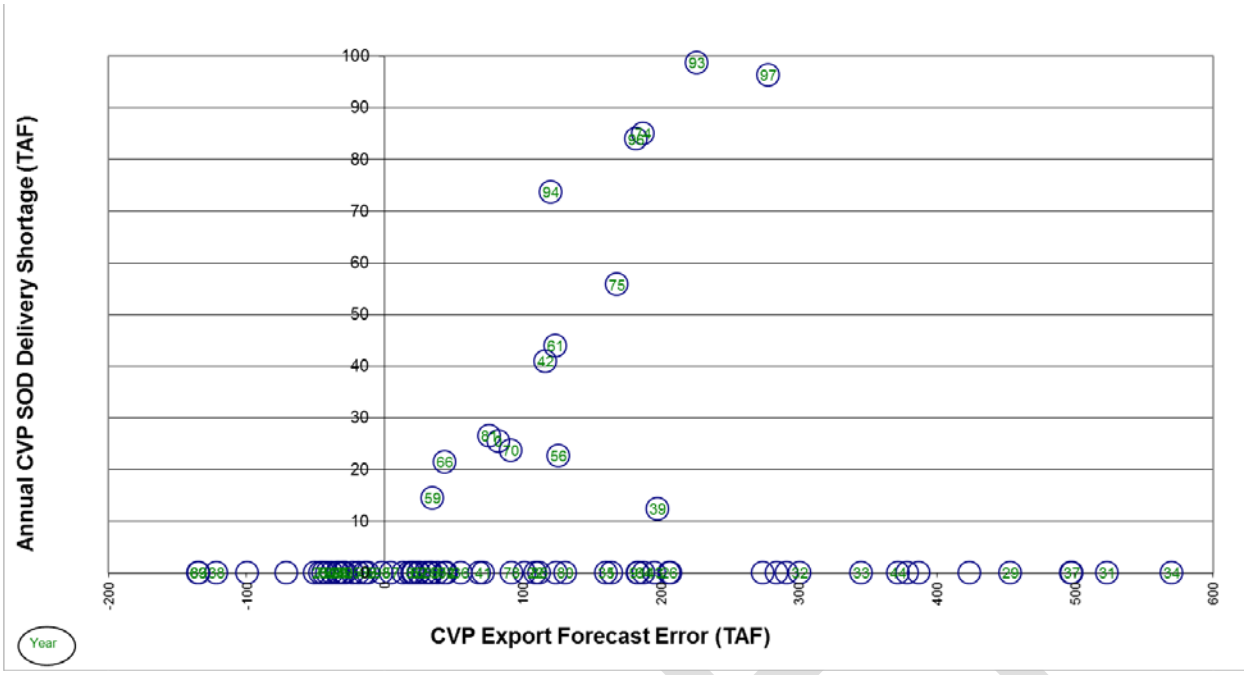


Figure 3. Annual CVP SOD delivery shortage versus CVP export forecast error in CalSim_27JAN2015

Problems with the SWP export forecast are similar to those explained above for the CVP. Table 2 lists the monthly SWP export estimates from January to August. Whereas the CVP contract year begins in March, the SWP contract year begins in January along with SWP allocations. Like the CVP, export estimates are conditioned on the SJR 60-20-20 index in April, May, and June. Unlike the CVP, the SWP export forecast logic adds a flood condition on the SJR in April and May. The flood condition is triggered when flow at Vernalis exceeds 16,000 cfs in March, April, or May. However, even with this added nuance, this is still a very coarse export forecast that does not capture the refinement inherent in real-time operations or what is needed in the model.

Table 2. Monthly SWP export estimates found in the CalSim_27JAN2015 lookup table ExportEstimate_SWP

CalSim Baseline SWP Export Forecast for Table A Allocation				
Month	Export Estimate (cfs)	Wet SJR Export Estimate (cfs)	Flood SJR Export Estimate (cfs)	Delivery Pattern Fraction
JAN	3750	0	0	0.737
FEB	4250	0	0	0.721
MAR	4250	0	0	0.695
APR	1000	2000	6000	0.657
MAY	1000	2000	6000	0.566
JUN	2500	6000	0	0
JUL	7000	0	0	0
AUG	7000	0	0	0

The SWP export forecast for July and August is 7,000 cfs as listed in Table 2. This exceeds permitted capacity of 6,680 cfs in these months, and simulated SWP exports in CalSim_27JAN2015 never exceed permitted capacity in July and August. In fact, simulated July and August SWP exports are often significantly below permitted capacity. The explanation for this is the same as it was for the CVP: just because capacity is available does not mean the SWP wants to use it; that depends on the storage condition of Oroville, and the export forecast in Table 2 does not consider such details.

Figure 4 compares SWP SOD shortage with export forecast error. Export forecast error was again calculated by subtracting April–August total SWP exports from the forecasted exports. Only 1979 had an underestimate of forecasted exports, and that underestimate was slight. In all other years the SWP export forecasts were overestimates with some errors greater than 1 million acre-feet (MAF). The greatest delivery shortage occurred in a wet year, 1995 (Figure 4). The delivery shortage was approximately 425 TAF; it was the result of a 500 TAF overestimate of exports. (Many of the shortages shown that are below 70 TAF in Figure 4 are not due to over-allocation and breaking San Luis; they are due to insufficient California Aqueduct capacity to meet the assumed demand pattern. These are of less concern than the shortages caused by breaking San Luis.)

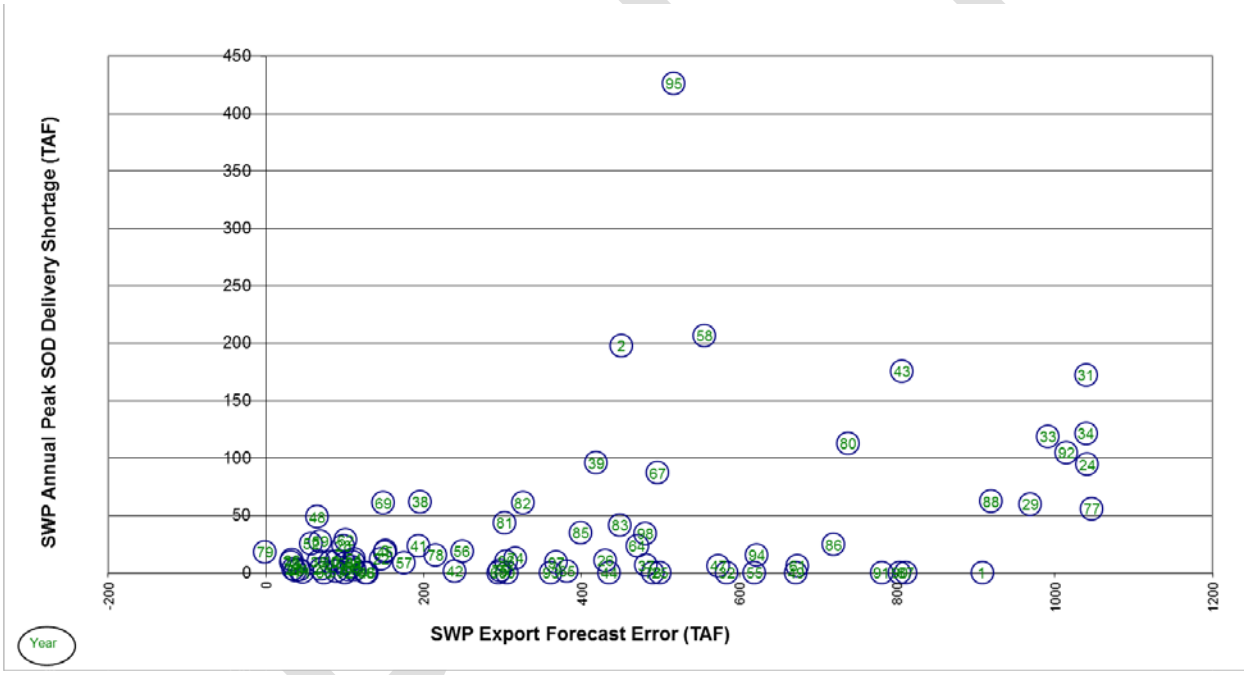


Figure 4. SWP annual peak SOD delivery shortage versus SWP export forecast error in CalSim_27JAN2015

To improve on the export forecasts, it is recognized that more detail is necessary. The two CVP and three SWP export forecast possibilities currently provided in CalSim do not adequately cover the different circumstances found from one year to the next. What follows is a proposal for deriving export forecasts that vary by year and month that will take into account hydrologic, regulatory, and operational variability. The methodology is similar to the WSI-DI procedure in that it requires infrequent iterations of CalSim, and it is best described as a series of steps.

STEP 1

Set the CVP and SWP export forecasts equivalent to Health and Safety (H&S) minimum export levels (800 cfs for the CVP and 300 cfs for the SWP). As such, the respective April to August export forecasts are approximately 240 TAF for the CVP and 90 TAF for the SWP. Run CalSim with this initial export forecast.

STEP 2

Use the CalSim CVP and SWP export results (D418 and D419_SWP, respectively) from Step 1 as new export estimates and re-run CalSim. Repeat until the maximum difference between aggregate export estimates and cumulative simulated exports is less than 100 TAF. Many previous trials indicate this will likely take three iterations. The first iteration (Step 1) uses the H&S export estimate, and the second and third use the CalSim-generated export estimates. A spreadsheet has been set up to process CalSim output into export forecast input for the purpose of expediting this process.

STEP 3

Refine export estimates as necessary to achieve desired balance of contract deliveries and storage carryover. This refinement of export forecasts can be done by an automated procedure or manually. A combination of both was employed in this analysis.

Ideally, the procedure would stop at Step 2. Understanding why the procedure progresses to Step 3 requires an understanding of the logic of the first two steps. Starting with the H&S export forecast in Step 1 ensures very low allocations for both projects in all years of that simulation. As such, export of available Delta supplies without supplemental reservoir release – or export of incidental Delta inflow – are sufficient in almost every year to meet allocated deliveries and San Luis carryover targets. So the final result of that first iteration and the iterations that follow in Step 2 is a lower bound on the SWP and CVP export forecasts. In any year that moving additional water from NOD reservoirs is not desired, the final export forecast derived in Step 2 also represents an upper bound. But in those years where NOD stored water and SOD export capacity are available, the export forecast must be increased to drive higher allocations and movement of that additional water through rulecurve. (Rulecurve will be discussed later in this memo.) There are also very wet years such as 1983, when a full San Luis prevented additional exports during the iterative process. A boost in the export forecast increases allocations and deliveries, which allows for higher exports when San Luis is full. Given the reasons for refinement, the only changes to the export forecasts going from Step 2 to Step 3 were increases.

The final CVP and SWP export forecasts derived from the three-step methodology are listed in Table 3 and Table 4. While these forecasts extend through the period of record (1922–2003), the tables show a small sample (1922–1931) for the sake of brevity. Each export forecast provided by year and month represents cumulative exports from the given month through August. As such, the export forecast can easily be retrieved from a lookup table or DSS timeseries (either data retrieval mechanism will work) and directly input into the current SWP and CVP export-based allocation logic (some minor edits were made for the new format of the export forecasts). Note the variability of

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the SWP and CVP export forecasts from a wet year like 1922, to a below-normal year like 1928, and to a critical year like 1931 (all SJR 60-20-20 index–based classifications). This is a significant change from the rough forecasts found in CalSim_27JAN2015.

Table 3. Sample CVP export forecast derived from the three-step process and used in CalSim_27JAN2015_Revised

Modified CVP Export Forecast for SOD Ag and M&I Allocation (cumulative from current simulation month to August)			
	Cumulative Export Estimate (TAF)		
Year	MAR	APR	MAY
1922	1255	972	901
1923	1083	883	817
1924	388	269	180
1925	1039	856	784
1926	622	339	271
1927	1062	835	775
1928	935	652	592
1929	501	338	269
1930	551	395	329
1931	325	261	189

Table 4. Sample SWP export forecast derived from the three-step process and used in CalSim_27JAN2015_Revised

Modified SWP Export Forecast for Table A Allocation (cumulative from current simulation month to August)					
	Cumulative Export Estimate (TAF)				
Year	JAN	FEB	MAR	APR	MAY
1922	2025	1805	1729	1409	1325
1923	1634	1413	1318	1117	1038
1924	412	232	111	93	75
1925	1227	1029	1049	800	709
1926	1179	981	1015	990	905
1927	1687	1542	1425	1192	1119
1928	1695	1482	1432	1132	1062
1929	684	482	299	136	67
1930	1209	1061	922	767	704
1931	508	308	152	88	71

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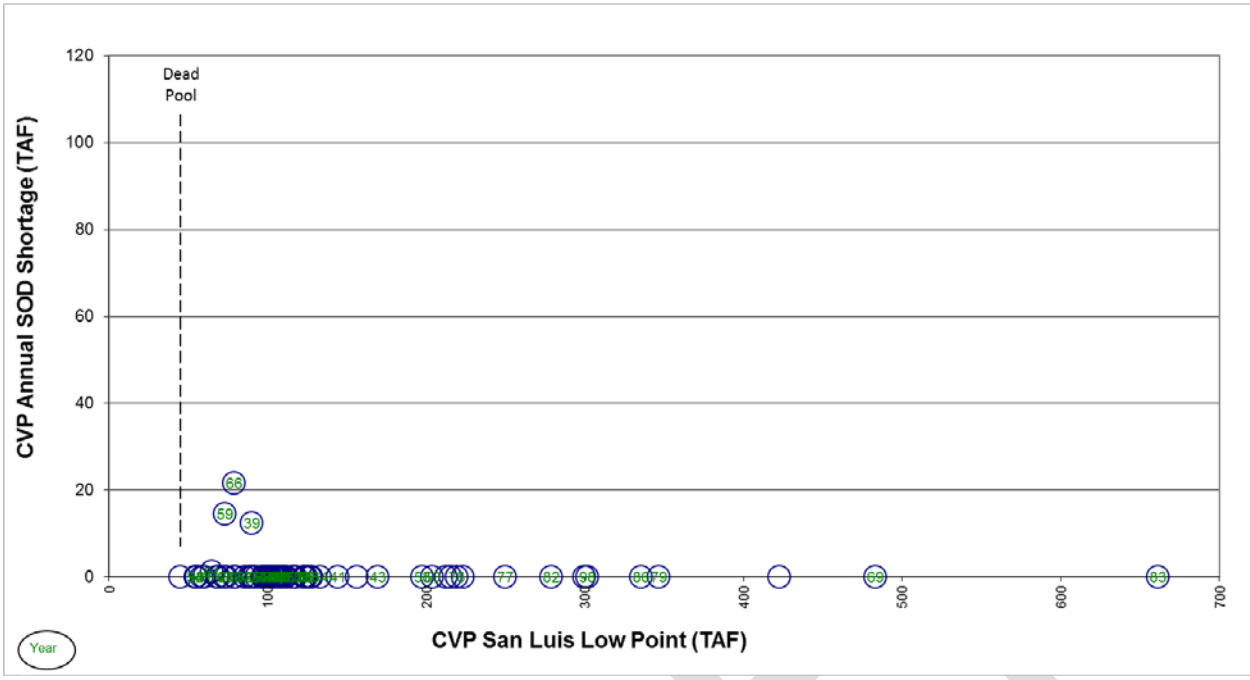


Figure 5. CVP annual SOD shortage versus CVP San Luis storage low point as simulated in CalSim_27JAN2015_Revised

Figure 5 and Figure 6 compare annual shortage and San Luis low point as simulated in CalSim_27JAN2015_Revised with the updated export forecasts listed above. CVP San Luis is drawn to dead pool only once and no shortage occurs in that year. The only years with CVP SOD shortages are 1939, 1959, and 1966; as discussed previously, the shortages are not caused by over-allocation but a quirk in the SJR model formulation. The SWP is drawn to dead pool in four years, but there are shortages in only two of them. (The two dead pool data points where the shortage is zero overlap.) All SWP shortages shown are reasonably small and are almost entirely caused by insufficient California Aqueduct capacity to meet the simulated delivery pattern. This type of shortage is of less concern than those caused by breaking San Luis. To gage the improvement in San Luis operations and reductions in project SOD delivery shortages due to the updated export forecasts, compare Figure 5 to Figure 1 and Figure 6 to Figure 2.

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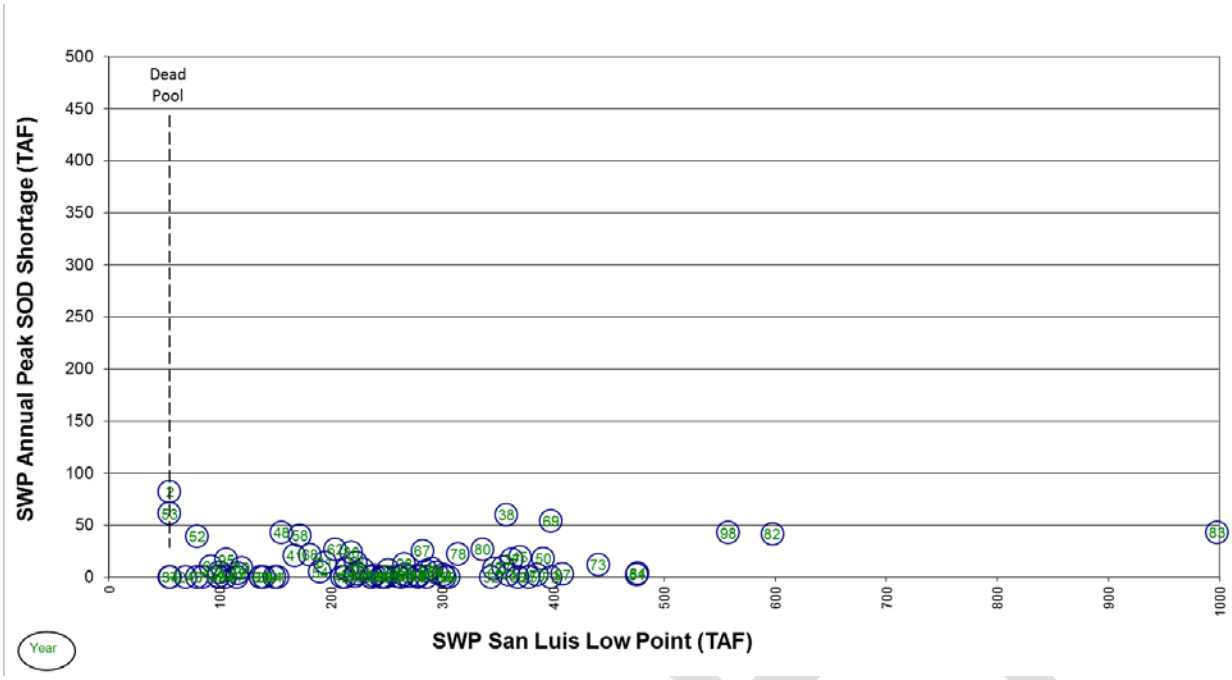


Figure 6. SWP annual maximum SOD shortage versus SWP San Luis storage low point as simulated in CalSim_27JAN2015_Revised

Export forecast error was shown to be large for both the CVP (Figure 3) and SWP (Figure 4) in CalSim_27JAN2015. Reducing export forecast error was essential to the prevention of breaking San Luis and shorting SOD contractors. Figure 7 relates CVP SOD delivery shortage to CVP export forecast error in CalSim_27JAN2015_Revised. As shown, most of the CVP export forecast errors fall under 100 TAF. Those errors above 100 TAF were edited in Step 3 of the proposed export forecast methodology to refine the balance between deliveries and carryover. Figure 8 relates SWP SOD delivery shortage to SWP export forecast error in CalSim_27JAN2015_Revised. The forecast error in three years is above 200 TAF: 1952, 1982, and 1983. It was recognized that in all three of these years there was sufficient water and export capacity to meet a 100% Table A allocation. The export forecast in each was set sufficiently high so that it would not prevent a full allocation. The rest of the SWP export forecast errors were less than 200 TAF. The refinements in Step 3 were responsible for pushing the errors above 100 TAF.

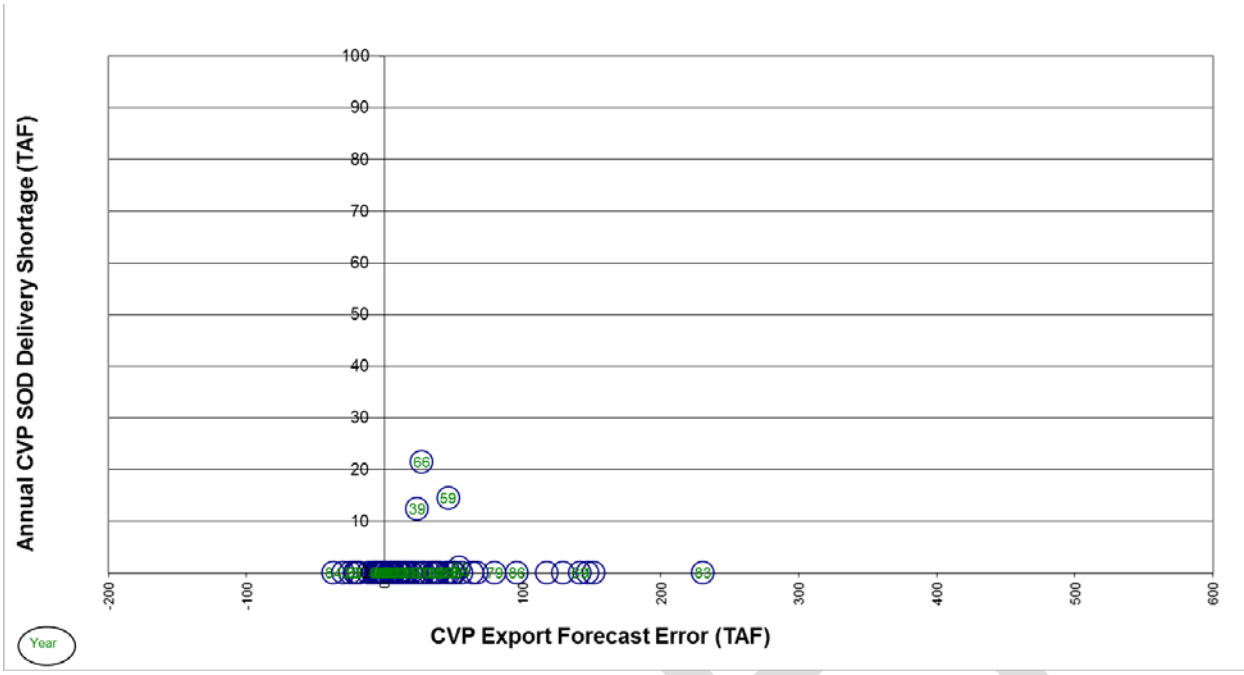


Figure 7. Annual CVP SOD delivery shortage versus CVP export forecast error in CalSim_27JAN2015_Revised

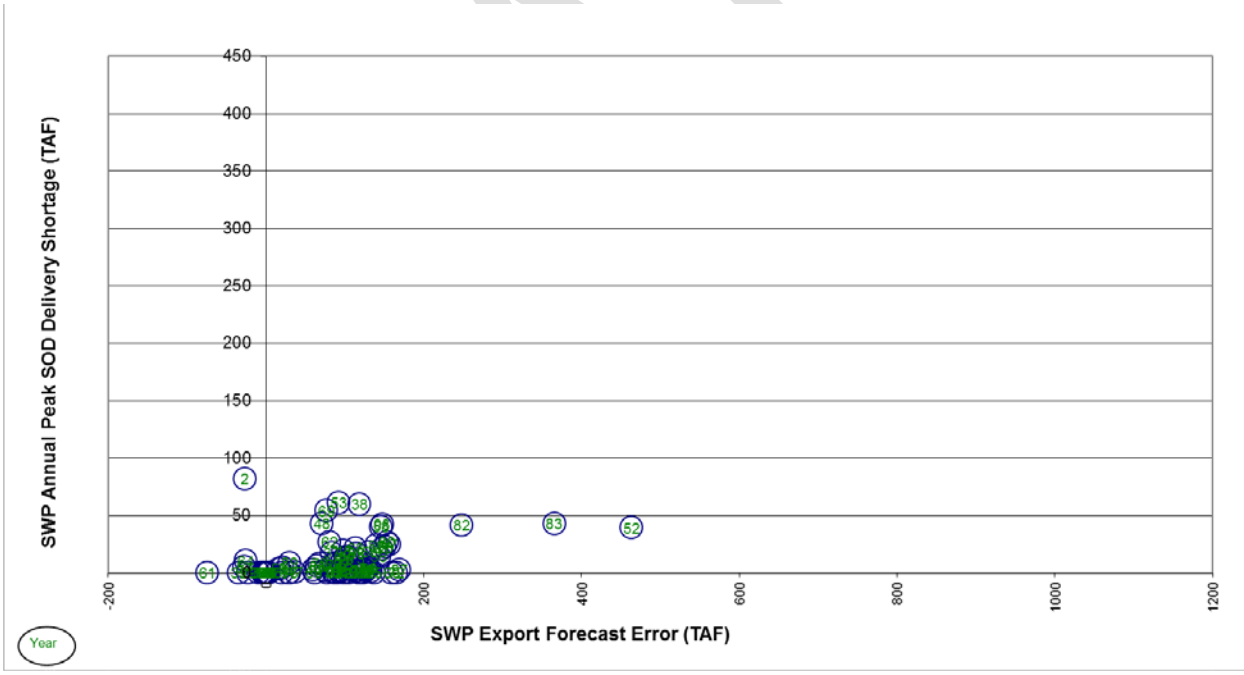


Figure 8. SWP annual peak SOD delivery shortage versus SWP export forecast error in CalSim_27JAN2015_Revised

CalSim CVP Allocation Logic Refinement

Other adjustments were made to CalSim_27JAN2015_Revised in addition to the update of the export forecasts used in CVP and SWP allocations. One was a refinement to the CVP allocation procedure to reduce instances where there are low CVP SOD service contract allocations in years

that end in excessively high San Luis carryover. Figure 9 links CVP San Luis low point with combined Shasta and Folsom carryover as simulated in CalSim_27JAN2015. Six of the annual data points are highlighted in red due the relatively high San Luis low point and low CVP SOD Ag Service allocation (see Figure 10 for the allocation associated with each data point). The highlighted years are 1932–1937, and the SOD Ag Service allocations in these years range from 4% in 1932 to 43% in 1936. The San Luis low point is above 300 TAF throughout this period and reaches almost 600 TAF in 1932. San Luis also fills during critical periods, thereby constraining CVP export of valuable winter surplus. Clearly, higher deliveries could be made SOD without impacting upstream storage; so it is advantageous to determine why the current model does not perform this operation, and what change can be made to more efficiently use available water.

The problem within the model is caused by dry conditions north of the American River and wetter conditions from the American River south. Such a hydrologic imbalance leaves Shasta and Trinity storage low but keeps San Luis storage high through export of surplus originating on the American and San Joaquin Rivers. Low Shasta and Trinity storage results in a low WSI-DI–based allocation. A low WSI-DI allocation supersedes a higher export-based allocation (recall that the model uses the minimum), and SOD service contractor allocations end up being governed by the dry conditions to the north even though there is sufficient water SOD to meet higher demand.

In the end, this is entirely the result of a modeling artifact. It is standard policy within the CVP that NOD service contractor allocations will be equal to or greater than SOD service contractor allocations. The issue lies with how this policy is applied in the model. NOD service contractor allocations are calculated using the WSI-DI method; SOD service contractor allocations are calculated as the minimum of the WSI-DI–based allocation and the export forecast–based allocation. This, at times, artificially constrains system-wide allocations based solely on low conditions at Shasta and Trinity.

In other words, the model ignores the details that operators would consider in developing a real-time service contractor allocation. Note that NOD Ag Service contracts along the Sacramento River total 377 TAF. As such, a NOD Ag Service allocation increase of 1 percent would expose Shasta and Trinity to a combined 4 TAF of additional drawdown. Also consider that SOD Ag Service contracts total 1,987 TAF. Therefore a 1 percent increase in SOD Ag Service allocations would require 20 TAF of combined drawdown in San Luis and/or increased exports. If in actual operations the CVP operators see the potential to boost SOD Ag Service allocations by 100 TAF due to high San Luis storage levels—an allocation increase of approximately 5 percentage points. There may be concern about boosting NOD Ag Service allocations by an equal percentage, but the operators would understand that such an increase would only result in an additional 20 TAF of load on Shasta and Trinity. There are certainly cases where such a tradeoff would be made, and years 1932–1937 as simulated in CalSim_27JAN2015 appear to be such cases.

The modification applied in CalSim_27JAN2015_Revised was to conditionally reformulate CVP Ag Service allocations in contract years 1932–1937. In these years, allocations for both NOD and SOD service contractors are allowed to be driven by the export-based methodology when appropriate. This does not circumvent the standard policy of maintaining NOD service contractor allocations at or above SOD allocations; this policy is maintained. The result of this change in allocation formulation is shown in Figure 11 and Figure 12. The data points highlighted in red correspond to

the same annual data points highlighted in Figure 9 and Figure 10. The San Luis low point in these years has been significantly reduced in CalSim_27JAN2015_Revised as compared to CalSim_27JAN2015 and the impact to upstream carryover is acceptable.

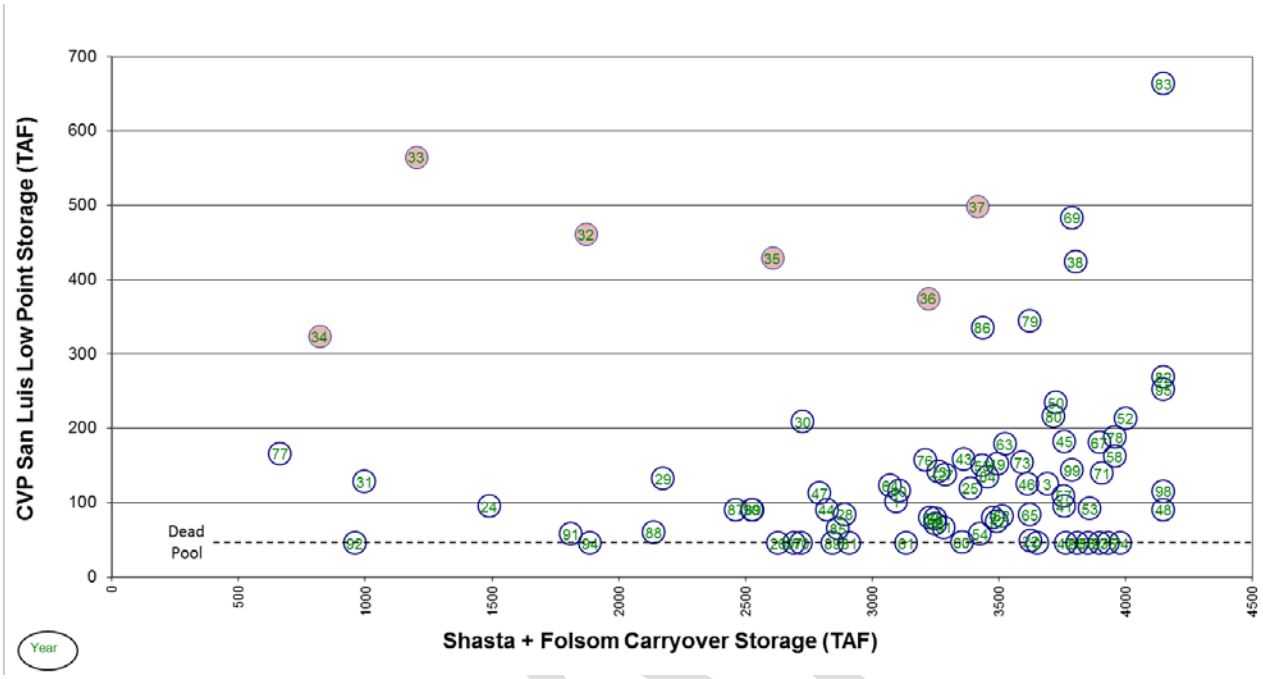


Figure 9. CVP San Luis low point storage versus combined Shasta and Folsom carryover in CalSim_27JAN2015 with contract year data label

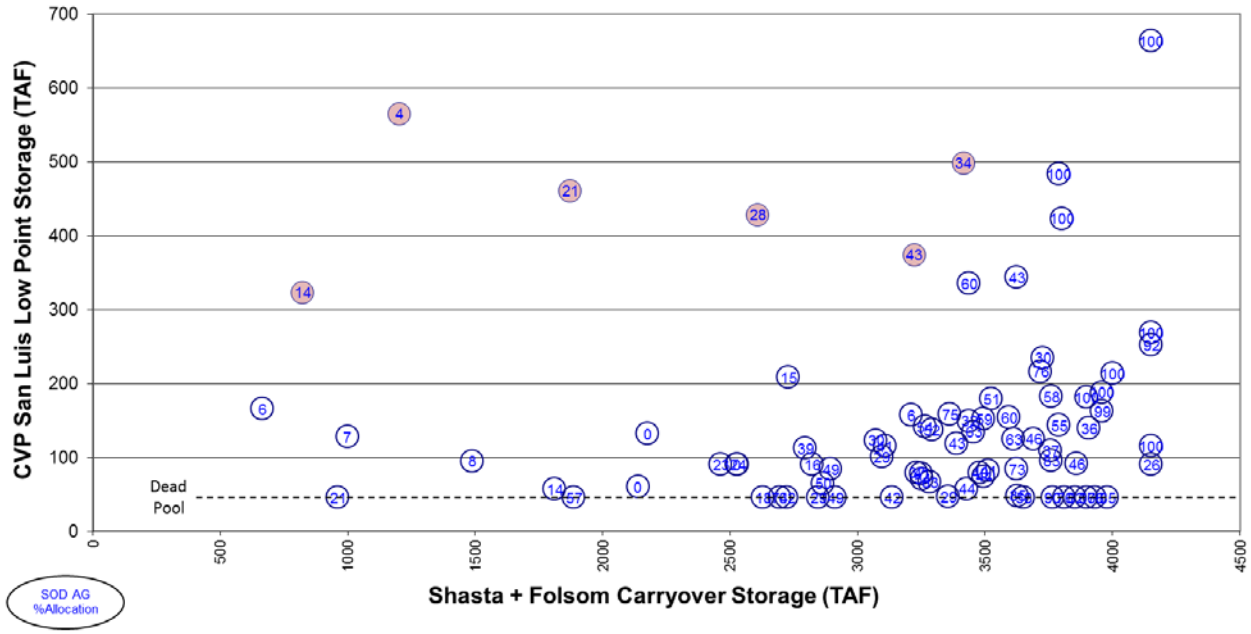


Figure 10. CVP San Luis low point storage versus combined Shasta and Folsom carryover in CalSim_27JAN2015 with SOD Ag Service allocation data label

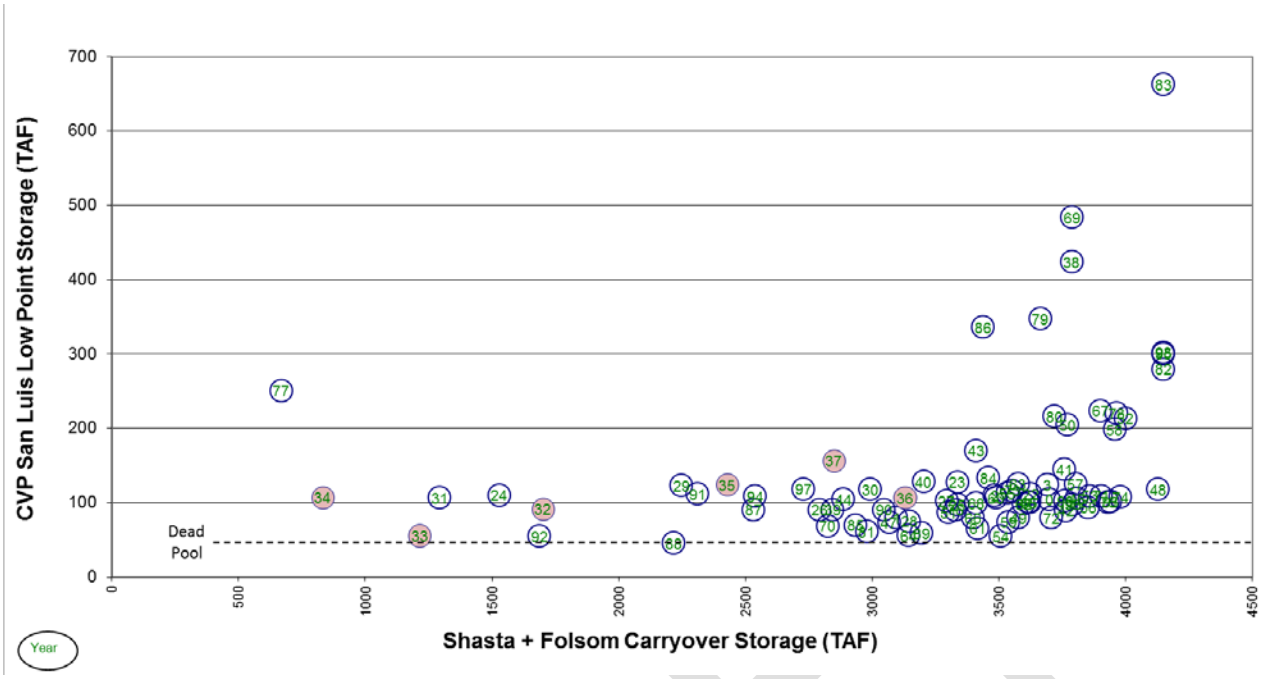


Figure 11. CVP San Luis low point storage versus combined Shasta and Folsom carryover in CalSim_27JAN2015_Revised with contract year data label

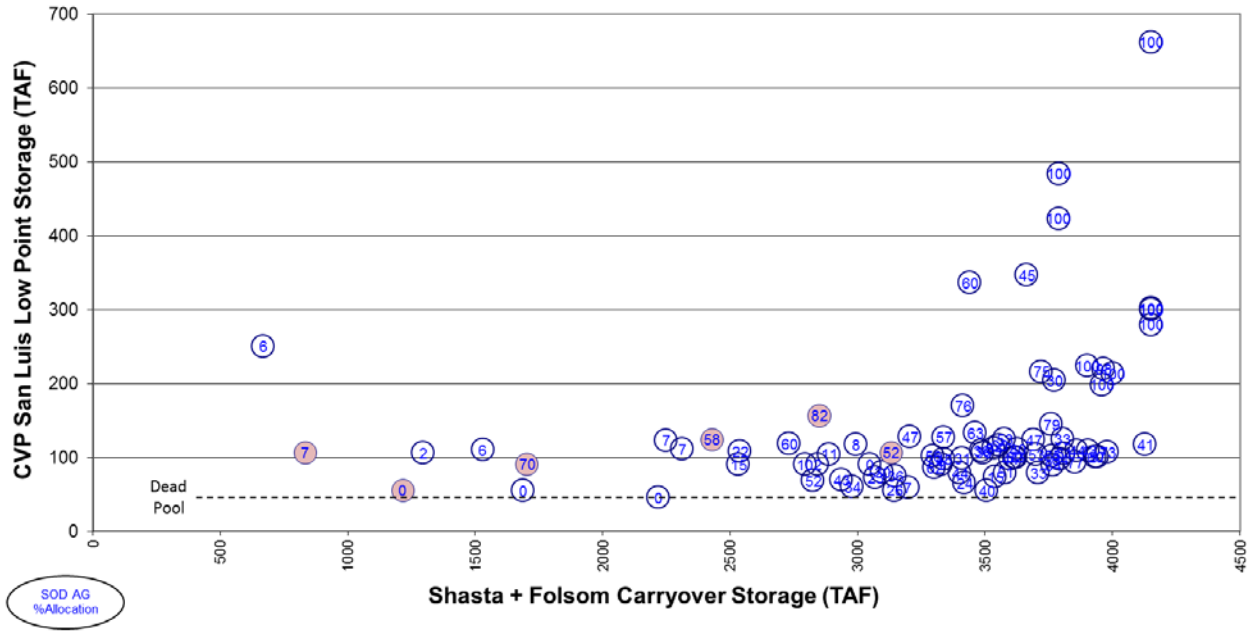


Figure 12. CVP San Luis low point storage versus combined Shasta and Folsom carryover in CalSim_27JAN2015_Revised with SOD Ag Service allocation data label

As discussed above, CalSim_27JAN2015_Revised results as plotted in Figure 5, Figure 6, Figure 7, Figure 8, Figure 11, and Figure 12 were significantly influenced by the revised export forecast used in CVP and SWP allocations and the reformulation of CVP allocation logic in 1932–1937. Two more changes were also made to CalSim_27JAN2015_Revised that affected results. However, while

important to NOD-SOD storage balance, these changes are less significant than those already discussed. The first of these additional edits is refinement of San Luis rulecurve for the SWP and CVP, and the second is an adjustment to operational logic under an ANN negative carriage constraint; these edits are detailed below.

RULECURVE

The purpose of rulecurve is to prioritize balance between NOD storage and San Luis for both the CVP and SWP. Rulecurve controls upstream release for export when there is a choice between storing water in upstream reservoirs and releasing water for export and storing it in San Luis. Operational constraints such as flood pool, minimum instream flow requirements, export regulations, H&S pumping requirements, and physical pump capacity override rulecurve; and when any of these control operations, choices for balancing NOD storage are limited.

During the winter, rulecurve is set to encourage the filling of San Luis though it rarely controls. Incidental Delta inflow typically drives San Luis filling during the rainy season. Upstream reservoir releases are often controlled by flood pool or minimum flow requirements, and exports are controlled by OMR flow requirements or maximum pumping capacity. Since rulecurve does not play a significant role in driving winter San Luis operations, there was no need to modify wintertime rulecurve logic.

Where rulecurve does make a difference (or should make a difference) is during irrigation season when there are windows of opportunity to coordinate upstream reservoir releases with Delta exports. During the summer, SOD project demand typically exceeds Delta exports. As such, SOD project demand is met with a combination of Delta exports and San Luis releases, and if rulecurve is controlling, it influences the balance between Delta exports and San Luis reservoir releases. If rulecurve is set lower, exports decrease and San Luis releases increase. When set higher, the opposite occurs. Ideally the combination of San Luis releases and project exports over the irrigation season is sufficient to satisfy project allocations and San Luis targeted carryover storage, and rulecurve should be set to encourage the appropriate balance.

Therefore, formulation of rulecurve during the irrigation season should boil down to an export scheduling problem, to be solved by determining how much to export within a season to achieve delivery and carryover goals, how to distribute these exports from month to month, and where to set SWP and CVP rulecurve to encourage those Delta exports and the supporting upstream releases. The problem with the current irrigation season rulecurve formulations in CalSim is that they do not consider the amount of exports needed over the season. In fact, for both the SWP and CVP, the rulecurve formulation assumes exports of 60 TAF per month whether that is sufficient to meet operational objectives or not. Rulecurve levels are driven by this export assumption.

The implemented fix to the irrigation season rulecurve formulation is to incorporate export scheduling in CalSim_27JAN2015_Revised; SWP and CVP formulations vary slightly. With the CVP, exports need to be scheduled to ensure the project can meet peak summer demand and prevent San Luis low point issues through the end of September. The SWP has similar concerns, but must also consider Article 56 carryover into the next calendar year with the added complication of Feather River flow limitations for half of October and all of November that can interfere with the

State's ability to make Oroville releases for export. So while the CVP's export scheduling formulation extends from May through September, the SWP's starts in April and extends through December. As an example, the SWP export schedule–based rulecurve formulation for the months of April–December is outlined below.

First, needed exports are calculated from the beginning of the current month of the simulation through the end of December (Required_Exports_NowtoDec (TAF)).

(1) Required_Exports_NowtoDec = max(0, remainDem_SOD + remain_evap + remain_loss + max(110, carryover_final + 55) – Beg_Month_SWP_San_Luis_Storage)

Where

- remainDem_SOD is the remaining Table A allocations to be delivered from now to the end of December (TAF)
- remain_evap is an estimate of total evaporation over the rest of the calendar year (TAF)
- remain_loss is an estimate of the total California Aqueduct losses over the rest of the calendar year (TAF)
- 110 is the SWP San Luis carryover target (TAF)
- carryover_final is the quantity of water needed in San Luis at the end of December to make Article 56 deliveries (TAF)
- 55 is SWP San Luis dead pool capacity (TAF)
- Beg_Month_SWP_San_Luis_Storage is SWP San Luis storage at the beginning of the current month of simulation (TAF)

Next, the amount that should be exported this month (Required_Exports (TAF)) in order to achieve the export goal for the remainder of the calendar year (Required_Exports_NowtoDec) is calculated. Assume exports will be scheduled uniformly over the remaining months of the calendar year, except for half of October and all of November due to Feather River flow restrictions. During the Feather River flow restrictions, we assume Banks pumping is held to the H&S level (300 cfs), which equals approximately 27 TAF over 1.5 months or 18 TAF over 1 month. So the formulation varies by month:

For the months April–September, the formulation is:

(2a) Required_Exports = (Required_Exports_NowtoDec - 27)/(remain_months - 1.5)

For the month of October, the formulation is:

(2b) Required_Exports = (Required_Exports_NowtoDec - 18)/(remain_months - 1)

And for the months of November–December the formulation is:

(2c) Required_Exports = Required_Exports_NowtoDec/remain_months

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Where

- remain_months is the number of months remaining in the calendar year starting from the beginning of this month of simulation to the end of December

At this point in the calculation, SWP exports could be prioritized up to Required_Exports such that Oroville releases would be made to support those exports. But that is not the modeling technique used in CalSim. As discussed, the balance of upstream storage and San Luis storage is guided with rulecurve; so to prioritize SWP exports up to Required_Exports, rulecurve must be appropriately set. Expected change in San Luis storage (Change_San_Luis_Storage (TAF)) if exports equal Required_Exports is now calculated. The formulation is:

(3) Change_San_Luis_Storage = Required_Exports – This_Month_Forecasted_Delivery – This_Month_Forecasted_Loss – This_Month_Forecasted_Evap

Where

- This_Month_Forecasted_Delivery is this month's estimated Table A deliveries (TAF)
- This_Month_Forecasted_Loss is this month's estimated California Aqueduct losses (TAF)
- This_Month_Forecasted_Evap is this month's estimated SWP San Luis evaporation (TAF)

Given the calculated Change_San_Luis_Storage, the rulecurve (SWP_Rulecurve (TAF)) that will encourage sufficient Oroville releases to support SWP exports at Required_Exports is determined as follows:

(4) SWP_Rulecurve = Beg_Month_SWP_San_Luis_Storage + Change_San_Luis_Storage

NEGATIVE CARRIAGE OPERATIONS

Delta carriage is the additional Delta outflow above minimum required Delta outflow (MRDO) necessary to meet D-1641 salinity standards. When salinity is controlling, an increase in exports requires an increase in release from upstream reservoirs to the Delta that equals the export increase plus carriage. In other words, carriage is the water cost of Delta exports when salinity standards are controlling. While higher exports typically result in higher carriage, there are times of the year when Rock Slough and Emmaton salinity standards can be met with higher exports and negative carriage. Essentially, when a negative carriage salinity constraint is controlling, a unit increase in Delta exports is supplied partially by a decrease in carriage (decrease in Delta outflow) and the remainder by an increase in upstream reservoir release. While negative carriage might be counterintuitive, it is an actual phenomenon observed in Delta operations.

Negative carriage in CalSim presents problems of prioritization. In CalSim, Delta outflow above MRDO, whether the outflow is surplus or carriage, is given a highly negative weight (low priority). The intent is to discourage any Delta outflow in excess of MRDO. So when a negative carriage salinity constraint is controlling operations, CalSim will operate to minimize Delta outflow even though it might cause an imbalance between NOD and SOD storage. Delta outflow is reduced through increased exports, but some water still has to be released from upstream reservoirs to

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support part of the increased export. If NOD reservoirs are relatively full, this could be a desirable operation, but if NOD reservoirs are low and further exports are not needed to support this year's allocation, minimizing Delta outflow at the expense of upstream storage is an unwarranted operational decision. During the critical periods, CalSim makes several of these decisions that result in the transfer of NOD storage to San Luis when the water would be better kept NOD.

The implemented negative carriage operation fix in CalSim_27JAN2015_Revised is to remove the model flexibility to make an unwarranted decision. In CalSim, SWP and CVP export estimates are made to guide operations when salinity standards are controlling (C400_MIF logic). This is used to ensure that needed exports are made even if positive carriage must be paid. In CalSim_27JAN2015_Revised, similar export estimates are now used to limit how much carriage can be reduced through increases in exports under a negative carriage constraint. Essentially, under an Emmaton or Rock Slough negative carriage constraint, the carriage is held at the level to support the estimated export – no more and no less. CalSim does not get an objective function benefit of releasing more water from upstream storage for a fractional reduction in Delta outflow.

COMPARISON OF CALSIM_27JAN2015 AND CALSIM_27JAN2015_REVISED RESULTS

The revisions in CalSim_27JAN2015_Revised change the storage balance between Oroville and SWP San Luis. Figure 13 and Figure 14 relate SWP San Luis low point storage to Oroville carryover in each year of the CalSim_27JAN2015 simulation. The only difference between the two figures is that data in Figure 13 is labeled by year and data in Figure 14 is labeled by Table A allocation. Note the years that SWP San Luis low point is at dead pool. This occurs over a wide spectrum of Oroville carryover and Table A allocations. Also note the four data points highlighted in red—1925, 1932, 1949, and 1955 with Table A allocations of 37%, 28%, 29%, and 38%, respectively. Ideally, higher allocations would have been made in these years, reducing San Luis low point storage. Figure 15 and Figure 16 relate SWP San Luis low point storage to Oroville carryover storage in each year of the CalSim_27JAN2015_Revised simulation. Compare Figure 15 and Figure 16 to Figure 13 and Figure 14, respectively to see the effect of the model edits (export forecast, rulecurve, and negative carriage) on the overall San Luis-Oroville storage balance. Note that the San Luis low point has been largely lifted above dead pool in CalSim_27JAN2015_Revised. Also note the red highlighted data points in Figure 15 and Figure 16, which correspond to the same years highlighted in red in Figure 13 and Figure 14. The combined effect of the model edits creates a more ideal balance between Oroville storage, SWP San Luis storage, and Table A allocations.

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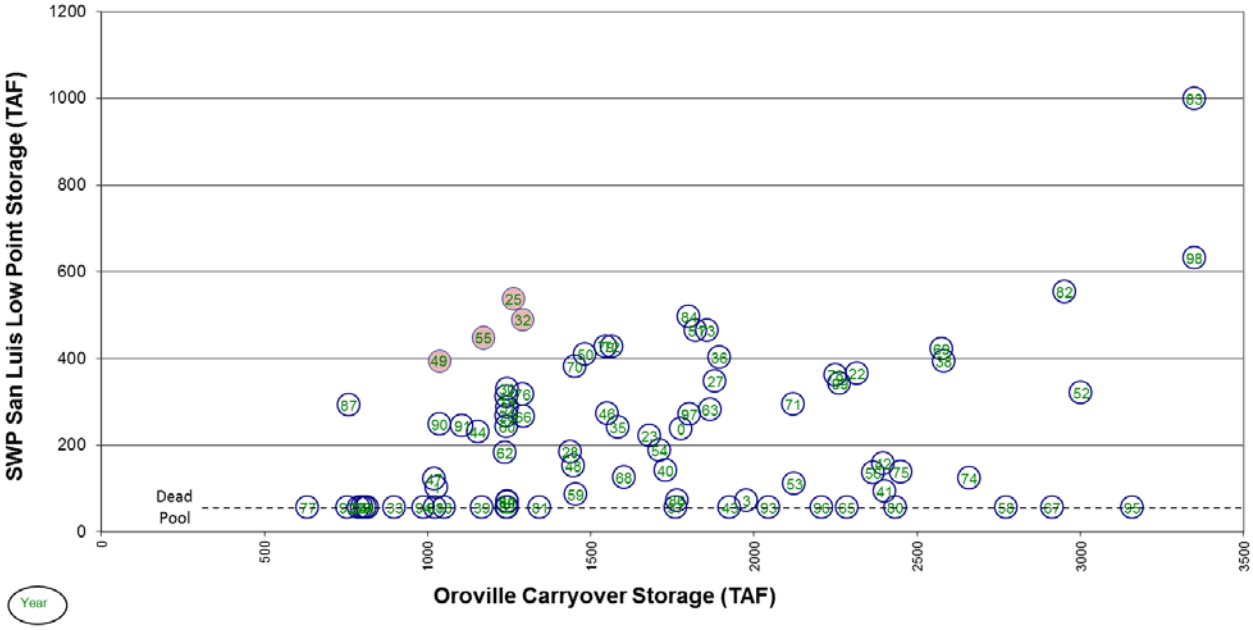


Figure 13. SWP San Luis low point storage versus Oroville carryover in CalSim_27JAN2015 with contract year data label

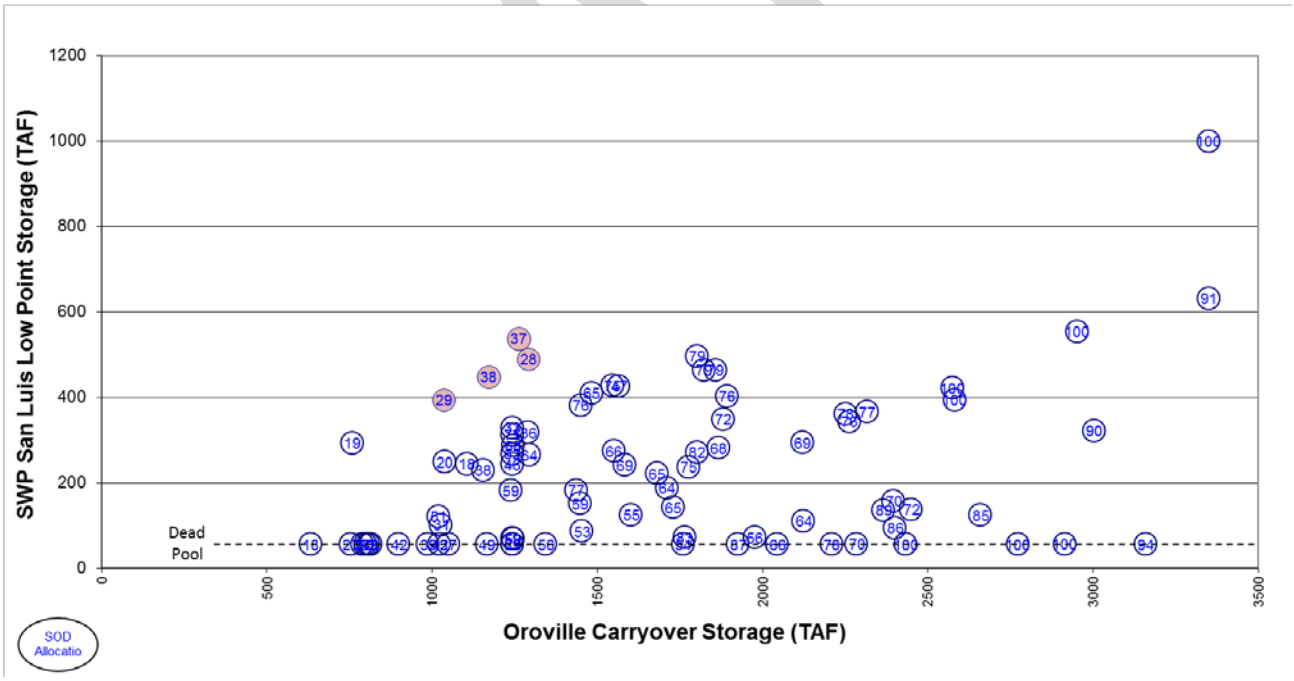


Figure 14. SWP San Luis low point storage versus Oroville carryover in CalSim_27JAN2015 with Table A allocation data label

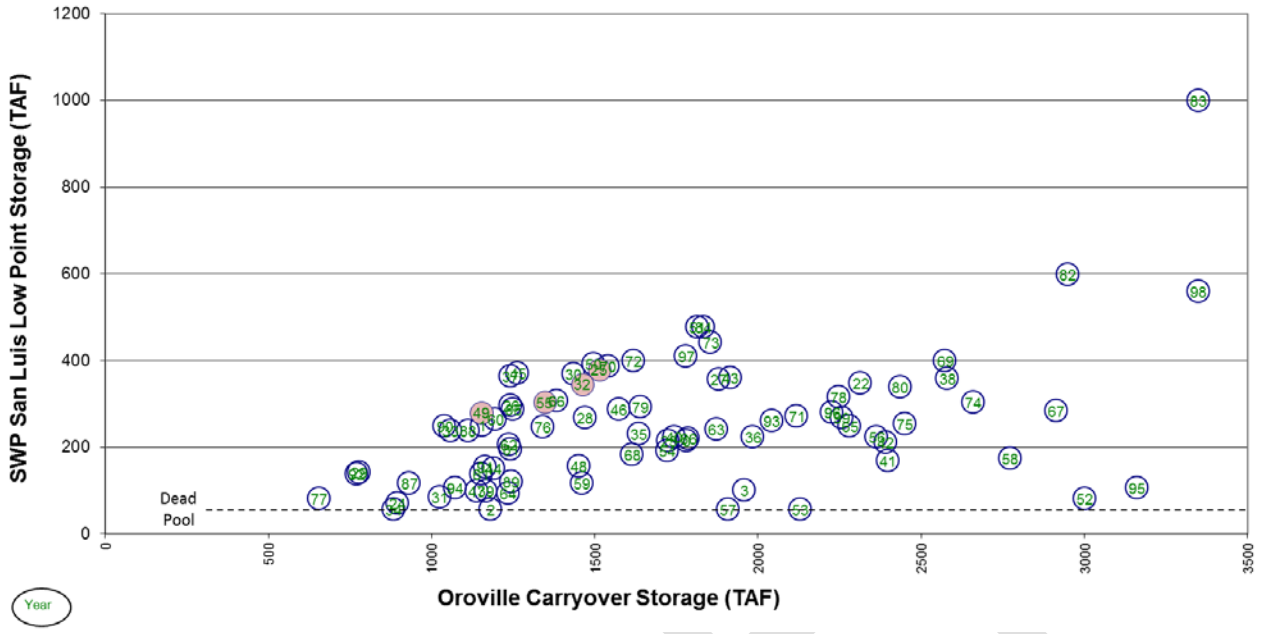


Figure 15. SWP San Luis low point storage versus Oroville carryover in CalSim_27JAN2015_Refined with contract year data label

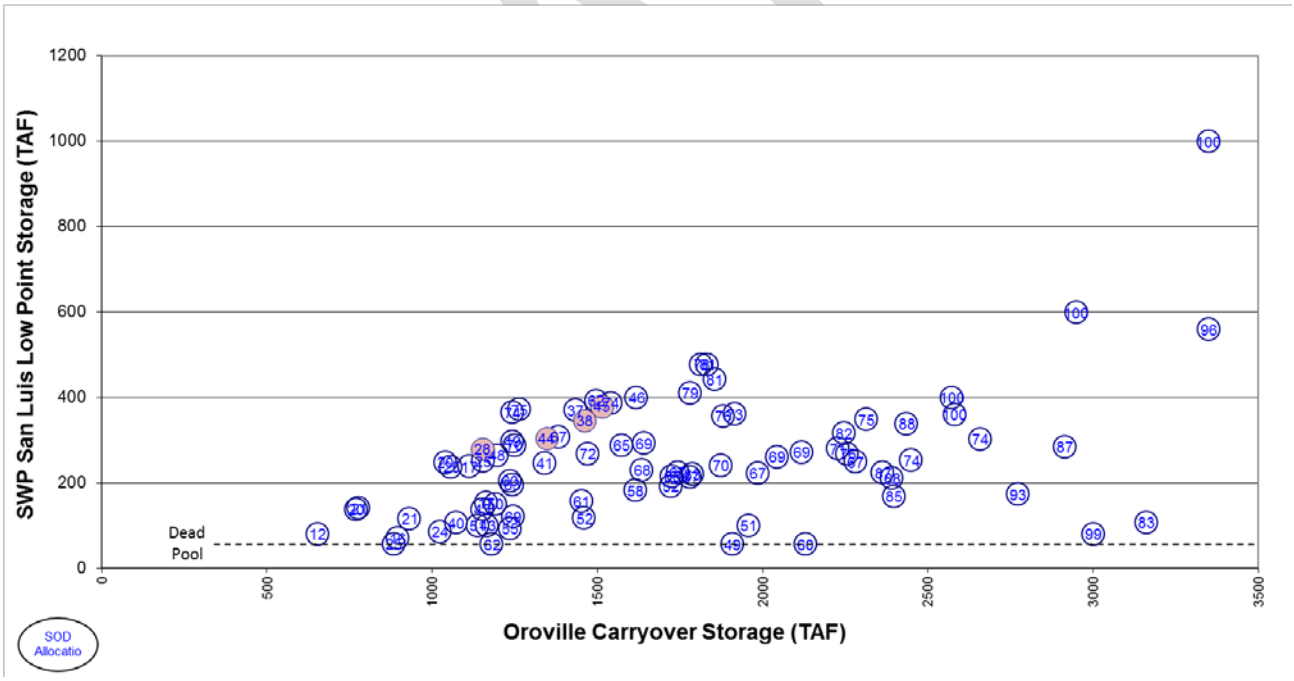


Figure 16. SWP San Luis low point storage versus Oroville carryover in CalSim_27JAN2015_Revised with Table A allocation data label

CVP San Luis storage often hits its annual low point in August. Figure 17 compares CVP San Luis end of August storage probability of exceedance curves for CalSim_27JAN2015 and CalSim_27JAN2015_Revised. In CalSim_27JAN2015, there is an almost 20% chance that end of August CVP San Luis storage is at dead pool; there is only slightly more than a 1% chance in

CalSim_27JAN2015_Revised. Also, in CalSim_27JAN2015_Revised, CVP San Luis is consistently drawn down to the 90 TAF low point target used in the CVP SOD export forecast allocation logic, whereas CalSim_27JAN2015 tends to diverge from this target.

SWP San Luis storage often hits its annual low point in October. Figure 18 compares SWP San Luis end-of-October storage probability of exceedance curves for CalSim_27JAN2015 and CalSim_27JAN2015_Revised. In CalSim_27JAN2015, there is a greater than 16% chance that end-of-October SWP San Luis storage is at dead pool; there is only a 3% chance in CalSim_27JAN2015_Revised. The low point target used in SWP export forecast allocation logic is 110 TAF. There is no obvious drawdown to this target in Figure 18 because of Article 56 carryover. CalSim_27JAN2015_Revised does a better job of preserving Article 56 requested by contractors. This is more evident when comparing CalSim_27JAN2015_Revised and CalSim_27JAN2015 Article 56 deliveries.

Model revisions also affect NOD carryover storage (end of September). Figure 19 through Figure 22 show the CalSim_27JAN2015 and CalSim_27JAN2015_Revised carryover storage probability exceedance curves for Trinity, Shasta, Folsom, and Oroville reservoirs, respectively. As shown, the model revisions had a largely positive effect on upstream carryover storage.

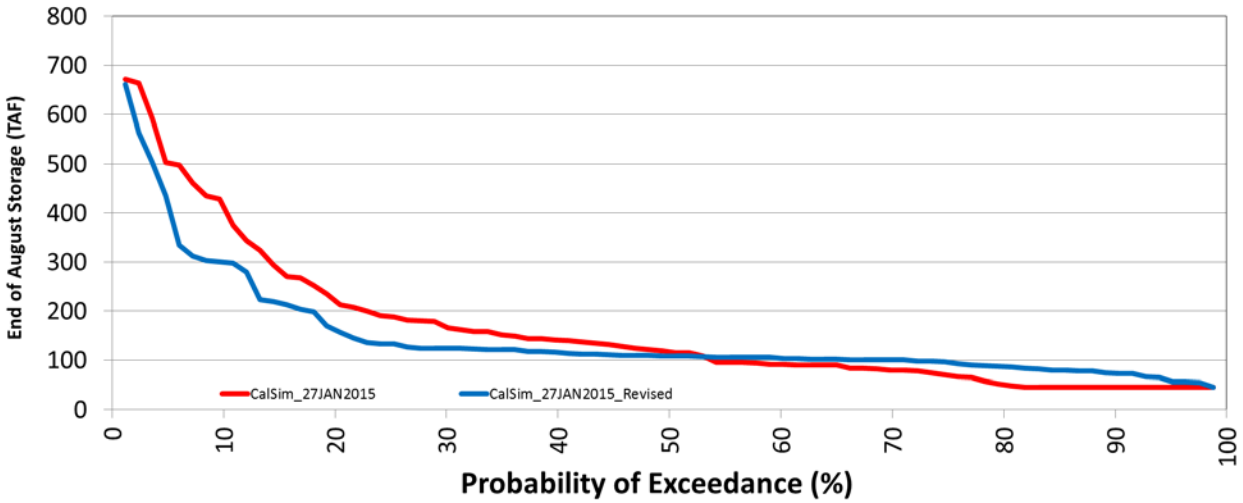


Figure 17. CVP San Luis end of August storage probability of exceedance for CalSim_27JAN2015 and CalSim_27JAN2015_Revised

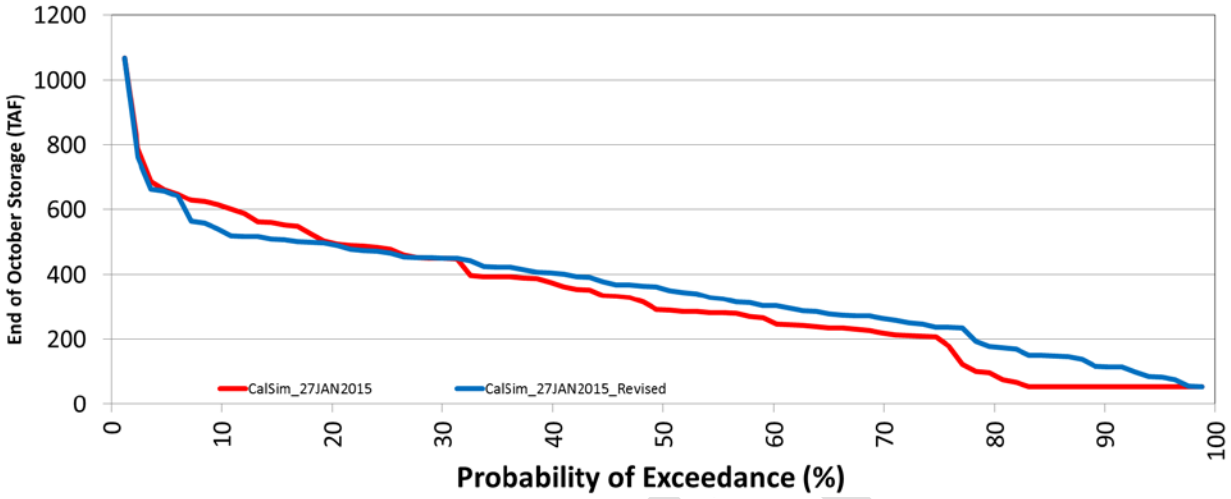


Figure 18. SWP San Luis end of October storage probability of exceedance for CalSim_27JAN2015 and CalSim_27JAN2015_Revised

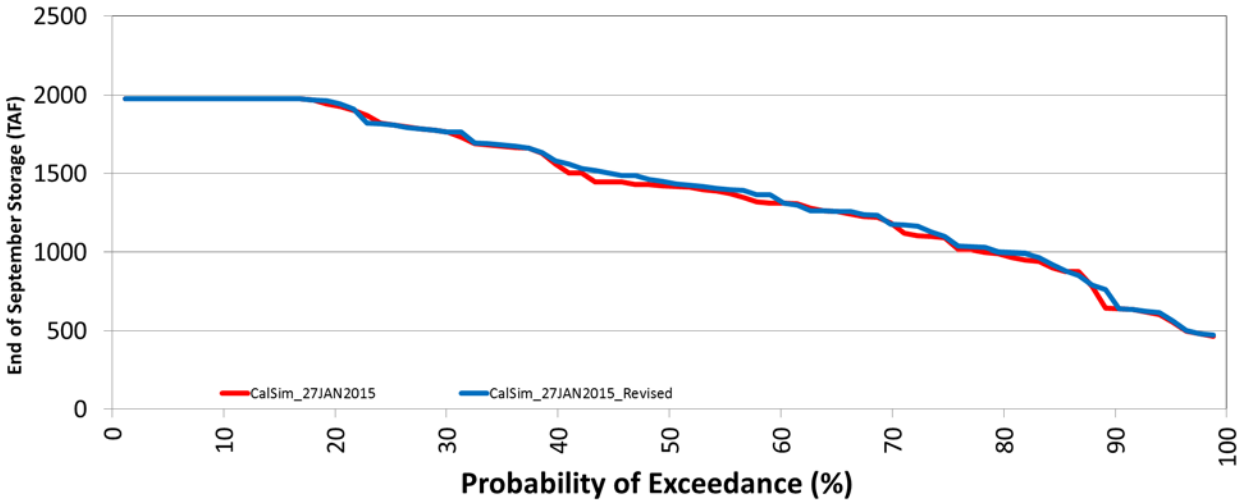


Figure 19. Trinity carryover storage probability of exceedance for CalSim_27JAN2015 and CalSim_27JAN2015_Revised

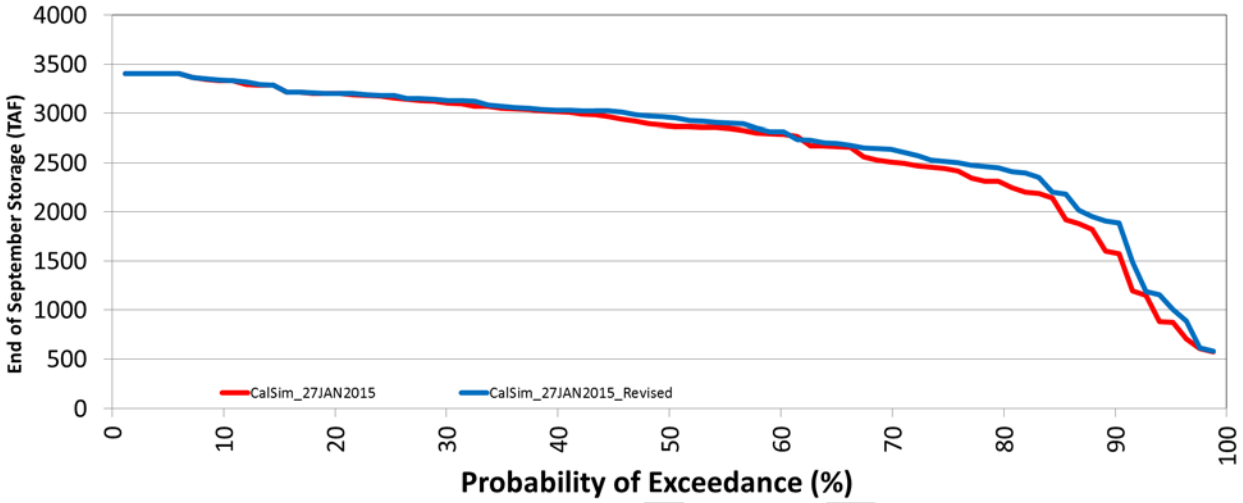


Figure 20. Shasta carryover storage probability of exceedance for CalSim_27JAN2015 and CalSim_27JAN2015_Revised

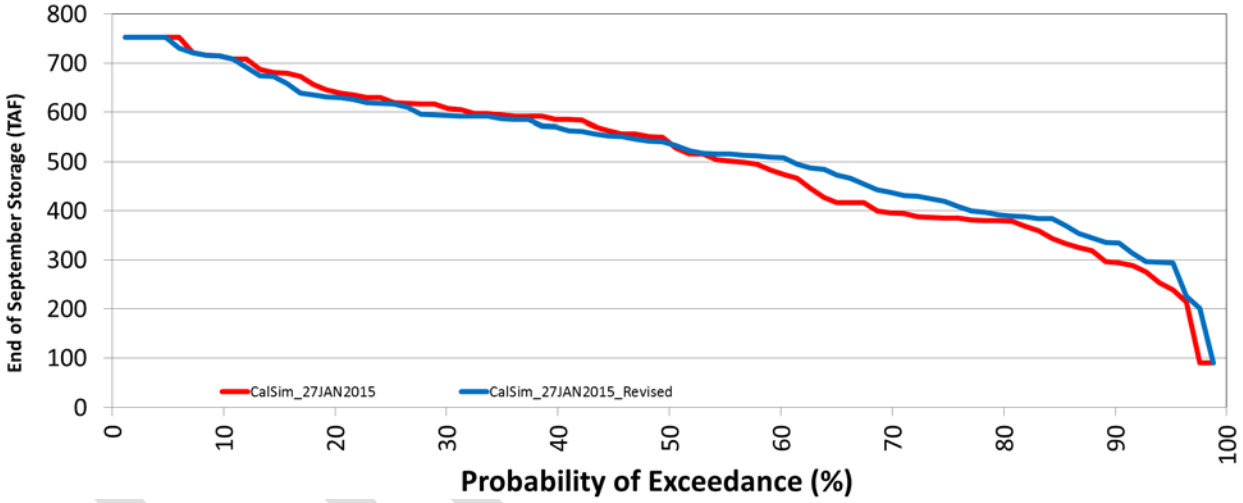


Figure 21. Folsom carryover storage probability of exceedance for CalSim_27JAN2015 and CalSim_27JAN2015_Revised

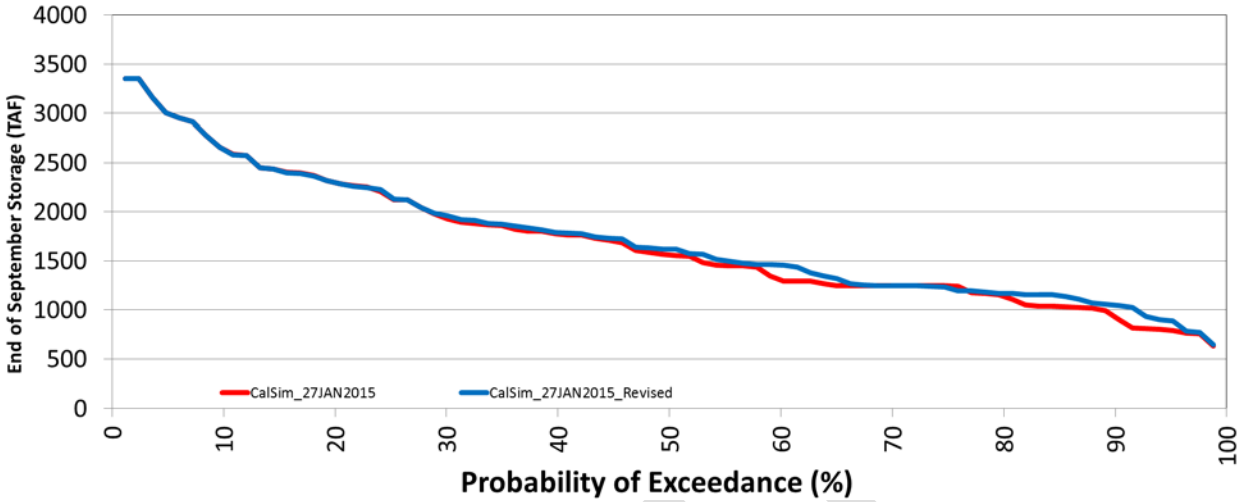


Figure 22. Oroville carryover storage probability of exceedance for CalSim_27JAN2015 and CalSim_27JAN2015_Revised

Significant changes in project reservoir operations necessarily affect project deliveries. Table 5 and Table 6 quantify the difference in CVP NOD and SOD project deliveries by month and water year type. Overall, CVP NOD project deliveries increased by 13 TAF, whereas CVP SOD project deliveries decreased by 25 TAF.

Table 5. Change in total CVP NOD project deliveries between CalSim_27JAN2015_Revised and CalSim_27JAN2015 (TAF)

Indx	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0	0	0	0	0	0	0	0	0	0	0	0	2
AN	0	0	0	0	0	0	1	1	2	2	2	1	8
BN	0	0	0	0	0	0	2	5	7	8	7	3	34
D	0	0	0	0	0	0	2	2	3	4	3	1	16
C	1	0	0	0	0	0	1	1	1	2	1	1	10
All	0	0	0	0	0	0	1	2	2	3	2	1	13

Table 6. Change in total CVP SOD project deliveries between CalSim_27JAN2015_Revised and CalSim_27JAN2015 (TAF)

Indx	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-2	-1	-2	-3	-4	2	-3	-3	-5	-6	11	-2	-18
AN	-3	-2	-3	-5	-5	4	-4	-5	-8	-10	3	-2	-41
BN	0	0	0	-1	-1	9	8	9	14	18	13	4	73
D	0	0	0	0	0	1	-6	-8	-13	-16	-9	-4	-57
C	-1	-1	-1	-2	-2	-4	-7	-12	-17	-22	-13	-6	-89
All	-1	-1	-1	-2	-2	2	-2	-4	-6	-7	2	-2	-25

Table 7 through Table 9 quantify the difference in SWP Table A, Article 56, and Article 21 project deliveries by month and water year type. Overall, Table A deliveries decreased 44 TAF, Article 56 deliveries increased 7 TAF, and Article 21 deliveries decreased 11 TAF. It is expected that reduced Table A allocations would result in fewer Article 56 requests. The reason for higher Article 56 deliveries is that the improved San Luis operation results in fewer Article 56 shortages.

Table 7. Change in SWP Table A deliveries between CalSim_27JAN2015_Revised and CalSim_27JAN2015 (TAF)

Indx	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-2	6	-2	1	-3	11	-10	-11	-11	-8	-7	-6	-41
AN	21	-10	-25	1	0	1	-12	-13	-15	-16	-16	-12	-97
BN	0	-3	-14	8	-6	-6	-4	-3	-1	0	0	0	-30
D	-9	-6	-40	1	1	2	15	9	7	6	14	14	13
C	10	7	-6	0	0	-1	-1	-18	-30	-39	-38	17	-97
All	2	0	-16	2	-2	3	-3	-6	-9	-9	-7	2	-44

Table 8. Change in SWP Article 56 deliveries between CalSim_27JAN2015_Revised and CalSim_27JAN2015 (TAF)

Indx	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0	0	0	6	4	2	0	0	0	0	0	0	11
AN	0	0	0	-4	-2	-1	0	0	0	0	0	0	-7
BN	0	0	0	3	2	2	0	0	0	0	0	0	7
D	0	0	0	3	3	2	0	0	0	0	0	0	9
C	0	0	0	4	4	1	0	0	0	0	0	0	9
All	0	0	0	3	2	1	0	0	0	0	0	0	7

Table 9. Change in SWP Article 21 deliveries between CalSim_27JAN2015_Revised and CalSim_27JAN2015 (TAF)

Indx	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0	0	0	-7	-6	7	-2	0	0	0	1	0	-7
AN	0	0	-1	-2	-1	-1	0	0	0	0	1	0	-4
BN	0	0	0	0	-1	-25	0	0	0	0	0	0	-25
D	0	0	0	0	-4	-2	0	0	0	0	1	0	-6
C	0	0	0	0	-14	-7	0	0	0	0	0	0	-20
All	0	0	0	-2	-5	-4	-1	0	0	0	1	0	-11

Table 10 quantifies the difference in Feather River Settlement Contractor fall rice decomposition deliveries by month and water year type. The annual average difference between the CalSim_27JAN2015_Revised and CalSim_27JAN2015 is 8 TAF. CalSim meets less than the rice decomposition demand when Oroville storage drops below 1.2 MAF. Since CalSim_27JAN2015_Revised maintains higher Oroville storage than CalSim_27JAN2015, the revised study is able to meet more of the rice decomposition demand annually.

Table 10. Change in Feather River Settlement Contractor rice decomposition deliveries between CalSim_27JAN2015_Revised and CalSim_27JAN2015 (TAF)

Indx	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	2	2	1	0	0	0	0	0	0	0	0	0	5
AN	-2	-2	-1	-1	0	0	0	0	0	0	0	0	-6
BN	4	6	4	2	0	0	0	0	0	0	0	0	16
D	4	4	2	1	0	0	0	0	0	0	0	0	12
C	4	5	3	1	0	0	0	0	0	0	0	0	12
All	2	3	2	1	0	0	0	0	0	0	0	0	8

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San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix C: Regulatory Settings

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Appendix C
Regulatory Settings

The Regulatory Settings Appendix supplements the San Luis Low Point Improvement Project (SLLPIP) Environmental Impact Statement/Environmental Impact Report (EIS/EIR). Federal and State of California (State) laws, rules and regulations, Executive Orders (EOs), and compliance requirements for implementation of the alternatives are described in the following sections. Descriptions are organized by Federal, State, and local requirements.

C.1 Federal Requirements

C.1.1 Advisory Council on Historic Preservation

Advisory Council on Historic Preservation (ACHP) regulations governing the Protection of Historic Properties (36 Code of Federal Regulations [CFR] Part 800) establish procedures for compliance with Section 106 of the National Historic Preservation Act (NHPA). These regulations define the Criteria of Adverse Effect; outline the role of the State Historic Preservation Officer (SHPO) in the Section 106 review process; set forth documentation requirements; and describe procedures to be followed if significant historic properties are discovered during implementation of an undertaking. Effects on prehistoric and historic period cultural resources, as well as traditional cultural properties of importance to Native American communities, that are deemed significant (i.e., eligible for listing in the National Register of Historic Places (NRHP) under 36 CFR Part 60.4) must be considered in project planning and construction. The responsible Federal agency must consult with the SHPO and other parties regarding any proposed undertaking that may affect NRHP-eligible properties. The NHPA Section 106 process also requires that, in the event that an undertaking will result in an adverse effect to historic properties, measures to avoid, minimize, or mitigate the adverse effect must be resolved through negotiated formal agreement in consultation with the SHPO and other consulting parties.

C.1.2 Bald and Golden Eagle Protection Act

Administered by the United States Fish and Wildlife Service (USFWS), the Bald and Golden Eagle Protection Act (BGEPA) provides for the protection of the bald eagle (*Haliaeetus leucocephalus*) and the golden eagle (*Aquila chrysaetos*) by prohibiting, except under certain specified conditions, the taking,

possession and commerce of such birds. The BGEPA prohibits unregulated take and makes it illegal to kill, wound, pursue, shoot, shoot at, poison, capture, trap, collect, molest, or disturb bald or golden eagles. Surveys are required to determine whether nests will be disturbed and, if so, a buffer area with a specified radius around the nest must be established so that no disturbance or intrusion is allowed until the young have fledged and left the nest. Coordination with the USFWS is recommended for establishing an appropriate buffer.

C.1.3 Central Valley Project Improvement Act

On October 30, 1992, Public Law 102-575 was signed into law. This law included Title 34, the Central Valley Project Improvement Act (CVPIA), which amended previous authorizations of the Central Valley Project (CVP). The CVPIA mandated changes in management of the CVP, requiring fish and wildlife protection, restoration, and mitigation as project purposes equal to that of agricultural irrigation, municipal and industrial (M&I) supplies, and power generation. The CVPIA also authorized the Accelerated Water Transfer Program, which allows voluntary water transfers under an accelerated process between CVP contractors through multi-year, programmatic environmental documentation.

C.1.4 Civil Rights Act of 1964 and Executive Order 12898

The concept of environmental justice is rooted in the Civil Rights Act of 1964 which prohibits discrimination in Federally-assisted programs, and EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,* issued February 11, 1994. EO 12898 requires all Federal agencies to conduct "programs, policies, and activities that substantially affect human health or the environment, in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under, such programs, policies, and activities, because of their race, color, or national origin." Section 1-101 of the Order requires Federal agencies to identify and address "disproportionately high and adverse human health or environmental effects" of programs on minority and low-income populations (EO 12898 1994).

The Council on Environmental Quality (CEQ) (1997) states that environmental justice concerns may arise from effects on the natural or physical environment, such as human health or ecological effects on minority or low-income populations, or from related social or economic effects.

In 1998, the United States Environmental Protection Agency (USEPA) issued final guidance on incorporating environmental justice concerns into National Environmental Policy Act (NEPA) analysis (USEPA 1998a). The guidance states that an affected area is considered to have a minority or low-income

population if the total minority or low-income population is more than 50 percent of the total population in the affected area or "meaningfully greater" than the percentage in the surrounding area (e.g., census tract compared to county, county compared to State). A minority is defined as a member of the following population groups: American Indian/Alaskan Native, Asian or Pacific Islander, Black (non-Hispanic), or Hispanic (CEQ 1997).

C.1.5 Clean Air Act

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

Table C-1 presents the current NAAQS for the criteria pollutants. O_3 is a secondary pollutant, meaning that it is formed in the atmosphere from reactions of precursor compounds under certain conditions. Primary precursor compounds that lead to formation of O_3 include volatile organic compounds (VOCs) and nitrogen oxides (NOx). Fine particulate matter with an aerodynamic diameter less than or equal to 2.5 microns can be emitted directly from sources (e.g., engines) or can form in the atmosphere from precursor compounds. Its precursor compounds in the area of analysis include sulfur oxides (SOx), NOx, VOCs, and ammonia.

The Federal CAA requires States to classify air basins (or portions thereof) as either "attainment" or "nonattainment" with respect to criteria air pollutants, based on whether the NAAQS have been achieved, and to prepare State Implementation Plans (SIPs) containing emission reduction strategies to maintain the NAAQS for those areas designated as attainment and to attain the NAAQS for those areas designated as nonattainment. Figure C-1 identifies the air basins that would be affected by the alternatives.

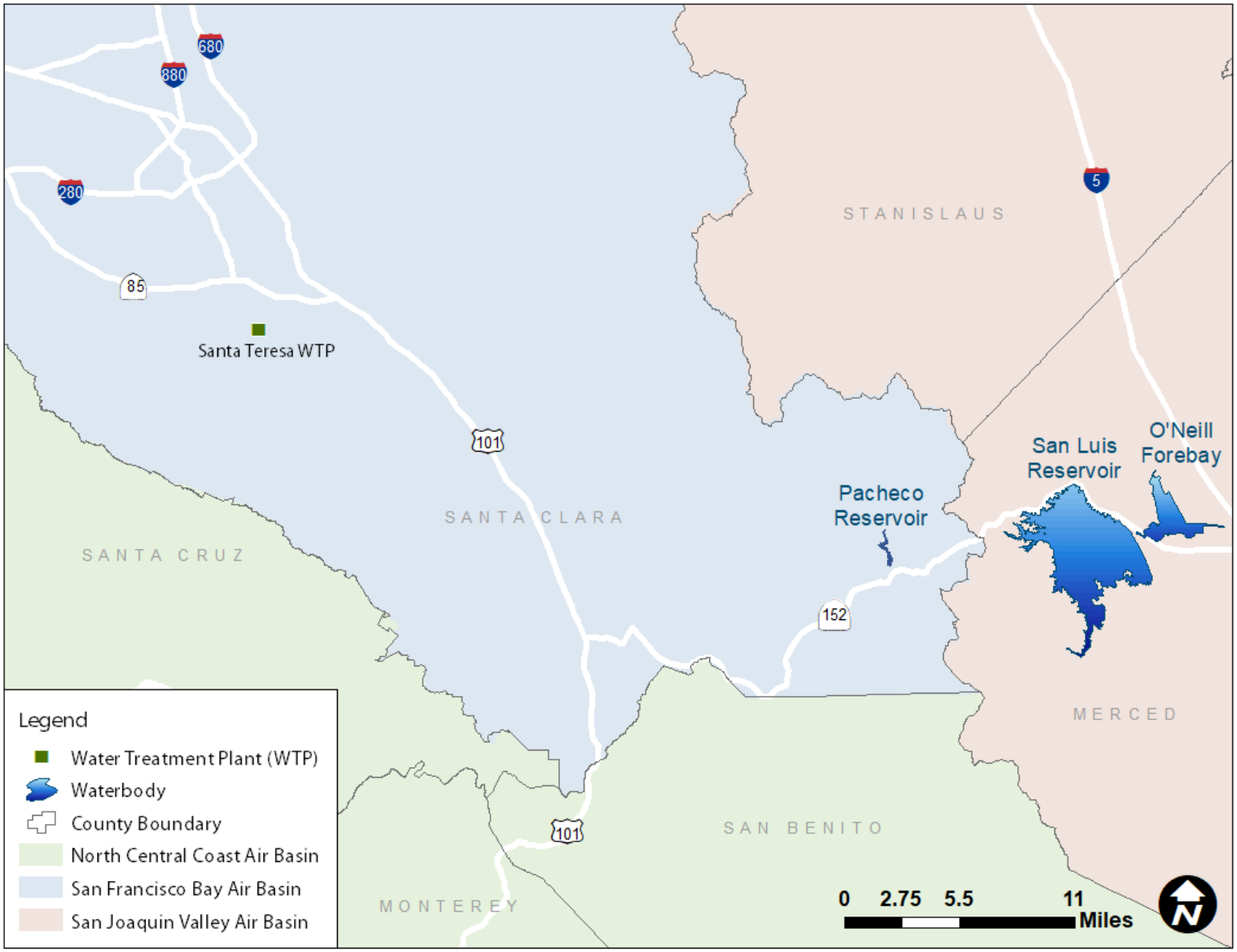
Table C-1. National Ambient Air Quality Standards

Pollutant	Averaging Time	NAAQS Primary	NAAQS Secondary	Violation Criteria
O_3	8 Hour	0.070 ppm (137 µg/m^3)	Same as Primary Standard	Annual fourth-highest daily maximum 8-hour concentration, averaged over three years
PM_{10}	24 Hour	150 µg/m^3	Same as Primary Standard	Not to be exceeded more than once per year on average over three years
$PM_{2.5}$	24 Hour	35 µg/m^3	Same as Primary Standard	98th percentile, averaged over three years
$PM_{2.5}$	Annual	12.0 µg/m^3	15 µg/m^3	Annual mean, averaged over three years
CO	1 Hour	35 ppm (40 mg/m^3)	N/A	Not to be exceeded more than once per year
CO	8 Hour	9 ppm (10 mg/m^3)	N/A	Not to be exceeded more than once per year
NO_2	1 Hour	100 ppb (188 µg/m^3)	N/A	98th percentile, averaged over three years
NO_2	Annual	53 ppb (100 µg/m^3)	Same as Primary Standard	Annual mean
SO_2	1 Hour	75 ppb (196 µg/m^3)	N/A	99th percentile of 1-hour daily maximum concentrations, averaged over three years
SO_2	3 Hour	N/A	0.5 ppm (1,300 µg/m^3)	Not to be exceeded more than once per year
Pb	Rolling 3-Month Average	0.15 µg/m	Same as Primary Standard	Not to be exceeded

Source: California Air Resources Board (CARB) 2016.

Key:

µg/m^3 = micrograms per cubic meter; CAAQS = California Ambient Air Quality Standard; CO = carbon monoxide; mg/m^3 = milligrams per cubic meter; N/A = not applicable; NAAQS = National Ambient Air Quality Standard; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; ppb = parts per billion; ppm = parts per million; SO_2 = sulfur dioxide



Source: CARB 2010.

Figure C-1. California Air Basins

C.1.5.1 General Conformity

Section 176 (c) of the CAA (42 United States Code [USC] 7506[c]) requires any entity of the Federal government that engages in, supports, or in any way provides financial support for, licenses or permits, or approves any activity to demonstrate that the action conforms to the applicable SIP required under Section 110 (a) of the Federal CAA (42 USC 7410[a]) before the action is otherwise approved. In this context, conformity means that such Federal actions must be consistent with a SIP's purpose of eliminating or reducing the severity and number of violations of the NAAQS and achieving expeditious attainment of those standards. Each Federal agency must determine that any action proposed that is subject to the regulations implementing the conformity requirements will, in fact, conform to the applicable SIP before the action is taken. This project is subject to the General Conformity Rule because it involves a Federal agency (United States Department of the Interior, Bureau of Reclamation [Reclamation]).

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

The general conformity regulations apply to a proposed Federal action in a nonattainment or maintenance area if the total of direct[1] and indirect[2] emissions of the relevant criteria pollutants and precursor pollutants caused by the proposed action equal or exceed certain de minimis amounts, thus requiring the Federal agency to make a determination of general conformity. A Federal agency can indirectly control emissions by placing conditions on Federal approval or Federal funding.

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

[1] Direct emissions are those that are caused or initiated by the Federal action, and occur at the same time and place as the Federal action.

[2] Indirect emissions are reasonably foreseeable emissions that are further removed from the Federal action in time and/or distance, and can be practicably controlled by the Federal agency on a continuing basis (40 CFR 93.152).

Table C-2. General Conformity De Minimis Thresholds

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

Source: 40 CFR 93.153.

Notes:

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

Key:

CO = carbon monoxide; n/a = not applicable; NAA = nonattainment area; NO_2 = nitrogen dioxide; NOx = nitrogen oxides; O_3 = ozone; Pb = lead; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compounds

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

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

- For any criteria pollutant or precursor, the total of direct and indirect emissions from the action is specifically identified and accounted for in

the applicable SIP's attainment or maintenance demonstration (40 CFR 93.158[a][1]); or

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

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

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

C.1.6 Clean Water Act

Growing public awareness and concern for controlling water pollution led to enactment of the Federal Water Pollution Control Act Amendments of 1972. As amended in 1977, this law became commonly known as the Clean Water Act (CWA). The CWA established the basic structure for regulating discharges of pollutants into the waters of the U.S. It gave the USEPA the authority to implement pollution control programs such as setting wastewater standards for industrial and municipal dischargers. The CWA also continued requirements to set water quality standards for all known contaminants in surface waters. The CWA made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions (USEPA 2002a).

Section 303(d) of the 1972 CWA requires States, territories and authorized tribes to develop a list of water quality-impaired segments of waterways. The 303(d) list includes water bodies that do not meet water quality standards for the specified beneficial uses of that waterway, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that these jurisdictions establish priority rankings for water

bodies on their 303(d) lists and implement a process, called Total Maximum Daily Loads (TMDLs), to meet water quality standards (USEPA 2002b).

The TMDL process is a tool for implementing water quality standards and is based on the relationship between pollution sources and in-stream water quality conditions. The TMDL establishes the maximum allowable loadings of a pollutant that can be assimilated by a water body while still meeting applicable water quality standards. The TMDL provides the basis for the establishment of water quality-based controls. These controls should provide the pollution reduction necessary for a water body to meet water quality standards. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The TMDLs allocation calculation for each water body must include a margin of safety to ensure that the water body can be used for the uses the State has designated. Additionally, the calculation also must account for seasonal variation in water quality (USEPA 2002b).

TMDLs are intended to address all significant stressors that cause or threaten to cause water body beneficial use impairments, including point sources (e.g., wastewater treatment plant discharges), nonpoint sources (e.g., runoff from fields, streets, range, or forest land), and naturally occurring sources (e.g., runoff from undisturbed lands). TMDLs may be based on readily available information and studies. In some cases, complex studies or models are needed to understand how stressors are causing water body impairment. In many cases, simple analytical efforts provide an adequate basis for stressor assessment and implementation planning. TMDLs are developed to provide an analytical basis for planning and implementing pollution controls, land management practices, and restoration projects needed to protect water quality. States are required to include approved TMDLs and associated implementation measures in State water quality management plans. Within California, TMDLs implementation is through regional Basin Plans.

The CWA also establishes the basic structure for regulating discharges of pollutants into the waters of the U.S. and gives the USEPA the authority to implement pollution control programs such as setting wastewater standards for industries (USEPA 2002c). In certain States such as California, the USEPA has delegated authority to State agencies.

Water quality of waters of the U.S. subjected to a discharge of dredged or fill material is regulated under Section 404 of the CWA. These actions must not violate Federal or State water quality standards. Specifically in the State of California, the applicable Regional Water Quality Control Board (RWQCB) administers Section 401 and either issues or denies water quality certifications depending upon whether the proposed discharge or fill material complies with applicable State and Federal laws.

In addition to complying with State and Federal water quality standards, all point sources that discharge into waters of the U.S. must obtain a National

Pollutant Discharge Elimination System (NPDES) permit under provisions of Section 402 of the CWA. In California, the State Water Resources Control Board (SWRCB) and RWQCBs are responsible for the implementation of the NPDES permitting process at the State and regional levels, respectively.

The NPDES permit process also provides a regulatory mechanism for the control of non-point source pollution created by runoff from construction and industrial activities, and general and urban land use, including runoff from streets. Projects involving construction activities (e.g., clearing, grading, or excavation) involving land disturbance greater than one acre must file a Notice of Intent (NOI) with the applicable RWQCB to indicate their intent to comply with the State General Permit for Stormwater Discharges Associated with Construction Activity (General Permit). The State General Permit specifies Best Management Practices (BMPs), to achieve compliance as well as numeric action levels (NALs) in order to achieve Federal standards to minimize sediment and pollutant loadings. The General Permit requires preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP) as well as a Rain Event Action Plan (REAP) prior to construction. The SWPPP and REAP are intended to help identify the sources of sediment and other pollutants, and assess the effectiveness of BMPs in preventing or reducing pollutants in storm water discharges and authorized non-storm water discharges. The CWA also requires that a permit be obtained from the USEPA and the United States Army Corps of Engineers (USACE) when discharge of dredged or fill material into wetlands and waters of the U.S. occurs. Section 404 of the CWA requires the USEPA and USACE to issue individual and general permits for these activities.

C.1.7 Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), also known as Superfund, created a tax on the chemical and petroleum industries to provide for response and cleanup of hazardous substances that may endanger public health or the environment. The Act established requirements for abandoned hazardous waste sites and provided for liability of persons responsible for releases of hazardous waste at these sites (USEPA 2015a).

C.1.8 Dam Safety Guidelines

The Federal government issued *Federal Guidelines for Dam Safety* in 1979 (reprinted April 2004) (Federal Emergency Management Agency [FEMA] 2004). The purpose of these guidelines is to enhance national dam safety and ensure protection of human life and property. Federal agencies are required to apply these guidelines in planning, design, construction, operation, and regulation to protect the structural integrity of dams and associated structures. Additional guidelines were developed in subsequent documents including dam

safety risk management, emergency action planning, earthquake analysis and design of dams, hazard potential classification for dams, and selecting appropriate inflow design floods for dams.

C.1.9 Earthquake Hazard Reduction Act of 1977

The Earthquake Hazard Reduction Act of 1977 established a national goal of reducing the risks of life and property from future earthquakes in the United States through the establishment and maintenance of an earthquake program including prediction and hazard assessment research, seismic monitoring and information dissemination. The Act established the Earthquake Hazard Reduction Program to promote the adoption of earthquake hazard reduction measures by Federal, State, and local governments. Section 8 of the Act calls for the adoption of standards for assessing and enhancing the seismic safety of buildings constructed for or leased by the Federal Government (42 United States Code [USC] 7701 et. seq.).

C.1.10 Endangered Species Act

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

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

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

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

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

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

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

The Coordinated Long-Term Operation of the CVP and State Water Project (SWP) is currently subject to the terms and conditions of the BOs issued by USFWS (2008) and NMFS (2009) pursuant to Section 7 of the Federal ESA. These BOs control operation of the CVP and SWP Sacramento-San Joaquin River Delta (Delta) pumps and consequently storage levels in San Luis Reservoir and deliveries to CVP and SWP contractors. The BOs requires maximum transfer volume to be limited to 600,000 acre-feet (AF) for critical and dry years and to 360,000 AF for all other year types.

In 2011, these BOs were remanded by court order to the federal fish and wildlife agencies for revision, these decisions were appealed to the Ninth Circuit Court of Appeals and in 2014 the orders to rewrite the BOs were reversed (Congressional Research Service 2014). The Ninth Circuit decision affirmed the requirement that Reclamation complete an EIS on implementing the BOs by December 1, 2015 (Congressional Research Service 2014). The Final EIS was published on November 23, 2015 and the Record of Decision was signed on January 11, 2016 (Reclamation 2016a).

C.1.11 Executive Order 11990, Protection of Wetlands

EO 11990 requires Federal agencies to take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. This requirement extends to actions involved with construction activities or increased storage in existing reservoirs which would affect wetlands. Federal agencies must provide opportunities for early public review of any plans or proposals for new construction in wetlands.

C.1.12 Executive Order 11988, Floodplain Management

EO 11988 (*Floodplain Management)* addresses floodplain issues related to human safety, health, and welfare. It requires Federal agencies to avoid adverse impacts due to occupancy and modification of floodplains and support of development within floodplains (FEMA 2015). The EO also encourages the restoration and preservation of the beneficial aspects of floodplains through the following actions:

- acquiring, managing, and disposing of federal lands and facilities;
- providing federally-undertaken, financed, or assisted construction and improvements; and
- conduct federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation and licensing activities.

C.1.13 Executive Order 13007

EO 13007 states that in managing Federal lands, each executive branch agency with statutory or administrative responsibility for those lands will accommodate access to and ceremonial use of Native American sacred sites by religious practitioners and will avoid adversely affecting the physical integrity of such sites. Under EO 13007, Federal lands encompass any lands owned by the US, including leasehold interests, with the exception of Native American trust lands. A Native American or “Indian” tribe under EO 13007 is considered any Native American or Alaskan tribe, band, pueblo, village, or community acknowledged by the Secretary of the Interior pursuant to 25 USC Section 479a. “Sacred sites”

are regarded as those identified by a Native American tribe or individual to be sacred by virtue of their established religious significance to, or ceremonial use by, a Native American religion. The American Indian Religious Freedom Act of 1978 also allows access to sites of religious importance to Native Americans.

C.1.14 Executive Order 13783, Promoting Energy Independence and Economic Growth

Section 3 of EO 13783 rescinds certain energy and climate-related presidential and regulatory actions. Actions that were revoked include EO 13653, Preparing the United States for the Impacts of Climate Change, and CEQ guidance entitled “Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews.”

C.1.15 Federal Water Project Recreation Act

The Federal Water Project Recreation Act requires Federal agencies with authority to approve water projects to include recreation development as a condition of approving permits. Recreation development must be considered along with any navigation, flood control, reclamation, hydroelectric, or multipurpose water resource project. The act states "consideration should be given to opportunities for outdoor recreation and fish and wildlife enhancement whenever any such project can reasonably serve either or both purposes consistently" (Reclamation 2011).

C.1.16 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA) of 1946 requires Federal agencies to provide for protection and supply of wildlife and wildlife resources, including the provision of public shooting and fishing recreation resources. It requires that fish and wildlife resources receive equal consideration to other project features. It also requires Federal agencies that construct, license or permit water resource development projects to first consult with the USFWS, NMFS, and State fish and wildlife agencies regarding the impacts on fish and wildlife resources and measures to mitigate these impacts. Under the FWCA, the USFWS coordinates with other agencies (e.g., NMFS and California Department of Fish and Wildlife [CDFW]) to ensure that the recommendations in the FWCA report reflects a more inclusive report that includes an evaluation of impacts on fish and wildlife from the project, required mitigation measures, and other recommendations to address these impacts.

C.1.17 Magnuson-Stevens Fishery Conservation and Management Act

The Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (Magnuson-Stevens Act)

(P.L. 94-256 or 10 USC 1801 et seq.) require heightened consideration of habitat for commercial fish species in resource management decisions. EFH is defined in the Magnuson-Stevens Act as "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity." NMFS interprets EFH to include aquatic areas and their associated physical, chemical, and biological properties used by fish that are necessary to support a sustainable fishery and the contribution of the managed species to a healthy ecosystem. The Magnuson-Stevens Act and its implementing regulations (50 CFR § 600.92[j]) require that before a Federal agency may authorize, fund, or carry out any action that may adversely affect EFH, it must consult with NMFS. The purpose of the consultation is to develop conservation recommendations that address reasonably foreseeable adverse effects on EFH. Freshwater EFH for Pacific salmonids includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically, accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers, and long-standing impassable natural barriers. For the purposes of this Project, the EFH provisions of the Magnuson-Stevens Act would apply to Chinook salmon.

C.1.18 Memorandum of April 29, 1994, "Government-to-Government Relations with Native American Tribal Governments"

President William J. Clinton's 1994 memorandum, "Government-to-Government Relations with Native American Tribal Governments," directed Reclamation to assess the effect of its programs on tribal trust resources and Federally-recognized tribal governments. Reclamation is tasked with actively engaging Federally-recognized tribal governments and consulting with such tribes on a government-to-government level (59 FR 1994).

C.1.19 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) decrees that all migratory birds and their parts (including eggs, nests and feathers) are fully protected. The MBTA protects nearly all native North American bird species. Under the MBTA, taking, killing, or possessing migratory birds is unlawful. Under the MBTA, surveys are required to determine whether nests will be disturbed and, if so, a buffer area with a specified radius around the nest must be established so that no disturbance or intrusion is allowed until the young have fledged and left the nest. The size of the buffer area would vary depending on species and local conditions (e.g., presence of busy roads) and the professional judgment of the project biologist. Coordination with the USFWS is recommended for establishing an appropriate buffer. Several species of migratory birds are known to occur in the area of analysis.

C.1.20 Native American Graves Protection and Repatriation Act

Native American Graves Protection and Repatriation (NAGPRA) of 1990 and its implementing regulations (43 CFR Part 10) require Federal agencies and museums to inventory human remains, associated and unassociated funerary objects, sacred objects, and objects of cultural patrimony and to provide affiliated tribes with an inventory of those cultural items. It further requires that those cultural items be repatriated upon the request of affiliated, Federally recognized tribes. If Native American human remains or NAGPRA cultural items are discovered on Federal lands, the agency must notify Federally recognized Native American tribal leaders of the discovery and provide them with an opportunity to claim affiliation with and priority of custody for those remains and items.

C.1.21 National Environmental Policy Act

Under NEPA, economic or social effects must be discussed if they are inter-related to the natural or physical environmental effects of a project. NEPA states the following with regard to analysis of economic effects (Title 40, CFR, Section 1508.14):

> "…economic or social effects are not intended by themselves to require preparation of an environmental impact statement. When an environmental impact statement is prepared and economic or social and natural or physical effects are interrelated, then the environmental impact statement will discuss all of these effects on the human environment."

Since economic effects of the project are related to physical environmental effects, a NEPA economic analysis is required.

NEPA (42 USC Section 4371 et seq.) also requires Federal agencies to foster environmental quality and preservation. Section 101(b)(4) declares that one objective of the national environmental policy is to "preserve important historic, cultural, and natural aspects of our national heritage...." For any major Federal actions significantly affecting environmental quality, Federal agencies must prepare and make available for public comment an EIS.

C.1.22 National Flood Insurance Program

The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program (NFIP) to provide affordable flood insurance to property owners and encourage communities to comply with FEMA regulations including enforcement of floodplain management regulations (FEMA 2016a). FEMA issues Flood Insurance Rate Maps (FIRMs) for communities participating in NFIP. These maps delineate flood hazard zones in the community. Flood zones are defined as follows (FEMA 2016b):

- Undetermined Risk Areas: Zone D includes areas where flooding could happen although the flood risks are undetermined because no analysis has been conducted (FEMA 2011).

- Minimal Flood Hazard Areas: Zones C and X (unshaded) are defined as areas of minimal flood hazard above the 500-year flood level.

- Moderate Flood Hazard Areas: Zones B and X (shaded) are defined as areas of moderate flood hazard usually located between the limits of the 100-year and 500-year floodplain.

- Special Flood Hazard Areas (SFHA): is defined as areas with a one percent annual chance of flooding (100-year floodplain); these areas are designated on the FIRM as Zones A, AO, AH, A1-A-30, AE, A99, AR, AR/AE, AR/AO, AR/A1-A30, AR/A, V, VE or V1-V30.

C.1.23 National Historic Preservation Act

The NHPA of 1966 (54 USC Section 300101 et seq.) requires Federal agencies to consider the preservation of prehistoric and historic period resources. The NHPA authorizes the Secretary of the Interior to expand and maintain the NRHP, and it establishes the ACHP as an independent Federal entity. Section 106 of the Act (54 USC Section 300108) requires Federal agencies to take into account the effects of their undertakings on historic properties and affords the ACHP an opportunity to comment on the undertaking prior to the licensing or approval of the expenditure of funds on any undertaking that may affect properties listed, or eligible for listing, in the NRHP. The implementing regulations at 36 CFR Part 800 identify the steps that must be followed to comply with Section 106 of the NHPA. These steps include consultation with the SHPO.

Section 106 regulations allow Federal agencies to conduct “nondestructive project planning activities before completing compliance with Section 106” (36 CFR 800.1[c]), provided any subsequent consideration of alternatives to avoid, minimize, or mitigate adverse effects is not restricted during the planning process. Feasibility studies, and environmental studies conducted in support of such studies, are considered planning activities that do not require completion of the Section 106 process. If and when Congress authorizes a SLLPIP alternative,

that undertaking will be subject to NHPA Section 106 compliance, to include consultation with the SHPO and other Section 106 consulting parties as required. Section 106 of the NHPA requires Federal agencies to consider the effects of the undertaking on historic properties and to afford the ACHP and the SHPO a reasonable opportunity to comment on any undertaking that would adversely affect properties listed or eligible for listing in the NRHP. Section 302706 (a) of the NHPA allows properties of traditional religious and cultural importance to Indian tribes to be determined eligible for inclusion in the NRHP. Under the NHPA, a "historic property" or significant cultural resource is one that meets the following NRHP criteria (36 CFR Part 60.4):

The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and:

A. That are associated with events that have made a significant contribution to the broad patterns of our history, or

B. That are associated with the lives of persons significant in our past, or

C. That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction, or

D. That have yielded, or may be likely to yield, information important in prehistory or history.

The Federal review of projects is typically referred to as the Section 106 process. Section 106 review normally involves a four-step procedure that is detailed in the implementing regulations (36 CFR Part 800):

1. *Establish undertaking.* Determine whether the proposed Federal action is an undertaking;

2. *Identification of historic properties.* Determine scope of identification efforts, phased identification and evaluation, evaluate historic significance, results of identification and evaluation;

3. *Assessment of adverse effects.* Apply criteria of adverse effect, finding of no adverse effect, consulting party review, results of assessment;

4. *Resolution of adverse effects.* Continue consultation, resolve adverse effects, memorandum of agreement.

Once cultural resources are identified in the project area of potential effects (APE), they must be evaluated under the four NRHP criteria found at 36 CFR

Part 60.4 pursuant to 36 CFR Part 800.4(c). If the agency determines historic properties are within the APE, then the effect of the undertaking on historic properties is assessed as outlined in 36 CFR 800.5. The effect can be either no adverse effect or adverse effect. Adverse effects must be resolved in consultation with and through agreement among the responsible Federal agency or agencies, the SHPO, and other Section 106 consulting parties pursuant to 36 CFR Part 800.6.

C.1.24 National Park Service Regulations

National Park Service (NPS) Regulations (36 CFR Part 60) set forth procedures for nominating properties to the NRHP and present the criteria to be applied in evaluating the eligibility of prehistoric and historic period resources for listing in the NRHP.

C.1.25 Noise and Vibration Legislation

In the past, the USEPA coordinated all Federal noise control activities through its Office of Noise Abatement and Control. However, in 1981, Congress concluded that noise issues were best handled at the State or local government level. As a result, the USEPA phased out the office's funding in 1982 as part of a shift in Federal noise control policy to transfer the primary responsibility of regulating noise to State and local governments. However, the Noise Control Act of 1972 and the Quiet Communities Act of 1978 were not rescinded by Congress and remain in effect today, although essentially unfunded. Additionally, Title IV – Noise Pollution, of the Clean Air Act provides guidance to State and local entities in establishing appropriate noise control standards.

C.1.26 Principles and Requirements for Federal Investments in Water Resources

Furthermore, Reclamation is subject to *Principles and Requirements for Federal Investments in Water Resources* (CEQ 2013). This document requires areas of risk and uncertainty to be identified, described, and considered when analyzing potential investments in water resources. It specifically requires climate change impacts to be accounted for and addressed.

C.1.27 Real-Time Decision-Making to Assist Fishery Management

Reclamation and the California Department of Water Resources (DWR) work closely with USFWS, NMFS, CDFW, and other agencies to coordinate the operation of the CVP and SWP with fishery needs. This coordination is facilitated through several forums, as discussed below.

CALFED Water Operations Management Team The Water Operations Management Team (WOMT) was established to facilitate decision making at the appropriate levels and provide timely support of decisions. This team,

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

CALFED Ops Group The CALFED Ops Group consists of participants from Reclamation, DWR, USFWS, NMFS, CDFW, the SWRCB, and the USEPA. The CALFED Ops Group generally meets 11 times a year in a public setting to discuss CVP and SWP operations, Central Valley Project Improvement Act (CVPIA) implementation, and coordination with efforts to protect endangered species. The CALFED Ops Group held its first public meeting in January 1995, and during the next six years the group developed and refined its process. The CALFED Ops Group is recognized within D-1641 and elsewhere as a forum where agencies can consult and achieve consensus on coordinating CVP and SWP operations with endangered species, water quality, and CVPIA requirements. Decisions made by the CALFED Ops Group have been incorporated into the Delta standards to protect beneficial uses of water (e.g., export/inflow ratios and some closures of Delta Cross Channel [DCC] gates).

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

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

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

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

coordination with the other operational programs or resource-related aspects of project operations.

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

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

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

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

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

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

American River Operations Work Group In 1996, Reclamation established an operational working group for the lower American River, known as the American River Operations Work Group. Although open to anyone, the work group's meetings generally include representatives from several agencies and organizations with ongoing concerns about management of the lower American River: Reclamation, USFWS, NMFS, CDFW, the Sacramento Area Flood Control Agency, the Water Forum, the City of Sacramento, Sacramento County, the Western Area Power Administration, and the Save the American River Association. The American River Operations Work Group convenes at least monthly to provide fisheries updates and reports to enable Reclamation to better manage Folsom Lake for fish resources in the lower American River.

C.1.28 Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) of 1976, administered by the USEPA, governs the disposal of solid and hazardous waste. Under RCRA, the USEPA was given authority of "cradle-to-grave" control of hazardous waste and this is the current approach for hazardous waste management. Three programs were established under RCRA including the solid waste program, hazardous waste program, and underground storage tank (UST) program. Under the law, controls for the generation, transport, treatment, storage, and disposal of hazardous waste are strictly mandated. Only active and future facilities are controlled under RCRA (USEPA 2015b).

There have been three amendments to RCRA, including the Hazardous and Solid Waste Amendments of 1984, the Federal Facility Compliance Act of 1992, and the Land Disposal Program Flexibility Act of 1996 (USEPA 2015b).

C.1.29 Safe Drinking Water Act

The Federal Safe Drinking Water Act (SDWA) was enacted in 1974 to protect the quality of drinking water in the United States (U.S.). This law focuses on all waters actually or potentially designated for drinking use, whether from above ground or underground sources. The SDWA authorized the USEPA to establish safe standards of purity for specified contaminants and required all owners or operators of public water systems to comply with primary (health-related) standards. State governments, which assume this power from the USEPA, also encourage attainment of secondary standards (nuisance-related). Contaminants of concern in a domestic water supply are those that either pose a health threat or in some way alter the aesthetic acceptability of the water. These types of contaminants are currently regulated by the USEPA through primary and secondary maximum contaminant levels (MCLs). As directed by the SDWA amendments of 1986, the USEPA has been expanding its list of primary MCLs. MCLs have been proposed or established for approximately 100 contaminants.

C.1.30 San Luis Reservoir State Recreation Area

Through an agreement between Reclamation and the California Department of Parks and Recreation (CDPR), a Resource Management Plan/General Plan (RMP/GP) was prepared for the San Luis Reservoir State Recreation Area (SRA) and adjoining Reclamation land (Reclamation and CDPR 2013). These areas are managed by State agencies including CDPR, DWR, CDFW, and Reclamation. Elements of the plan include limiting areas of future development and avoiding environmentally sensitive areas. The aesthetic resource goals of the plan include:

- Preserve scenic vistas that overlook open land and water through the identification and definition of significant vista points and viewsheds (Goal RES-S1).

- Maintain large expanses of open space free of visual and physical interruptions (Goal RES-S2).

- Make new structures architecturally compatible with their use as recreation facilities and distinguishable from the water operations structures but in keeping with overall site character (Goal RES-S3).

- Identify a common and unified set of site-related details and materials (signage, gates, surface materials, fences, etc.) so that new facilities and infrastructure are compatible with the character of the site and are distinctive for recreation facilities (Goal RES-S4).

- Prevent aesthetic and environmental damage from duration and intensity of lighting and fixtures (Goal RES-S5).

C.1.31 Stage 1 and Stage 2 Disinfectants and Disinfection Byproducts Rules (D/DBPR) and Long-Term 1 and 2 Enhanced Surface Water Treatment Rules (LT1ESWTR and LT2ESWTR)

While disinfectants are effective in controlling many microorganisms, certain types react with natural organic and inorganic matter in source water and distribution systems to form Disinfection Byproducts (DBPs).

The Stage 1 D/DBPR updates and supersedes the 1979 regulations for total trihalomethanes. In addition, it is intended to reduce exposure to three disinfectants and many DBPs. The D/DBPR establishes maximum residual disinfectant level goals and maximum residual disinfectant levels for three chemical disinfectants – chlorine, chloramine and chlorine dioxide (Table 4-1). It also establishes maximum contaminant level goals (MCLGs) and MCLs for total trihalomethanes, haloacetic acids, chlorite, and bromate (Table C-3).

Table C-3. Maximum Contaminant Levels (MCLs) and Maximum Residual Disinfectant Levels (MRDLs) for Stage 1 Disinfectants and Disinfection Byproducts Rule

Disinfectant Residual	MCL (mg/L)	MRDL (mg/L)
Chlorine		4.0 (as CI2)
Chloramine		4.0 (as CI2)
Chlorine Dioxide		0.8 (as ClO2)
Total trihalomethanes (TTHM) 1	0.080	
Haloacetic acids (five) 2	0.060	
Dichloroacetic acid	0	
Chlorite	1.0	
Bromate	0.010	

Source: USEPA 2002d.
mg/L = milligrams per liter
MCL = Maximum Contaminant Level
MRDL = Maximum Residual Disinfectant Level
[1] Total trihalomethanes is the sum of the concentrations of chloroform, bromodichloromethane, dibromochloromethane, and bromoform.
[2] Haloacetic acids (five) are the sum of the concentrations of the mono-, di-, and trichloroacetic acids and mono- and dibromoacetic acids.

Water systems that use surface water, or groundwater under the direct influence of surface water, and that use conventional filtration treatment are required to remove specified percentages of organic materials, measured as total organic carbon (TOC), that may react with disinfectants to form DBPs (Table C-4). Removal is to be achieved through application of a treatment technique (e.g., enhanced coagulation or enhanced softening), unless the system meets alternative criteria.

Table C-4. Required Removal of Total Organic Carbon by Enhanced Coagulation and Enhanced Softening for Subpart H Systems Using Conventional Treatment[1] Recent Required Removal of TOC

Source Water TOC (mg/L)	Source Water Alkalinity (mg/L as $CaCO_3$)		
	0-60	>60-120	>120[2]
>2.0-4.0	35%	25%	15%
>4.0-8.0	45%	35%	25%
>8.0	50%	40%	30%

Source: USEPA 1998b.

$CaCO_3$ = calcium carbonate

mg/L = milligrams per liter

TOC = Total Organic Carbon

[1] Systems meeting at least one of the alternative compliance criteria in the rule are not required to meet the removals in this table.

[2] Systems practicing softening must meet these TOC removal requirements.

The Stage 2 DBPR mandates stricter compliance monitoring requirements for Trihalomethanes (THMs) and Haloacetic Acids (HAA5) and targets public water systems considered at the highest risk.

The federal LT1ESWTR provides increased public health protection against microbial pathogens, specifically the protozoan Cryptosporidium. The federal LT1ESWTR is a counterpart to the federal Interim Enhanced Surface Water Treatment Rule (IESWTR) and applies to public water systems (PWS) using surface water or ground water under the direct influence (GWUDI) and serving fewer than 10,000 persons.

The Long Term 1 Enhanced SWTR provisions include the following:

- MCLG of zero for Cryptosporidium;
- 2-log Cryptosporidium removal requirements for systems that filter;
- Strengthened performance standards and individual filter turbidity monitoring provisions;
- Disinfection benchmark provisions to assure continued levels of microbial protection while facilities take necessary steps to comply with new DBP standards;
- Inclusion of Cryptosporidium in the definition of groundwater under the direct influence of surface water and additional avoidance criteria for unfiltered public water systems;
- Requirements for covers on new finished water reservoirs; and
- Sanitary surveys for all surface water and groundwater under the direct influence of surface water systems regardless of size.

The federal LT2ESWTR provides increased public health protection through control of microbial contaminants by focusing on PWS with elevated Cryptosporidium risk and by preventing significant increases in microbial risk that might otherwise occur when systems implement the federal Stage 2 Disinfectants and Disinfection Byproducts Rule. The federal LT2ESWTR applies to PWS using surface water or GWUDI (California Department of Public Health [CDPH] 2013). The CDPH required compliance with Stage 2 DBP rules by 2012-2013, dependent on population served by the system.

C.1.32 Superfund Amendments and Reauthorization Act

In 1986, the Superfund Amendments and Reauthorization Act (SARA), allowed CERCLA to continue with cleanup of sites and added several amendments. SARA made changes to CERCLA with regard to enforcement authorities and settlement tools. In addition, SARA emphasized the implementation of permanent remediation with the use of innovative treatment technologies for cleanup of hazardous waste sites; increased State coordination with Superfund programs; increased focus on affects to human health by hazardous waste sites; and encouraged the greater public to participate in decision making about site cleanup (USEPA 2015a).

C.1.33 Surface Water Treatment Rule

The Federal Surface Water Treatment Rule (SWTR) became effective on June 19, 1989. The California Surface Water Treatment Rule (California SWTR), which implements the Federal SWTR within the State, became effective in June 1991. The California SWTR satisfies three specific requirements of the SDWA. First, it establishes criteria for determining when filtration is required for surface waters. Second, it defines minimum levels of disinfection for surface waters. Third, it addresses Giardia lamblia, viruses, Legionella, turbidity, and heterotrophic plate count by setting a treatment technique. It is appropriate to set a treatment technique in lieu of an MCL for a contaminant when it is not technologically or economically feasible to measure that contaminant. For example, methods to accurately detect Giardia lamblia are very time-consuming and costly, and may not be accurate. The SWTR is based on providing treatment to achieve a minimum theoretical percent removal/inactivation of 99.9 percent (3 log) of Giardia lamblia and 99.99 percent (4 log) of viruses. Treatment required includes the use of a filtration system, unless very stringent source water quality and site-specific conditions are met. The level of treatment needed to meet the 3- and 4-log removal must be achieved by disinfection processes.

Certain chemical disinfectants used to treat Giardia lamblia and viruses can react with naturally-occurring materials in the water to form unintended byproducts. These byproducts may pose health risks. Amendments to the SDWA in 1996 require USEPA to develop rules to balance the risks between microbial pathogens and DBPs. The intent of these amendments is to

strengthen public health protection against microbial contaminants, and at the same time, reduce potential health risks of DBPs. The Stage 1 Disinfectants and Disinfection Byproducts Rule (Stage 1 D/DBPR) and Interim Enhanced SWTR, announced in December 1998, are the first of a set of rules under the 1996 SDWA Amendments.

C.1.34 United States Department of the Interior, Bureau of Reclamation National Environmental Policy Act Handbook

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

C.1.35 United States Department of the Interior, Bureau of Reclamation Safety of Dams Act

The Safety of Dams Act of 1978 as amended gives Reclamation authority to modify dams and other actions to reduce the risk related to dam failure (Reclamation 2016b). Reclamation's Safety of Dams Program ensures regular monitoring, examination and evaluation of dam performance to identify potential risks to the public, property or the environment. The evaluation considers loading conditions and the consequences of structural dam failure. Unreasonable risks require corrective actions to be developed and implemented. The Safety of Dams Process entails a four-phased approach including: comprehensive and periodic inspections and reviews every 8 and 4 years respectively; issues evaluation which may include additional studies; corrective action study as recommended by the issues evaluation; and design/modification as recommended in the corrective action study (Reclamation 2016c). A Corrective Action Study of B.F. Sisk Dam is underway by Reclamation in collaboration with DWR (Reclamation 2016d).

C.1.36 United States Department of the Interior, Climate Change Adaptation Plan

In 2014, U.S. Department of Interior (DOI) released its Climate Change Adaptation Plan, which focuses on the department's work to address climate change through implementation of EO 13653 (since rescinded) and its Climate Change Adaptation Policy (523 DM 1). The plan summarizes DOI's efforts to address climate-related risks and demonstrates its efforts to modernize programs to support climate resilience investment (DOI 2014).

C.1.37 United States Department of the Interior Plan for a Coordinated, Science-Based Response to Climate Change Impacts on Our Land, Water, and Wildlife Resources

DOI subsequently released *Interior's Plan for a Coordinated, Science-Based Response to Climate Change Impacts on Our Land, Water, and Wildlife Resources*. The plan provides a framework for DOI's conservation strategies related to climate change. DOI relies on three main resources – climate change impact science, data integration and dissemination, and enabling science-based adaptation strategies – to implement its vision. As part of its response to climate change, DOI established Climate Science Centers and Landscape Conservation Cooperatives to form the foundation of an integrated approach to climate change science and adaptation (DOI no date).

C.1.38 United States Department of the Interior, Secretarial Order No. 3215

In 2000, the DOI issued a Secretarial Order, Principles for the Discharge of the Secretary's Trust Responsibility, assigns responsibility for ensuring protection of ITAs to the heads of bureaus and offices (DOI 2000). Reclamation is required to "protect and preserve Indian trust assets from loss, damage, unlawful alienation, waste, and depletion" (DOI 2000).

C.1.39 United States Department of the Interior Secretarial Order No. 3289, Amendment No. 1

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

C.1.40 United States Department of the Interior Secretarial Order No. 3360

In 2017, the DOI issued a Secretarial Order that continues the implementation of EO 13783 by rescinding documents inconsistent with EO 13783. The order rescinds Departmental Manual Part 523, Chapter 1: Climate Change Policy, and directs each bureau and office to review all existing regulations, orders, guidance documents, policies, instructions, notices, and implementing actions

that are inconsistent with EO 13783 and initiate a process to suspend, revise, or rescind any such actions (DOI 2017).

C.2 State Requirements

C.2.1 Alquist-Priolo Earthquake Fault Zoning Act

The 1972 Alquist-Priolo Earthquake Fault Zoning Act (California Public Resources Code [PRC] Section 2621 *et seq*.) requires local agencies to regulate development within earthquake fault zones to reduce the hazards associated with surface fault ruptures. It also regulates construction in earthquake fault zones.

C.2.2 California Air Resources Board Scoping Plan

The initial California Air Resources Board (CARB) Scoping Plan (CARB 2008) provides a framework for the State's strategy to reduce GHG emissions to 1990 levels by 2020. This reduction goal means reducing GHG emissions by approximately 30 percent from business-as-usual emission levels projected for 2020 or approximately 15 percent from 2005 levels. Key features of the State's plan for reducing emissions include six main recommendations:

- Expand and strengthen existing energy efficiency programs and building and appliance standards
- Achieve a statewide renewables energy mix of 33 percent
- Develop a cap-and-trade program that links other partner programs to create a regional market system
- Establish targets for transportation-related GHG emissions for regions throughout the State, and pursue policies and incentives to achieve those targets
- Adopt and implement measures, including California's clean car standards, goods movement measures, and the low carbon fuel standard
- Create targeted fees to fund the administrative costs of the State's long-term commitment to Assembly Bill 32 implementation

The Scoping Plan recommends 39 measures that would achieve an emissions reduction of 174 $MMTCO_2e$/year if fully implemented. The recommended measures cover nine sectors: 1) transportation, 2) electricity and natural gas, 3) green buildings, 4) water, 5) industry, 6) recycling and waste management, 7)

forests, 8) high GWP gases[3], and 9) agriculture. Additionally, nine discrete early actions were adopted to reduce GHG emissions.

The First Update to the Climate Change Scoping Plan (CARB 2014b) builds on the 2008 Scoping Plan by identifying the next steps that are required to meet the State's emission reductions beyond 2020 (i.e., 80 percent below 1990 levels by 2050). The update adjusts the 2020 statewide limit to 431 $MMTCO_2e$ to reflect updated GWPs.

In November 2017, CARB finalized *California's 2017 Climate Change Scoping Plan* to describe potential policies that could be implemented to achieve the 2030 target established by EO B-30-15 (CARB 2017c).

C.2.3 California Assembly Bill 32

California AB 32, the Global Warming Solutions Act of 2006, codifies the State's GHG emissions targets by requiring the State's global warming emissions to be reduced to 1990 levels by 2020 and directs CARB to enforce the statewide cap that would begin phasing in by 2012. In 2007, CARB recommended and adopted a 1990 Greenhouse Gas (GHG) emissions level and 2020 emissions limit of 427 million metric tons CO_2e ($MMTCO_2e$); however, this limit has subsequently been updated to 431 $MMTCO_2e$ using the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report global warming potentials (GWPs) (CARB 2017a). The limit is a statewide limit and does not require individual sectors or facilities to reduce emissions equally. Key AB 32 milestones are as follows (CARB 2014):

- January 1, 2009 – Scoping Plan adopted indicating how emissions will be achieved from significant sources of GHGs via regulations, market mechanisms, and other actions.
- During 2009 – CARB staff drafted rule language to implement its plan and held a series of public workshops on each measure (including market mechanisms).
- January 1, 2010 – Early action measures took effect.
- During 2010 – CARB conducted series of rulemakings, after workshops and public hearings, to adopt GHG regulations including rules governing market mechanisms.
- January 1, 2011 – Completion of major rulemakings for reducing GHGs including market mechanisms.

[3] GWP is a metric that measure how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to 1 ton of CO_2.

- January 1, 2012 – GHG rules and market mechanisms adopted by CARB take effect and are legally enforceable.

- November 14, 2012 – CARB held first quarterly auction of GHG emissions allowances as part of the cap-and-trade program.

- January 1, 2013 – Cap-and-trade program began with a GHG emissions cap that declines over time.

- September 17, 2013 – CARB issued first carbon offset credits as part of the cap-and-trade program.

- May 22, 2014 – CARB approved First Update to the Climate Change Scoping Plan.

- December 31, 2020 – Deadline for achieving 2020 GHG emissions cap.

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

C.2.4 California Building Code

Minimum standards for structural design and construction are outlined in the California Building Standards Code (CBSC) (Title 24, California Code of Regulations). The CBSC is based on the Uniform Building Code (UBC), which is widely used throughout the United States and has been modified for California conditions with numerous, more detailed and/or more stringent regulations.

C.2.4.1 Geology, Seismicity, and Soils

The CBSC requires that "classification of the soil at each building site…be determined when required by the building official" and that "the classification be based on observation and any necessary test of the materials disclosed by borings or excavations." In addition, the CBSC states that "the soil classification and design-bearing capacity shall be shown on the (building) plans, unless the foundation conforms to specified requirements." The CBSC provides standards for various aspects of construction, including but not limited to excavation, grading, and earthwork construction; fill placement and embankment construction; construction on expansive soils; foundation investigations; and liquefaction potential and soil strength loss. In accordance with California law, project design and construction would be required to comply with provisions of the CBSC.

C.2.4.2 Noise and Vibration

The Code provides acoustical regulations for both exterior-to-interior sound insulation, as well as sound and impact isolation between adjacent spaces of various occupied units. Title 24 regulations generally state that interior noise levels generated by exterior noise sources shall not exceed 45 A-weighted decibels (dBA) L_{dn}/ Community Noise Equivalent Level (CNEL), with windows closed, in any habitable room for general residential uses.

C.2.5 California Clean Air Act

The California Clean Air Act (CCAA) substantially added to the authority and responsibilities of the State's air pollution control districts. The CCAA establishes an air quality management process that generally parallels the Federal process. The CCAA, however, focuses on attainment of the California Ambient Air Quality Standards (CAAQS) that, for certain pollutants and averaging periods, are typically more stringent than the comparable NAAQS. Table C-5 summarizes the CAAQS.

Table C-5. California Ambient Air Quality Standards

Pollutant	Averaging Time	CAAQS	Violation Criteria
O_3	1 Hour	0.09 ppm (180 µg/m^3)	Not to be exceeded
O_3	8 Hour	0.070 ppm (137 µg/m^3)	Not to be exceeded
PM_{10}	24 Hour	50 µg/m^3	Not to be exceeded
PM_{10}	Annual	20 µg/m^3	Not to be exceeded
$PM_{2.5}$	Annual	12 ug/m^3	Not to be exceeded
CO	1 Hour	20 ppm (23 mg/m^3)	Not to be exceeded
CO	8 Hour	9.0 ppm (10 mg/m^3)	Not to be exceeded
NO_2	1 Hour	0.18 ppm (339 µg/m^3)	Not to be exceeded
NO_2	Annual	0.030 ppm (57 µg/m^3)	Not to be exceeded
SO_2	1 Hour	0.25 ppm (655 µg/m^3)	Not to be exceeded
SO_2	24 Hour	0.04 ppm (105 µg/m^3)	Not to be exceeded
Pb	30-Day Average	1.5 µg/m^3	Not to be equaled or exceeded
Visibility Reducing Particles	8 Hour	See footnote 1	Not to be exceeded

Pollutant	Averaging Time	CAAQS	Violation Criteria
Sulfates	24 Hour	25 µg/m^3	Not to be equaled or exceeded
Hydrogen sulfide	1 Hour	0.03 ppm (42 µg/m^3)	Not to be equaled or exceeded
Vinyl chloride	24 Hour	0.01 ppm (26 µg/m^3)	Not to be equaled or exceeded

Source: CARB 2016.

Note:

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

Key:

µg/m^3 = micrograms per cubic meter; CAAQS = California Ambient Air Quality Standard; CO = carbon monoxide; mg/m^3 = milligrams per cubic meter; N/A = not applicable; NAAQS = National Ambient Air Quality Standard; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; ppm = parts per million; SO_2 = sulfur dioxide

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

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

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

C.2.6 California Department of Fish and Wildlife Species Designations

CDFW maintains an informal list of species called "species of special concern." These are broadly defined as plant and wildlife species that are of concern to CDFW because of population declines and restricted distributions and/or because they are associated with habitats that are declining in California. These species are inventoried in the California Natural Diversity Database (CNDDB) regardless of their legal status. Impacts on species of special concern may be considered significant.

C.2.7 California Department of Toxic Substances Control

The mission of the California Department of Toxic Substances Control (DTSC) is to protect California's people and environment from harmful effects of toxic substances by restoring contaminated resources, enforcing hazardous waste

laws, reducing hazardous waste generation, and encouraging the manufacture of chemically safer products. The DTSC establishes standards for the management of hazardous waste, including regulation of the generation, transportation, and disposal of hazardous waste.

C.2.8 California Department of Water Resources, Division of Safety of Dams

At the State level, the responsibility for the supervision of dams and reservoirs is assigned to the DWR and delegated to the Division of Safety of Dams (DSOD). California Water Code Division 3 regulates alterations; repairs and maintenance; operation; and, removal of dams and reservoirs. Leroy Anderson Dam, on the Coyote Creek at Anderson Reservoir, falls under the jurisdiction of the State of California (Dam No. 72-009) (DWR 2014).

Through the Division of Flood Management, DWR conducts flood forecasting, and emergency response activities as well as permitting of flood protection projects. The Division of Flood Management coordinates with Federal, State, and local agencies to provide integrated flood management and emergency response systems throughout California as part of DWR's FloodSAFE California Program (DWR 2016).

C.2.9 California Department of Water Resources Non-Project Water Acceptance Criteria

Acceptance criteria has been developed by DWR to govern the water quality of non-Project water that may be conveyed through the California Aqueduct. These criteria require DWR to consult with SWP contractors and the CDPH on drinking water quality issues relating to non-Project water as needed to assure the protection of SWP water quality. DWR uses a two-tier approach for accepting non-Project water pumped into the California Aqueduct. Tier 1 programs have "no adverse impact" criteria and are tied to historical water quality levels in the California Aqueduct. Programs meeting all Tier 1 criteria are approved by DWR.

Tier 2 programs have water quality levels that exceed the historical water quality levels in the California Aqueduct and have potential to cause adverse effects to SWP contractors. Tier 2 programs are referred to a State water contract facilitation group for review. The facilitation group reviews the program and, if needed, makes recommendations to DWR during consideration of the project.

C.2.10 California Endangered Species Act

CDFW, formerly the California Department of Fish and Game (CDFG), is responsible for administration of the California Endangered Species Act (CESA). For projects that affect a species that is both State and Federal listed,

compliance with the Federal Endangered Species Act will satisfy the CESA if the CDFW determines that the Federal incidental take authorization is "consistent" with the CESA. Projects that result in a "take" of a State-listed species require an incidental take permit under the CESA. The State act also lends protection to species that are considered rare enough by the scientific community and trustee agencies to warrant special consideration, particularly with regard to protection of isolated populations, nesting or den locations, communal roosts, and other essential habitat. The area of analysis is known to support species listed under the CESA.

Fully Protected Species under California Fish and Game Code – Protection of fully protected species is described in four sections of the California Fish and Game Code that list 37 fully protected species (California Fish and Game Code Sections 3511, 4700, 5050, and 5515). These statutes prohibit take or possession at any time of fully protected species.

C.2.11 California Energy Efficiency Strategic Plan

The California Public Utilities Commission (CPUC) created the California Energy Efficiency Strategic Plan as a framework to make energy efficiency a way of life in California by refocusing ratepayer-funded energy efficiency programs on achieving long-term savings through structural changes in the way Californians use energy (CPUC 2011). Plan sets forth a roadmap for energy efficiency in California through the year 2020 and beyond. It articulates a long-term vision and goals for each economic sector and identifies specific near-term, mid-term and long-term strategies to assist in achieving those goals. The four energy efficiency strategies include:

- All new residential construction in California will be zero net energy by 2020;
- All new commercial construction in California will be zero net energy by 2030;
- Heating, Ventilation and Air Conditioning (HVAC) will be transformed to ensure that its energy performance is optimal for California‘s climate; and
- All eligible low-income customers will be given the opportunity to participate in the low income energy efficiency program by 2020 (CPUC 2011).

C.2.12 California Environmental Protection Agency Unified Program

The California Environmental Protection Agency (CalEPA) Unified Program was developed to protect Californians from hazardous waste and materials.

CalEPA has certified 83 local government agencies as California Unified Program Agencies (CUPAs), including Merced and Santa Clara counties' Environmental Health Departments, who are responsible for implementing the hazardous waste and materials standards for five different state agencies including: CalEPA, DTSC, Governor's Office of Emergency Services (CalOES), California Department of Forestry and Fire Protection (CalFire), and the SWRCB (CalEPA 2016a). Under the Unified Program, the administration, permit, inspection and enforcement activities are consolidated for the following environmental and emergency management programs (CalEPA 2016b).

- Aboveground Petroleum Storage Act (APSA) Program
- Area Plans for Hazardous Materials Emergencies
- California Accidental Release Prevention (CalARP) Program
- Hazardous Materials Release Response Plans and Inventories (Business Plans [HMBP])
- Hazardous Material Management Plan (HMMP) and Hazardous Material Inventory Statements (HMIS) (California Fire Code)
- Hazardous Waste Generator and Onsite Hazardous Waste Treatment (tiered permitting) Programs
- Underground Storage Tank Program

A more in depth discussion of some of these programs that have applicability to the SLLPIP are described below.

C.2.12.1 Hazardous Material Management Plan and Hazardous Material Inventory Statements

The Hazardous Material Business Plans program mandates the creation of a planning document by businesses and other entities who handle hazardous materials of certain quantities. The Business Plan shall include, among other things, an inventory of hazardous materials, a site location map, emergency plan and training program for their employees. These plans are to be submitted electronically to the California Environmental Reporting System (CERS). The local CUPA agency may be contacted for assistance with preparation of Business Plans. The CUPA will verify this information and provide it to "local emergency responders such as firefighters, health officials, planners, public safety officers, health care providers, regulatory agencies and other interested" parties. This information is prepared in response to federal community right-to-know laws (CalOES 2016a).

C.2.12.2 California Accidental Release Prevention Program

The CalARP program was developed to assist with prevention of harmful substances releases which could seriously harm the public and/or the environment. Businesses that handle certain quantities of regulated substances

are required to prepare a Risk Management Plan (RMP) that includes an engineering analysis of potential accident scenarios with mitigation measures. The mitigation measures, when implemented, would reduce the accident potential at a business. CalARP is implemented at the local government level (CUPA) who work directly with the regulated business (CalOES 2016b):

C.2.12.3 California Area Plan Program

The Area Plan Program requires CUPAs to prepare a plan utilizing information from CalARP and HMBP. The Area Plan includes emergency response procedures to minimize impacts from a hazardous material release or threatened release. Provisions for multi-agency coordination and notification during emergency responses are also to be addressed in the Area Plan (CalOES 2016c).

C.2.13 California Environmental Quality Act Guidelines

On March 18, 2010, the California Natural Resources Agency adopted amendments to the CEQA Guidelines to include provisions for evaluating the significance of GHG emissions. The amended guidelines give the Lead Agency leeway in determining whether GHG emissions should be evaluated quantitatively or qualitatively, but requires that the following factors be considered when assessing the significance of impacts from GHG emissions (§15064.4):

- The extent to which the project may increase or reduce GHG emissions as compared to the existing environmental setting.
- Whether the project emissions exceed a threshold of significance that the Lead Agency determines applies to the project.
- The extent to which the project complies with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of GHG emissions.

The amended CEQA Guidelines also suggest measures to mitigate GHG emissions, including implementing project features to reduce emissions, obtaining carbon offsets to reduce, or sequestering GHG.

The CEQA does not consider economic or social changes resulting from a project as adverse effects on the environment. If a physical change in the environment is caused by economic or social effects, the physical change may be regarded as an adverse effect. Specifically, under CEQA guidelines (Section 15358[b]), an EIR must analyze impacts “related to physical changes” in the environment. CEQA guidelines Section 15131(a) states that “economic or social effects of a project shall not be treated as significant effects on the environment” unless the economic effects result in physical effects.

The guidelines also say that "An EIR may trace a chain of cause and effect from a proposed decision on a project through anticipated economic or social changes resulting from the project to physical changes caused in turn by economic or social changes. The intermediate economic or social changes caused need not be analyzed in any detail greater than necessary to trace the chain of cause and effect. The focus of the analysis should be on the physical changes."

In other words, the economic or social effect of a project may be used to determine the significance of physical changes caused by the project. However, analyses of other environmental resources in this document rely of resource specific tools or qualitative discussions to determine environmental effects. Therefore, economic effects are not needed to judge the significance of changes to other environmental resources.

Physical effects of the project alternatives are evaluated separately and do not require economic analysis; therefore, this section does not provide a CEQA analysis.

CEQA, as codified at PRC Section 21000 et seq., requires lead agencies to determine if a proposed project would have a significant impact on archaeological resources. As defined in PRC Section 21083.2, a "unique" archaeological resource is an archaeological artifact, object, or site about which it can be clearly demonstrated that, without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:

- Contains information needed to answer important scientific research questions and there is a demonstrable public interest in that information;
- Has a special and particular quality such as being the oldest of its type or the best available example of its type;
- Is directly associated with a scientifically recognized important prehistoric or historic period event or person.

In addition, CEQA *Guidelines* define a historical resource as (1) a resource in the CRHR; (2) a resource included in a local register of historical resources, as defined in PRC Section 5020.1(k) or identified as significant in a historical resource survey meeting the requirements of PRC Section 5024.1(g); or (3) any object, building, structure, site, area, place, record, or manuscript that a lead agency determines to be historically significant or significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political, military, or cultural annals of California, provided the lead agency's determination is supported by substantial evidence in light of the whole record.

If a lead agency determines that an archaeological resource constitutes a historical resource, the provisions of PRC Section 21084.1 and CEQA

Guidelines Section 15064.5 would apply. If an archaeological site does not meet the CEQA *Guidelines* criteria for a historical resource, then the site is to be treated in accordance with the provisions of PRC Section 21083 regarding unique archaeological resources. The CEQA *Guidelines* note that if a resource is neither a unique archaeological resource nor a historical resource, the effects of a project on that resource shall not be considered a significant impact on the environment (CEQA *Guidelines* Section 15064.5[c][4]).

Pursuant to CEQA, a proposed project would be considered to have a significant impact on the environment if it would:

1. Cause a substantial adverse change in the significance of a historical resource as defined in Section 15064.5;

2. Cause a substantial adverse change in the significance of an archaeological resource pursuant to Section 15064.5;

3. Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature; or

4. Disturb any human remains, including those interred outside of formal cemeteries.

On Federal lands, Native American human remains are subject to NAGPRA and its implementing regulations (43 CFR Part 10). On non-Federal lands, human remains, including those interred outside formal cemeteries, are protected under several State laws, including PRC Section 5097.98 and Health and Safety Code Section 7050.5. Health and Safety Code Section 7050.5 establishes intentional disturbance, mutilation or removal of interred human remains as a misdemeanor. It also requires that upon the discovery of human remains outside of a dedicated cemetery, further excavation or disturbance of that discovery must cease until a county coroner makes a report. It requires the county coroner to contact the Native American Heritage Commission within 24 hours if the coroner determines that the remains are not subject to his or her authority and if the coroner recognizes the remains to be those of a Native American.

C.2.14 California Executive Order S-3-05

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

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

The order also requires the Secretary of the CalEPA to report to the Governor and the State Legislature biannually on progress made toward meeting the GHG emission targets, commencing in January 2006.

California GHG emissions were estimated to be 446.06 million tonnes (metric tons) of carbon dioxide equivalent (CO_2e) in 2010, compared to 467.19 million tonnes of CO_2e in 2000 (CARB 2017b). The GHG emissions inventory indicates that emissions decreased by over 21 million tonnes of CO_2e over the decade, representing a 4 percent decrease in statewide emissions. As a result, the State was successful in meeting the first milestone of S-3-05.

C.2.15 California Executive Order B-30-15 and Senate Bill 32

California Governor Edmund G. Brown issued EO B-30-15 to reduce California GHG emissions to 40 percent below 1990 levels by 2030. The order aligns California's GHG reduction targets with the United Nations Climate Change Conference in Paris. In 2016, SB 32 codified the EO B-30-15 target and directed State regulatory agencies to develop rules and regulations to meet the 2030 State target.

C.2.16 California Fish and Game Code Section 1600, Streambed Alterations

Section 1600 et seq. of the California Fish and Game Code, as administered by CDFW, mandates that "it is unlawful for any person to substantively divert or obstruct the natural flow or substantially change the bed, channel, or bank of any river, stream, or lake designated by the department, or use any material from the streambeds, without first notifying the department of such activity." Streambed alteration must be permitted by CDFW through a Streambed Alteration Agreement. CDFW defines streambeds as "a body of water that flows at least periodically or intermittently through a bed or channel having banks and supports fish or other aquatic life" and lakes as "natural lakes and man-made reservoirs." CDFW jurisdiction includes ephemeral, intermittent, and perennial watercourses, and can extend to habitats adjacent to watercourses, including flood plains. Wetlands near watercourses would also be considered habitats adjacent to watercourses". Several of the proposed alternatives may need to submit a Lake and Streambed Alteration Agreement application for construction actions disturbing the bed and bank of rivers or reservoirs.

C.2.17 California Fish and Game Code Sections 3500 - 3705, Migratory Bird Protection

Sections 3500 through 3705 of the California Fish and Game Code regulate the taking of migratory birds and their nests. These codes prohibit the taking of nesting birds, their nests, eggs, or any portion thereof during the nesting season. Typically, the breeding/nesting season is from March 1 through August 30. Depending on each year's seasonal factors, the breeding season can start earlier

and/or end later. Several species of migratory birds are known to occur in the area of analysis.

C.2.18 California General Plan Guidelines

The State's *General Plan Guidelines* recommend that local governments "'analyze and quantify' noise levels and the extent of noise exposure through actual measurement and the use of noise modeling." In addition to other requirements, the guidelines state that "technical data relating to mobile and point sources must be collected and synthesized into a set of noise control policies and programs that 'minimizes the exposure of community residents to excessive noise'" (California Governor's Office of Planning and Research [OPR] 2003).

As part of the county-level planning process, analysis of existing conditions and community tolerance for noise are used to dictate the normally acceptable community noise exposure. Measured in dBA, a normally acceptable community noise exposure is used by the State to signify satisfactory land use in relation to noise exposure. Other terms used by the State to analyze community noise exposure are:

- **Normally Acceptable -** Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

- **Conditionally Acceptable -** New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.

- **Normally Unacceptable -** New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.

- **Clearly Unacceptable -** New construction or development should generally not be undertaken.

Table C-6 displays land use categories and community noise exposure levels.

Table C-6. Noise Compatible Land Use Planning

Land Use	Normally Acceptable L_{dn} or CNEL (dBA) [1]	Conditionally Acceptable L_{dn} or CNEL (dBA) [1]	Normally Unacceptable L_{dn} or CNEL (dBA) [1]	Clearly Unacceptable L_{dn} or CNEL (dBA) [1]
Residential – Low Density Single Family, Duplex, Mobile Homes	50-60	55-70	70-75	75+
Residential – Multi Family	50-65	60-70	70-75	75+
Transient Lodging – Motels, Hotels	50-65	60-70	70-80	80+
Schools, Libraries, Churches, Hospitals, Nursing Homes	50-70	60-70	70-80	80+
Auditoriums, Concert Halls, Amphitheaters	N/A	50-70	N/A	65+
Sports Arena, Outdoor Spectator Sports	N/A	50-75	N/A	70+
Playgrounds, Neighborhood Parks	50-70	N/A	67-75	72+
Golf Courses, Riding Stables, Water Recreation, Cemeteries	50-75	N/A	70-80	80+
Office Buildings, Business Commercial and Professional	50-70	67-77	75+	N/A
Industrial, Manufacturing, Utilities, Agriculture	50-75	70-80	75+	N/A

Source: OPR 2003.

Note:

[1] Ranges in the community noise exposure levels (and any subsequent overlaps in the different categories) reflect the differing noise goals of a community, the community's sensitivity to noise, and the community's assessment of the relative importance of noise pollution (OPR 2003).

Key:

CNEL = Community Noise Equivalent Level

dBA = A-weighted decibel scale

L_{dn} = day-night average level

N/A – = Not Applicable

C.2.19 California Government Code 65040.12

California law defines environmental justice as the "fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies," in Government Code Section 65040.12(e). Section 65040.12(a) designates the Governor's Office of Planning and Research (OPR) as the coordinating agency in State government for environmental justice programs and requires OPR to develop guidelines for incorporating environmental justice into general plans (7 California Government Code 65040.12). Environmental Justice analysis is not required in CEQA documents.

C.2.20 California Occupational Safety and Health Administration Standards

The California Occupational Safety and Health Administration (CalOSHA) enforces laws and regulations related to the safety and health of workers in the workplace. Laws and regulations enforced by CalOSHA include regulations related to construction and handling of carcinogens and asbestos (CalOSHA 2016).

C.2.21 California Porter-Cologne Water Quality Control Act

The California Porter-Cologne Water Quality Act (Porter-Cologne Act) was enacted in 1969 and established the SWRCB. The Porter-Cologne Act defines water quality objectives as the limits or levels of water constituents that are established for reasonable protection of beneficial uses. Unlike the CWA, the Porter-Cologne Act applies to both surface and groundwater. The Porter-Cologne Act requires that each of nine semi-autonomous RWQCB establish water quality objectives, while acknowledging that water quality may be changed to some degree without unreasonably affecting beneficial uses. Beneficial uses, together with the corresponding water quality objectives, are defined as standards, per Federal CWA regulations. Therefore, the regional plans provide the regulatory framework for meeting State and Federal requirements for water quality control. Changes in water quality are only allowed if the change is consistent with the most restrictive beneficial use designation identified by the State, does not unreasonably affect the present or anticipated beneficial uses, and does not result in water quality less than that prescribed in the water quality control plans (WQCP) (SWRCB 2016a).

A State of California General Permit for Discharges of Stormwater Associated with Construction Activity Construction General Permit Order 2009-0009-DWQ (as amended in 2010 and 2012) will be required prior to any ground disturbance that is greater than one acre or is part of a common plan of development greater than one acre. A NOI and SWPPP must be developed and electronically submitted to the Storm Water Multiple Application and Report Tracking System (SMARTS), an online database maintained by the SWRCB. A Qualified SWPPP Developer (QSD) must prepare the SWPPP. The SWPPP, other permit-required documents, and monitoring data must be maintained on the construction site. A Qualified SWPPP Practitioner (QSP) must implement the SWPPP during construction including installation, inspection, and maintenance of BMPs required by the General Permit.

The General Permit requires dischargers to determine the relative risk levels at each construction site. The risk factors are based on the potential for sedimentation and impacts to downstream receiving waters.

Based on the site's risk level, the SWPPP must list BMPs the discharger will use to protect stormwater runoff as well as the placement of those BMPs. These measures may include but would not be limited to: revegetation, silt fences,

turbidity fences, mulching of unstabilized areas, dewatering structures, stormwater drainage system and construction fencing. The SWPPP will require a visual monitoring program; a chemical monitoring program for the "non-visual" pollutants to be implemented if there is a failure of BMPs; and a sediment monitoring plan if the site discharges directly to a water body listed on the 303(d) list for sediment. This monitoring program will assess compliance with NALs appropriate to the project. The SWPPP should also contain a site map(s) which shows the construction site perimeter, existing and proposed buildings, lots, roadways, storm water collection and discharge points, general topography both before and after construction, and drainage patterns across the project. At higher risk sites, REAPs must be developed ensure that active construction sites have adequate erosion and sediment controls implemented prior to forecasted storm events.

1995 Bay Delta Water Quality Control Plan The 1995 Bay Delta Water Quality Control Plan establishes water quality control measures which contribute to the protection of beneficial uses in the Bay-Delta Estuary. The SWRCB imitated a water rights proceeding following adoption of the 1995 Bay Delta Water Quality Control Plan. The water rights address the water supply-related objectives in the plan through the amendment of water rights under the authority of the SWRCB.

WQCPs are adopted and amended by nine regional water boards under a structured process involving full public participation and State environmental review. WQCPs and amendments thereto do not become effective until approved by the SWRCB. Regulatory provisions must be approved by the Office of Administrative Law. Adoption or revision of surface water standards is subject to the approval of the USEPA.

C.2.22 California Register of Historical Resources

The CRHR is "an authoritative listing and guide to be used by State and local agencies, private groups, and citizens in identifying the existing historical resources of the State and to indicate which resources deserve to be protected, to the extent prudent and feasible, from substantial adverse change" (PRC Section 5024.1[a]). Criteria for CRHR eligibility are based on NRHP criteria (PRC Section 5024.1[b]). Certain resources are determined by the statute to be automatically included in the CRHR, including California properties formally determined eligible for or listed in the NRHP.

To be eligible for the CRHR, or to be deemed a "historical resource," a prehistoric or historic period cultural resource must be important at the local, State, and/or Federal level under one or more of the following criteria:

1. It is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage;

2. It is associated with the lives of persons important in our past;

3. It embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values; or

4. It has yielded, or is likely to yield, information important in prehistory or history.

For a cultural resource to be eligible for the CRHR, it must also retain enough of its character or appearance (i.e., integrity) to be recognizable as a historical resource and to convey the reason for its significance. A historical resource that does not retain sufficient integrity to meet NRHP criteria may still be eligible for listing in the CRHR.

The CRHR consists of resources that are listed automatically as well as those that must be nominated through an application and public hearing process. The CRHR automatically includes the following:

- California properties listed in the NRHP and those formally determined to be eligible for the NRHP;

- California Historical Landmarks (CHL) No. 770 onward;

- California Points of Historical Interest that have been evaluated by the OHP and have been recommended to the State Historical Resources Commission for inclusion in the CRHR.

Other resources that may be nominated to the CRHR include the following:

- Historical resources with a significance rating of Category 3 through 5 (i.e., properties identified as eligible for listing in the NRHP, the CRHR, and/or a local jurisdiction register);

- Individual historical resources;

- Historical resources contributing to historic districts;

- Historical resources designated or listed as local landmarks, or designated under any local ordinance, such as a historic preservation overlay zone.

C.2.23 California Safe Drinking Water Act

The California SDWA improves upon the minimum requirements of the Federal SDWA. Under the California SDWA (Chapter 7 of the California Health and Safety Code), the CDPH, Division of Drinking Water and Environmental Management has authority to regulate public water systems, and permit water

treatment devices. Water Supply Permits are required when projects will create new drinking water storage facilities or drinking water treatment operations. An amendment to an existing domestic water supply permit is necessary before new water treatment technologies are installed. The CDPH, Drinking Water Program staff, as a part of the Water Supply Permit process, reviews the Final EIR and prepares California Environmental Quality Act (CEQA) findings and conditions as required by California Code of Regulations, Title 14, Section 15091 and 15093.

C.2.24 California Senate Bill 32

In 2016, Senate Bill (SB) 32 codified the EO B-30-15 target of 40 percent reduction below 1990 levels by 2030 and directed State regulatory agencies to develop rules and regulations to meet the 2030 State target.

In November 2017, CARB finalized *California's 2017 Climate Change Scoping Plan* to describe potential policies that could be implemented to achieve the 2030 target established by EO B-30-15 (CARB 2017c). The scoping plan indicates that the annual 2030 statewide target emissions level for California is 260 $MMTCO_2e$.

C.2.25 California State Parks Guidelines

The California State Parks system does not have regulations regarding noise impacts on campgrounds. For CEQA purposes, the park system defines significant adverse noise impacts as an increase above background that would be clearly discernible and objectionable to park users (CDPR 2006).

C.2.26 California Water Code

The California Water Code establishes state policy, laws, statutes, and definitions for water rights. The Water Code established the SWRCB, delegating adjudicatory and regulatory functions of the state to the SWRCB in the field of water resources. Regulations pertaining to water law are found in Title 23, Sections 640 to 1024. After the enactment of the State Water Commission Act in 1914, the state required any person or agency seeking to use surface water, without an existing riparian right, to apply for and receive approval for such use from the SWRCB. Water rights permits granted by the SWRCB include detailed descriptions of the amounts, conditions, and construction timetables under which the proposed water project must comply. Prior to permit issuance, the SWRCB must take into account all prior rights and the availability of water in the basin. The SWRCB must also consider the flows needed to preserve instream uses such as recreation and fish and wildlife habitat. The SWRCB may impose additional conditions to ensure that these criteria are satisfied and it may use its continuing authority to enforce and revise the conditions of water right permits over time. The SWRCB is also

empowered to revoke a permit or issue cease and desist orders if conditions of the permit are not being met.

Exchanges between CVP and SWP water contractors as a component of the San Luis Reservoir Expansion Alternative would require a change in places of use specified in DWR and Reclamation water right permits. To obtain a change in place of use, DWR and Reclamation would need to petition the SWRCB for said change. Prior to approving these petitions, the SWRCB must find that the change would not cause injury to any legal user of the water involved or result in harm to fish or wildlife. Other water right holders and the public would have an opportunity to object to the proposed change by filing a protest with the SWRCB. If a protest cannot be resolved, the SWRCB can hold a hearing on the petition and would either grant or refuse permission to make the change. Because the SWRCB has discretion to approve the requested petition, it must comply with the CEQA.

Similar to the San Luis Reservoir Expansion Alternative, the Pacheco Reservoir Expansion Alternative would require SCVWD to obtain a new water right from the SWRCB. SCVWD would submit a combination application/petition from the SWRCB for the proposed new structures, and a new water right and change in use. The change in use for Pacheco Reservoir will include adding fish preservation and enhancement.

C.2.26.1 Water Code (Section §10750) or Assembly Bill 3030

AB 3030, commonly referred to as the Groundwater Management Act permits local agencies to develop groundwater management plans (GMPs). Subsequent legislation has further amended the Water Code to make the adoption of a management program mandatory if an agency is to receive public funding for groundwater projects, creating an incentive for the development and implementation of plans. Section 6.1.2.3, Local Regulation, provides more detail on AB 3030.

C.2.26.2 Water Code (Section §10753.7) or Senate Bill 1938

SB 1938, requires local agencies seeking State funds for groundwater construction or groundwater quality projects to have the following: (1) a developed and implemented GMP that includes basin management objectives[4] (BMOs) and addresses the monitoring and management of groundwater levels, groundwater quality degradation, inelastic land subsidence, and surface water/groundwater interaction; (2) a plan addressing cooperation and working relationships with other public entities; (3) a map showing the groundwater subbasin the project is in, neighboring local agencies, and the area subject to the GMP; (4) protocols for the monitoring of groundwater levels, groundwater quality, inelastic land subsidence, and groundwater/surface water interaction;

[4] BMOs are management tools that define the acceptable range of groundwater levels, groundwater quality, and inelastic land subsidence that can occur in a local area without causing significant adverse impacts.

and (5) GMPs with the components listed above for local agencies outside the groundwater subbasins delineated by Bulletin 118 (DWR 2003).

C.2.26.3 Water Code (Section 10920-10936 and 12924) or Senate Bill X7 6

SB X7 6, established a voluntary statewide groundwater monitoring program and requires that groundwater data collected be made readily available to the public. The bill requires DWR to: (1) develop a statewide groundwater level monitoring program to track seasonal and long-term trends in groundwater elevation; (2) conduct an investigation of the state's groundwater basins delineated by Bulletin 118 and report its findings to the Governor and Legislature no later than January 1,2012 and thereafter in years ending in five or zero; and (3) work cooperatively with local Monitoring Entities to regularly and systematically monitor groundwater elevation to demonstrate seasonal and long-term trends. AB 1152, Amendment to Water Code Sections 10927, 10932 and 10933, allows local Monitoring Entities to propose alternate monitoring techniques for basins meeting certain conditions and requires submittal of a monitoring plan to DWR for evaluation. Santa Clara Valley Water District (SCVWD) is the designated monitoring entity for the Santa Clara Valley and Llagas Area subbasin (DWR 2013).

C.2.26.4 Water Code (Section 10927, 10933, 12924, 10750.1 and 10720) or Senate Bill 1168 (Sustainable Groundwater Management Act)

SB 1168, the Sustainable Groundwater Management Act (SGMA), requires the establishment of Groundwater Sustainability Agencies (GSA) and adoption of Groundwater Sustainability Plans (GSP). GSAs must be formed by June 30, 2017. GSAs are new entities that consist of local agency(ies) and include new authority to: 1) investigate and determine the sustainable yield of a groundwater basin; 2) regulate groundwater extractions; 3) impose fees for groundwater management; 4) require registration of groundwater extraction facilities; 5) require groundwater extraction facilities to use flow measurement devices; and 6) enforce the terms of a GSP.

Additionally, this bill required groundwater basins to be prioritized as high-, medium-, low- or very low- with respect to groundwater conditions, adverse impacts on local habitat and adverse impacts on local stream flow no later than January 31, 2015. DWR has determined that the initial basin prioritization developed in June 2014 will be the prioritization adopted under this legislation. DWR has identified and finalized 21 basins/subbasins with critical overdraft conditions as of January 2016.

GSPs for groundwater basins designated by DWR as high- and medium-priority with critical overdraft conditions (per SB X7 6) are required to be developed by January 31, 2020. GSPs for the remaining high- and medium-priority groundwater basins are to be developed by January 31, 2022. GSPs are encouraged to be developed for groundwater basins prioritized as low- or very

low-priority (Pavley 2014a). All high- and medium-priority basins must achieve sustainability within 20 years of adopting a GSP.

As required by the SGMA, in 2016, DWR adopted GSP emergency regulations. (23 Cal. Code Regs. Sections 350 et seq.). In January of 2017, DWR completed, as required by the SGMA, a draft report on the water available for groundwater replenishment in the state. This report was developed in coordination with SGMA advisory groups and stakeholders (DWR 2017a). Also, as required by SGMA, in January 2017 DWR published on its web site best management practices for the sustainable management of groundwater (DWR 2017b).

C.2.26.5 Water Code (Section 10729, 10730, 10732, 10733 and 10735) or Assembly Bill 1739

AB 1739 establishes the following: (1) provides the specific authorities to a GSA (as defined by SB 1168); (2) requires DWR to publish best management practices for the sustainable management of groundwater by January 1, 2017; and (3) requires DWR to estimate and report the amount of water available for groundwater replenishment by December 31, 2016. The bill authorizes DWR to approve and periodically review all GSPs (Dickinson 2014).

The bill authorizes the SWRCB to: (1) conduct inspections and obtain an inspection warrant; (2) designate a groundwater basin as a probationary groundwater basin; (3) develop interim plans for probationary groundwater basins in consultation with DWR if the local agency fails to remedy a deficiency resulting in the designation of probationary; and (4) issue cease and desist orders or violations of restrictions, limitations, orders, or regulations issued under AB 1739 (Dickinson 2014).

C.2.26.6 Water Code (Section 10735.2 and 10735.8) or Senate Bill 1319

SB 1319 authorizes the SWRCB to designate high- and medium-priority basins (defined by SB 1168) as a probationary basin after January 31, 2025. This bill allows the SWRCB to develop interim management plans that may override a local agency. However, if the appointed GSA can demonstrate compliance with sustainability goals for the basin, then the SWRCB has to exclude the groundwater basin or a portion of the groundwater basin from probationary status (Pavley 2014b).

Per SB 13 the local agency or GSA has a 90 to 180 day window to remedy certain deficiencies that caused the SWRCB to designate a basin as probationary. The SWRCB could develop an interim plan for certain probationary basins one year after the designation (Pavley 2015).

C.2.26.7 Water Code (Section 10722.2) or Basin Boundary Emergency Regulation

SB 1168 established a procedure for local agencies to request adjustment of basin boundaries identified in Bulletin 118. Boundary modification can be requested based on geologic or hydrologic criteria (scientific modification) or to promote sustainable groundwater management (jurisdictional modification). The Basin Boundary Emergency Regulation specifies the information a local agency is required to provide for the requested boundary adjustment and the procedure for the modification request and public input (DWR 2015).

C.2.26.8 Water Code (Section 10722.4 and 10730) or AB 939

AB 939 authorizes a GSA to impose fees to fund the GSP and requires the GSA to hold at least one public meeting prior to imposing the fee or increasing the same. The GSA is required to make the data upon which the proposed fee is based available to the public at least 10 days prior to the public meeting (Salas 2015).

C.2.26.9 Water Code (Section 10540, 10721, 10727.4, 10727.8, 10733.4, 10726.5 and 10732.2) or Assembly Bill 617

AB 617 requires measures addressing in-lieu use to be included in the groundwater sustainability plan. This bill also requires groundwater sustainability planning to be incorporated into the integrated regional water management plan (Perea 2015).

C.2.26.10 Water Code Section 13240, Regional Water Quality Control Plans

The California Water Code (Section 13240) requires the preparation and adoption of WQCPs (Basin Plans), and the Federal CWA (Section 303) supports this requirement. According to Section 13050 of the California Water Code, Basin Plans consist of a designation or establishment for the waters within a specified area of beneficial uses to be protected, water quality objectives to protect those uses, and an implementation program needed for achieving the objectives. State law also requires that Basin Plans conform to the policies set forth in the Water Code, beginning with Section 13000, and any State policy for water quality control. The Basin Plans are regulatory references for meeting the State and Federal requirements for water quality control (40 Code Federal Regulations 131.20). One significant difference between the State and Federal programs is that California's basin plans also establish standards for groundwater in addition to surface water (Central Valley RWQCB 1998).

Basin Plans complement other WQCPs adopted by the SWRCB, such as the WQCP for Temperature Control and Ocean Waters. The SWRCB and the regional water boards maintain each Basin Plan in an updated and readily available edition that reflects the current water quality control programs.

Several different regional WQCPs govern water bodies within the SLLPIP area of analysis.

- The *Central Valley Region Basin Plan* covers the drainage areas of the entire Sacramento and San Joaquin river basins, involving an area bound by the crests of the Sierra Nevada on the east and the Coast Range and Klamath Mountains on the west. The area covered in this WQCP extends some 400 miles, from the California – Oregon border to the headwaters of the San Joaquin River.

- The *San Francisco Bay Region Basin Plan* covers all or major portions of Alameda, Contra Costa, Marin, Napa, San Mateo, San Francisco, Santa Clara, Solano, and Sonoma Counties.

- *San Francisco Bay/Sacramento-San Joaquin Delta Estuary Plan* establishes water quality objectives for water bodies within the region in order to protect beneficial uses. The WQCP includes beneficial uses to be protected, water quality objectives, and a program to help achieve the water quality objectives. This plan supplements other water quality control plans, by the SWRCB and RWQCBs, relevant to the Bay-Delta Estuary watershed. These other plans and policies establish water quality standards and requirements for parameters such as toxic chemicals, bacterial contamination, and other factors which have the potential to adversely affect beneficial uses or cause nuisance conditions (SWRCB 2006).

State Water Resources Control Board Decision 1641 SWRCB Decision-1641 presents the current water right requirements to implement the Delta flow-dependent objectives of WQCPs through the SWRCBs water rights authority under the water code. In SWRCB Decision-1641, the SWRCB assigned responsibilities to Reclamation and DWR for meeting these requirements. These responsibilities require that the CVP and the SWP be operated to protect water quality, and that DWR and/or Reclamation will ensure that the flow dependent water quality objectives are met in the Delta (SWRCB 1999).

C.2.27 Hazardous Waste Control Act

The Hazardous Waste Control Act (HWCA) was passed in 1972 by the State Legislature. The Hazardous Waste Control Law (Health and Safety Code sections 25100 et seq.) mandates regulatory standards for the generation, handling, processing, storage, transportation, and disposal of hazardous wastes through a “cradle to grave” system. The California DTSC and local CUPAs are responsible for administration of the California Hazardous Waste Control Program (Brown 2007).

C.2.28 Noise Element Guidelines (Health and Safety Code §46050.1)

The State of California provides guidance for the preparation of general plans and noise ordinances. In 1976, the State Department of Health Services (now the Department of Public Health) issued *Noise Element Guidelines* (Health and Safety Code §46050.1). In 1977, the State Office of Noise Control (ONC) published a model noise ordinance and mandated that each county develop a noise element as part of its general plan (Section 65203[f] of the California Government Code). The purpose of this element is to identify and appraise noise problems in the community. The ONC's model ordinance recommends limits on temporary construction noise levels and operational noise levels in residential, commercial, and industrial areas.

C.2.29 Seismic Hazards Mapping Act

The 1990 Seismic Hazards Mapping Act (PRC Section 2690-2699.6) was enacted to minimize loss of life and property from strong ground shaking, liquefaction, landslides, or other ground failures as a result of earthquakes. The Act requires the California Geological Survey (CGS) to identify and map areas with the potential for liquefaction, landslides, or ground shaking. These maps are used by cities and counties in their land use permitting process and to adequately prepare the safety element of their general plans (CGS 1991). Permits for development projects are not issued until geologic investigations have been completed and mitigation has been developed to address any seismic hazard issues.

C.2.30 State Scenic Highways

California's Scenic Highway Program was created by the Legislature in 1963. Applicable State regulations protecting visual resources stem from the protection of State scenic highways running through or near the project area. There is one officially designated state scenic highway, State Route (SR) 152, in the area of analysis (California Department of Transportation [Caltrans] 2011). Caltrans has full control and possession of all State highways, and the Scenic Highway Program is under their stewardship as well. Scenic highway legislation establishes the State's responsibility to protect and enhance California's scenic beauty by identifying portions of the State highway system and adjacent scenic corridors, which require special conservation treatment. The legislation also assigns responsibility for regulating land use and development along scenic highways to the appropriate local governmental agencies (Caltrans 2008).

C.2.31 State Water Resource Control Board, Hazardous Waste Management

The SWRCB is responsible for several programs related to cleanup and management of hazardous waste sites in California including: the Site Cleanup Program, UST Program, Department of Defense Program, and Land Disposal

(SWRCB 2016b). All of these programs are administered by the San Francisco RWQCB in Santa Clara County north of Morgan Hill, the Central Coast RWQCB in Santa Clara County from Morgan Hill south to the County line, and the Central Valley RWQCB in Merced County (SWRCB 2013). The Cleanup Program regulates unauthorized releases to soils and groundwater, and in some cases surface waters or sediments. The purpose of the UST Program is to "protect public health and safety and the environment from releases of petroleum and other hazardous substances from tanks." The Land Disposal program regulates the discharge of waste "to land for treatment, storage and disposal" (SWRCB 2016b).

C.2.32 Surface Mining and Reclamation Act of 1975

The Surface Mining and Reclamation Act (SMARA) of 1975 (PRC, Division 2, Chapter 9, § 2710 et. seq.) addresses surface mining and requires mitigation to reduce adverse impacts to public health, property, and the environment. Through the law, the State Geologist instated mineral land classifications to help identify and protect mineral resources in the State that may be subject to urban development pressures or other "irreversible land uses" which would inhibit mineral extraction (California Department of Conservation [DOC], State Mining and Geology Board [SMGB] and Division of Mines and Geology Nd.). Following classification by the State Geologist, the SMGB designates lands containing mineral deposits as being of regional or statewide significance (California DOC, SMGB and Division of Mines and Geology Nd.).

The SMARA applies to anyone (including a government agency) that disturbs more than one acre or removes more than 1,000 cubic yards of material through surface mining activities, even if activities occur on Federally managed lands (California DOC, Office of Mine Reclamation 2007). Local city and county Lead Agencies are required to develop ordinances for permitting that provide the regulatory framework for mining and reclamation activities. The SMGB reviews Lead Agency ordinances to ensure they comply with SMARA (California DOC, Office of Mine Reclamation 2007).

The SMARA regulations, Article 2, describes areas designated as having regional significance due to the presence of mineral resources. Construction aggregate resources in the South San Francisco Bay Region are identified in Article 2 (§3550.10). There are no areas designated as having regional mineral significance within the area where construction of the alternatives would take place; the closest area is located northeast of Lexington Reservoir, located south of Los Gatos (United States Geological Survey [USGS] 1982). There are no areas in the vicinity of San Luis Reservoir that are mined for aggregate mineral resources or that have been determined to contain minerals of regional, statewide, or multi-community significance (Kohler 2006).

C.2.33 Williamson Act

The Williamson Act, formally known as the California Land Conservation Act of 1965, enables local governments to enter into contracts with private landowners for the purpose of promoting the continued use of relevant land for agricultural or related open space use. The Williamson Act empowers local governments to establish "agricultural preserves" consisting of lands devoted to agricultural and other compatible uses. After such preserves are established, the locality may offer the owners of included agricultural land the opportunity to enter into annually renewable contracts that restrict the land to agricultural or open space use for a minimum of 10 years.

The Williamson Act was enhanced in 1998 with the Farmland Security Zones (FSZs; also known as Super Williamson Act lands) provisions. These provisions offer a minimum 20-year contract and must be located in an "agricultural preserve" and designated as Prime Farmland, Farmland of Statewide Importance, Unique Farmland, or Farmland of Local Importance.

C.3 Local/Regional Requirements

C.3.1 Bay Area Air Quality Management District (BAAQMD) Plans

The current, USEPA-approved SIPs for each federal nonattainment or maintenance pollutant in the Bay Area Air Quality Management District (BAAQMD) are summarized below:

- CO – Final Carbon Monoxide Redesignation Request and Maintenance Plan for Ten Federal Planning Areas, approved by USEPA on June 1, 1998 (63 FR 15305)[5]

- O_3 – *Revised San Francisco Bay Area Ozone Attainment Plan for the 1-Hour National Ozone Standard*, partially approved by the USEPA on May 24, 2004 (69 FR 21717). In its approval, the USEPA also determined that the San Francisco Bay Area O_3 nonattainment area attained the 1-hour O_3 NAAQS.

On April 19, 2017, the BAAQMD adopted the *2017 Clean Air Plan* (CAP). While not a federal SIP-approved plan, the CAP serves as a control strategy to reduce O_3, particulate matter, toxic air contaminants (TACs), and greenhouse gas emissions in an integrated plan.

On February 8, 2013, the USEPA determined that the San Francisco Bay Area nonattainment area attained the 2006 24-hour $PM_{2.5}$ NAAQS (78 FR 1760).

[5] On July 22, 2004, CARB approved an update to the SIP with the *2004 Revisions to the Carbon Monoxide Maintenance Plan*, which was subsequently submitted to the USEPA for approval on November 8, 2004. Because the USEPA has not yet approved the update, the 1998 plan is the current SIP-approved plan.

This action suspended the SIP requirements to develop a plan to attain the NAAQS.

C.3.2 California DWR San Luis Division

The San Luis Field Division of the DWR Emergency Action Plan details response plans for emergencies at all DWR reservoirs in the division including San Luis Reservoir. The Emergency Action Plan describes procedures for emergency response to different types of emergencies including hazardous materials spills. The plan includes procedures for the containment and reporting of spills. The plan also details assistance to operators available from outside emergency responders (DWR 2006). Outside emergency responders may include Merced County Fire Department and CalFire.

C.3.3 City of Gilroy Performance Standards

Although no direct construction or operational activities for any alternative would occur in Gilroy, construction worker trips, haul trucks, or vendors associated with the Lower San Felipe Intake may originate in the City of Gilroy.

General provisions of the City of Gilroy Performance Standards (Section 30.41) prohibits objectionable noise levels. The noise ordinance sets maximum permissible outdoor noise levels of 70 dBA (L10) at a residential property line between the hours of 7 a.m. to 10 p.m. Noise producing activities are prohibited between the hours of 10 p.m. and 7 a.m. (City of Gilroy 2013).

The City of Gilroy's general provisions in Section 30.41 also prohibits objectionable vibration levels. There are no quantitative thresholds in the city ordinance (City of Gilroy 2013).

C.3.4 City of Gustine Code of Ordinances

Although no direct construction or operational activities for any alternative would occur in Gustine, construction worker trips, haul trucks, or vendors associated with the Lower San Felipe Intake Alternative may originate in the City of Gustine.

The noise ordinance in Section 7-7-121 of the City of Gustine Code of Ordinances provides standards for the construction of buildings and projects. Construction activities are prohibited within a residential zone or within a radius of 500 feet of a residential zone between the hours of 10 p.m. of one day and 7 a.m. of the next day if they would cause discomfort or annoyance to a resident unless a special permit is obtained (City of Gustine 2012a).

The Zoning and Subdivision Code includes noise standards (Section 4-30-050) for sensitive land uses. Outdoor noise levels at residential, transient lodging, hospitals, and religious properties are limited to 65 dBA L_{dn}. Noise levels at playgrounds and parks are limited to 70 dBA L_{dn}. Construction is limited to

between 7 a.m. and 7 p.m. on Mondays through Fridays, between 8 a.m. and 7 p.m. on Saturdays, and with City approval between 9 a.m. and 5 p.m. on Sundays (City of Gustine 2012b).

Ground vibration that is perceptible without instruments at the property line is prohibited according to the City of Gustine's Performance Standards of the Zoning and Subdivision Code (Section 4-30-070). Vibrations from temporary construction or demolition activities and motor vehicle operations are exempt (City of Gustine 2012b).

C.3.5 City of Los Banos Municipal Code

Although no direct construction or operational activities for any alternative would occur in Los Banos, construction worker trips, haul trucks, or vendors associated with the Lower San Felipe Intake Alternative and San Luis Reservoir Expansion Alternative may originate in the City of Los Banos.

The City of Los Banos noise ordinance in Title 9, Chapter 3, Article 27 of the Municipal Code sets maximum permissible sound levels by receiving land use. Table C-7 summarizes the City's exterior noise limits, which are not to be exceeded for more than 30 minutes in any hour. Higher noise levels are allowed for shorter durations (City of Los Banos 1987).

Table C-7. Exterior Noise Limits (City of Los Banos)

Time Period	Residential/Noise Sensitive	Commercial
Daytime (7 a.m. to 10 p.m.)	55 dBA	70 dBA
Nighttime (10 p.m. to 7 a.m.)	45 dBA	70 dBA

Source: City of Los Banos 1987.
Key:
dBA = A-weighted decibel scale

The County also defines allowable interior noise levels for residential dwellings. Between 10 p.m. and 7 a.m. this level is 35 dBA (for no more than five minutes in any hour) and between 7 a.m. and 10 p.m. this level is 45 dBA (for no more than five minutes in any hour). Higher noise levels are allowed for shorter durations (City of Los Banos 1987).

Construction noise is exempt from the noise limits between 7 a.m. and 9 p.m. on Mondays through Fridays and between 8 a.m. and 5 p.m. on Saturdays or Sundays (City of Los Banos 1987).

The City of Los Banos does not have regulations pertaining to vibration levels.

C.3.6 City of San Jose General Plan

C.3.6.1 Visual Resources

The City of San Jose's Envision San Jose 2040 General Plan outlines land use, economic and environmental policies as it relates to the future character and quality of development within the City of San Jose (City of San Jose 2011). Applicable visual resource goals and policies include:

- Use new development within neighborhoods to enhance the public realm, provide for direct and convenient pedestrian access, and visually connect to the surrounding neighborhood. As opportunities arise, improve existing development to meet these objectives (VN-1.7).

- Development should maximize visual and physical access to creeks from the public right-of-way while protecting the natural ecosystem. Consider whether designs could incorporate linear parks along creeks or accommodate them in the future (CD-1.25).

- Promote consistent development patterns along streets, particularly in how buildings relate to the street, to promote a sense of visual order, and to promote attractive streetscapes (CD-4.3).

- Accomplish sound attenuation for development along City streets through the use of setbacks and building design rather than sound attenuation walls. When sound attenuation walls are located adjacent to expressways or freeways, or railroad lines, landscaping, public art, and/or an aesthetically pleasing and visually interesting design should be used to minimize visual impacts (CD-4.11).

- Preserve and enhance the visual access to scenic resources of San Jose and its environs through a system of scenic routes (Goal CD-9).

- Ensure that development within the designated Rural Scenic Corridors is designed to preserve and enhance attractive natural and man-made vistas (Policy CD-9.1).

- Design new public and private utility facilities to be safe, aesthetically pleasing, compatible with adjacent uses, and consistent with the Envision General Plan goals and policies for fiscal sustainability, environmental leadership, ad innovative economy, and quality neighborhoods (IN-1.9).

- Condition land development and/or purchase property along designated trail and pathway corridors in order to provide sufficient trail right-of-way and to ensure that new development adjacent to the trail and pathways corridors does not compromise safe trail access nor detract from the scenic and aesthetic qualities of the corridor (PR-7.2).

C.3.6.2 Land Use and Agricultural Resources

The City of San Jose *Envision San Jose 2040 General Plan* outlines land use, economic, and environmental policies as it relates to the future character and quality of development within the City of San Jose (City of San Jose 2011).

The SLLPIP alternatives with components located in the City of San Jose fall within the Open Space Parklands and Habitats land use designation. The General Plan identifies these lands as intended for low intensity uses. Lands in this designation are primarily devoted to open space, parks, recreation areas, trails, habitat buffers, nature preserves and other permanent open space areas. The General Plan calls for new development within this designation to be limited to minimize potential environmental and visual impacts and should avoid use of non-native, irrigated vegetation or development of new structures that would alter the environmental and visual quality of native habitat areas (City of San Jose 2011).

C.3.6.3 Cultural Resources

The current General Plan for the City of San Jose (2011) outlines the following goals, policies, and actions related to cultural resources:

Goal Preservation of historically and archaeologically significant structures, sites, districts and artifacts in order to promote a greater sense of historic awareness and community identity and to enhance the quality of urban living.

Policies Policy 1. Because historically or archaeologically significant sites, structures and districts are irreplaceable resources, their preservation should be a key consideration in the development review process.

Policy 2. The City should use the Area of Historic Sensitivity overlay and the landmark designation process of the Historical Preservation Ordinance to promote and enhance the preservation of historically or architecturally significant sites and structures.

Policy 3. An inventory of historically and/or architecturally significant structures should be maintained and periodically updated in order to promote awareness of these community resources.

Policy 4. Areas with a concentration of historically and/or architecturally significant sites or structures should be considered for preservation through the creation of Historic Preservation Districts.

Policy 5. New development in proximity to designated historic landmark structures and sites should be designed to be compatible with the character of the designated historic resource. In particular, development proposals located within the Areas of Historic Sensitivity designation should be reviewed for such design sensitivity.

Policy 6. The City should foster the rehabilitation of individual buildings and districts of historic significance and should utilize a variety of techniques and measures to serve as incentives toward achieving this end. Approaches which should be considered for implementation of this policy include, among others: Discretionary Alternate Use Policy Number 3, permitting flexibility as to the uses allowed in structures of historic or architectural merit; transfer of development rights from designated historic sites; tax relief for designated landmarks and/or districts; alternative building code provisions for the reuse of historic structures; and such financial incentives as grants, loans and/or loan guarantees to assist rehabilitation efforts.

Policy 8. For proposed development sites which have been identified as archaeologically sensitive, the City should require investigation during the planning process in order to determine whether valuable archaeological remains may be affected by the project and should also require that appropriate mitigation measures be incorporated into the project design.

Policy 9. Recognizing that Native American burials may be encountered at unexpected locations, the City should impose a requirement on all development permits and tentative subdivision maps that upon discovery of such burials during construction, development activity will cease until professional archaeological examination and reburial in an appropriate manner is accomplished.

Policy 10. Heritage trees should be maintained and protected in a healthy State. The heritage tree list, identifying trees of special significance to the community, should be periodically updated.

C.3.7 City of San Jose Municipal Code

The City of San Jose limits sound pressure levels at the property line exceeding 55 dB in residential areas, 60 dB in commercial areas, and 70 dB in industrial areas (City of San Jose Code of Ordinances Sections 20.30.700, 20.40.600, and 20.50.300). With respect to construction, Section 20.100.450 of the Municipal Code limits hours of construction within 500 feet of a residential unit to Monday through Friday 7 a.m. to 7 p.m. Construction on weekends within 500 feet of a residential unit is not allowed (City of San Jose 2016).

In addition to these requirements, Goal EC-1.7, Community Noise Levels and Land Use Compatibility, of the *2040 General Plan* requires construction operations within San Jose to use best available noise suppression devices and techniques. Additionally, the City considers significant construction noise impacts to occur if a project located within 500 feet of a residential use or 200 feet of a commercial or office uses would involve substantial noise generating activities continuing for more than 12 months (City of San Jose 2011).

The City's acceptable exterior noise level objective is 60 dBA L_{dn} or less for residential land uses. Conditionally acceptable noise levels fall within 60 to 75 dBA L_{dn}. Unacceptable noise levels are those that are greater than 75 dBA L_{dn} for residential, hotels and motels, and hospitals and residential care land uses (City of San Jose 2011).

Vibration that is perceptible without an instrument at the property line is prohibited in residential, commercial, or industrial zones (City of San Jose Code of Ordinances Sections 20.30.700, 20.40.600, and 20.50.300, 2016).

C.3.8 Merced County Code

The Merced County Code (Section 10.60.030) sets sound level limitations for the county. General limitations state that no sound source should exceed the background sound level at the receiving property line by 10 dBA or more during the daytime hours (7 a.m. to 10 p.m.) and by 5 dBA or more during the nighttime hours (10 p.m. to 7 a.m.). The maximum permissible sound levels for residential property are 65 dBA L_{dn} or 75 dBA $L_{max.}$ The maximum permissible sound levels for property other than residential property are 70 dBA L_{dn} or 80 dBA L_{max} (Merced County 2009).

The County's ordinance exempts construction activities, "provided that all construction in or adjacent to urban areas shall be limited to the daytime hours between 7 a.m. and 6 p.m., and all construction equipment shall be properly muffled and maintained." Operation of construction equipment outside of these daytime hours or at any time on a weekend day or legal holiday is prohibited (Merced County 2009).

Section 18.41.090 of the Merced County Code states that no use shall create any disturbing ground vibration based on typical human reaction beyond the boundaries of the site (Merced County 1977).

C.3.9 Merced County General Plan

C.3.9.1 Water Quality

The *2030 Merced County General Plan - Water Element* (Merced County 2013) sets forth countywide goals and policies applicable to water quality including:

Goal W-2: Protect the quality of surface and groundwater resources to meet the needs of all users.

- Policy: Ensure that land uses and development on or near water resources will not impair the quality or productive capacity of these water resources.

- Policy: Prepare updated development regulations, such as best management practices, that prevent adverse effects on water resources from construction and development activities.

- Policy: Encourage the use of natural channels for drainage and flood control to benefit water quality and other natural resource values.

- Policy: Encourage agriculture and urban practices to comply with the requirements of the RWQCB for irrigated lands and confined animal facilities, which mandate agricultural practices that minimize erosion and the generation of contaminated runoff to ground or surface waters by providing assistance and incentives

- Policy: Monitor and enforce provisions of the USEPA NPDES program to control non-point source water pollution.

- Policy: Coordinate with the SWRCB, RWQCB, and other responsible agencies to ensure that sources of water contamination (including boron, salt, selenium and other trace element concentrations) do not enter agricultural or domestic water supplies, and will be reduced where water quality is already affected.

C.3.9.2 Flood Control

The *2030 Merced County General Plan* (Merced County 2013) offers guidance concerning floodplain management, flood emergency response, funding development to finance construction of flood control facilities, flood risk consideration when developing within floodplains, flood control design and construction, public awareness programs and adapting infrastructure to accommodate for climate change. The plan directs that certain high occupancy or critical facilities, such as schools or hospitals should be discouraged in floodplains while open space uses are logical uses of flood prone areas. Policy 4-HS-2.9 in the Health and Safety Element of the General Plan states that "within areas subject to 100-year and 200-year frequency floods, all public utilities and facilities, such as roads, structures, wastewater treatment plants, gas, electrical and water systems, should be located and constructed to minimize or eliminate flood damage to the facilities."

C.3.9.3 Geology, Seismicity, and Soils

The *2030 Merced County General Plan – Health and Safety (HS) Element* (Merced County 2013) establishes the following goal and policies related to seismic and geologic hazards:

- Goal HS-1: Minimize the loss of life, injury, and property damage of County residents due to seismic and geologic hazards.

  - Policy HS-1.1: Require that all new habitable structures be located and designed in compliance with the Alquist-Priolo Special Studies Zone Act and related State earthquake legislation.

  - Policy HS-1.2: Support efforts to obtain financial assistance from Federal and State agencies in order to implement corrective seismic safety measures required for existing County buildings and structures.

  - Policy HS-1.3: Require all new structures located within dam inundation areas to conform to standards of dam safety as required by the State Division of Safety of Dams.

  - Policy HS-1.4: Require earthquake resistant design for proposed critical structures such as hospitals, fire stations, emergency communication centers, private schools, high occupancy buildings, bridges and freeway overpasses, and dams that are subject to County permitting requirements.

  - Policy HS-1.5: Encourage educational programs to inform the public of earthquake dangers in Merced County.

  - Policy HS-1.6: Prohibit habitable structures on areas of unconsolidated landslide debris or in areas vulnerable to landslides.

  - Policy HS-1.7: Discourage construction and grading on slopes in excess of 30 percent.

  - Policy HS-1.8: Require that the provisions of the International Building Code be used to regulate projects subject to hazards from slope instability.

  - Policy HS-1.9: Require and enforce all standards contained in the International Building Code related to construction on unstable soils.

The *2030 Merced County General Plan – Natural Resources (NR) Element* addresses goals, objectives, and policies related to soil and mineral resources in the county (Merced County 2013). Applicable policies include:

- Goal NR-3: Facilitate orderly development and extraction of mineral resources while preserving open space, natural resources, and soil resources and avoiding or mitigating significant adverse impacts.

  - Policy NR-3.1: Protect soil resources from erosion, contamination, and other effects that substantially reduce their value or lead to the creation of hazards.

- Policy NR-3.2: Require minimal disturbance of vegetation during construction to improve soil stability, reduce erosion, and improve stormwater quality.

- Policy NR-3.3: Encourage landowners to participate in programs that reduce soil erosion and increase soil productivity. This shall include promoting and coordinating the efforts of University of California Cooperative Extension, various Resource Conservation Districts, and other similar agencies and organizations.

The Merced County Code Title 16, Chapter 16.16 requires construction projects within the county's jurisdiction to follow the International Building Code standards and California State Amendments to the code (Ord. 1856 § 2, 2009). Among other important specifications, the International Building Code includes requirements and standards for geotechnical investigations (Section 1803); excavation, grading, and fill (Section 1804); structural design (Chapter 16); and, earthquake loads (Section 1613).

The Merced County Public Works Department regulates building and building safety within the unincorporated county. The Building and Safety Division and the Planning and Community Development Department are responsible for assessing proposed building projects and issuing building permits (Merced County 2011). Merced County does not have a grading ordinance and does not require permits for proposed grading.

Chapter 18.43 establishes the county's surface mining and reclamation ordinance. Merced's ordinance was certified in 1997. The purpose of the county's ordinance is to regulate surface mining and reclamation operations consistent with the county general plan and the SMARA at the State level. The county's SMARA ordinance was certified by the SMGB in 1997.

Chapter 18.41 of the county code sets performance standards to ensure compatibility between land uses by limiting such things as fumes, odor, noise, and dust. Section 030 covers dust mitigation from construction activities including clearing, grading, earth moving and other site preparation activities. The ordinance requires the application of water to prevent dust from leaving the project site.

C.3.9.4 Visual Resources

The *2030 Merced County General Plan* discusses aesthetic resources and their importance to the County's character (Merced County 2013). The following policies are relevant to the protection of visual resources in the project area.

- Scenic Resources: Protect scenic resources and vistas (Goal NR-4).

- Scenic Resource Preservation: Promote the preservation of agricultural land, ranch land, and other open space areas as a means of protecting the County's scenic resources (Policy NR-4.1).

- Special Review Process for Structures Adjacent to Scenic Highways: Coordinate with Caltrans, during the review of proposed structures and activities located adjacent to State-designated scenic highways, to ensure that scenic vistas and local scenic values are not significantly degraded (Policy NR-4.2).

- Building Design: Require that siting and design of buildings protect, improve, and enhance the scenic quality of the built and natural environments and take full advantage of scenic resources through site orientation, building setbacks, preservation of viewsheds, height limits, and the use of appropriate construction materials and exterior modulation (Policy NR-4.3).

- New Roads: Consider the surrounding landscape, topography, and existing scenic values when determining the location and construction of new roads (Policy NR-4.4).

- Light Pollution Reduction: Require good lighting practices, such as the use of specific light fixtures that reduce the light pollution, minimize light impacts, and preserve views of the night sky (Policy NR-4.5).

- Preserve, enhance, expand, and manage Merced County’s diverse system of regional parks, trails, recreation areas, and natural resources for the enjoyment of present and future residents and park visitors (Goal RCR-1).

- Scenic Resource and Public Land Protection: Encourage the use of regional parks and open space areas as a mechanism to preserve the County's natural scenic beauty and protect land for public purposes (Policy RCR-1.11).

C.3.9.5 Noise and Vibration

The *2030 Merced County General Plan*, which was adopted on December 10, 2013, includes noise standards for new noise-sensitive land uses such as residences, hospitals, and churches that are affected by transportation noise sources, as shown in Table C-8 (Merced County 2013). Table C-9 summarizes the interior and exterior noise level standards for noise-sensitive areas affected by existing non-transportation noise sources.

Table C-8. Noise Standards for New Uses Affected by Traffic, Railroad and Airport Noise in Merced County

New Land Use	Sensitive Outdoor Area[1] – L_{dn} (dBA)	Sensitive Indoor Area[2] – L_{dn} (dBA)
All residential[3]	65	45
Transient Lodging[3,4]	65	45
Hospitals & Nursing Homes[3,4,5]	65	45
Theaters & Auditoriums[4]	---	35
Churches, Meeting Halls, Schools, Libraries, etc.[4]	65	40
Office Buildings[4]	65	45
Commercial Buildings[4]	---	50
Playgrounds, Parks, etc.	70	---
Industry[4]	65	50

Source: Merced County 2013.

Notes:

1. Sensitive Outdoor Areas include primary outdoor activity areas associated with any given land use at which noise-sensitivity exists and the location at which the County's exterior noise level standards are applied.
2. Sensitive Interior Areas includes any interior area associated with any given land use at which noise-sensitivity exists and the location at which the County's interior noise level standards are applied. Examples of sensitive interior spaces include, but are not limited to, all habitable rooms of residential and transient lodging facilities, hospital rooms, classrooms, library interiors, offices, worship spaces, theaters. Interior noise level standards are applied within noise-sensitive areas of the various land uses with windows and doors in the closed positions.
3. Railroad warning horn usage shall not be included in the computation of L_{dn}.
4. Only the interior noise level standard shall apply if there are no sensitive exterior spaces proposed for these uses.
5. Since hospitals are often noise-generating uses, the exterior noise level standards are applicable only to clearly identified areas designated for outdoor relaxation by either hospital staff or patients.

Table C-9. Non-Transportation Noise Standards Median (L_{50}) / Maximum (L_{max})[1]

Receiving Land Use	Outdoor Daytime (dBA)	Outdoor Nighttime (dBA)	Interior Day or Night (dBA)
All residential	55 / 75	50 / 70	35 / 55
Transient Lodging[4]	55 / 75	---	35 / 55
Hospitals & Nursing Homes[5,6]	55 / 75	---	35 / 55
Theaters & Auditoriums[6]	---	---	30 / 50
Churches, Meeting Halls, Schools, Libraries, etc.[6]	55 / 75	---	35 / 60
Office Buildings[6]	60 / 75	---	45 / 65
Commercial Buildings[6]	55 / 75	---	45 / 65
Playgrounds, Parks, etc.[6]	65 / 75	---	---
Industry[6]	60 / 80	---	50 / 70

Source: Merced County 2013.

Notes:

1 These standards shall be reduced by 5 dB for sounds consisting primarily of speech or music, and for recurring impulsive sounds. If the existing ambient noise level exceeds the standards in this table, then the noise level standards shall be increased at 5 dB increments to encompass the ambient.

2 Sensitive Outdoor Areas include primary outdoor activity areas associated with any given land use at which noise-sensitivity exists and the location at which the County's exterior noise level standards are applied.

3 Sensitive Interior Areas includes any interior area associated with any given land use at which noise-sensitivity exists and the location at which the County's interior noise level standards are applied. Examples of sensitive interior spaces include, but are not limited to, all habitable rooms of residential and

transient lodging facilities, hospital rooms, classrooms, library interiors, offices, worship spaces, theaters. Interior noise level standards are applied within noise-sensitive areas of the various land uses with windows and doors in the closed positions.

[4] Outdoor activity areas of transient lodging facilities are not commonly used during nighttime hours.

[5] Since hospitals are often noise-generating uses, the exterior noise level standards are applicable only to clearly identified areas designated for outdoor relaxation by either hospital staff or patients.

[6] The outdoor activity areas of these uses (if any) are not typically used during nighttime hours.

[7] Where median (L_{50}) noise level data is not available for a particular noise source, average (L_{eq}) values may be substituted for the standards of this table provided the noise source operates for at least 30 minutes. If the source operates less than 30 minutes the maximum noise level standards shown shall apply.

These standards are enforced to protect noise-sensitive land uses in the county and do not pertain to short-term construction noise.

C.3.9.6 Fisheries and Terrestrial Resources

The *2030 Merced County General Plan - Natural Resources Element* (Merced County 2013) sets forth the following goal and policies regarding terrestrial resources:

Goal NR-1: Preserve and protect, through coordination with the public and private sectors, the biological resources of the County.

- Policy NR-1.1: Habitat Protection- Identify areas that have significant long-term habitat and wetland values including riparian corridors, wetlands, grasslands, rivers and waterways, oak woodlands, and vernal pools, and provide information to landowners.

- Policy NR-1.2: Protected Natural Lands- Identify and support methods to increase the acreage of protected natural lands and special habitats, including but not limited to, wetlands, grasslands, and vernal pools, potentially through the use of conservation easements.

- Policy NR-1.3: Forest Protection- Preserve forests, particularly oak woodlands, to protect them from degradation, encroachment, or loss.

- Policy NR-1.4: Important Vegetative Resource Protection- Minimize the removal of vegetative resources which stabilize slopes, reduce surface water runoff, erosion, and sedimentation.

- Policy NR-1.5: Wetland and Riparian Habitat Buffer- Identify wetlands and riparian habitat areas and designate a buffer zone around each area sufficient to protect them from degradation, encroachment, or loss.

- Policy NR-1.6: Terrestrial Wildlife Mobility - Encourage property owners within or adjacent to designated habitat connectivity corridors that have been mapped or otherwise identified by the CDFW or USFWS to install wildlife-friendly fencing, provide roadway undercrossing, or install oversized culverts and bridges to allow movement of terrestrial wildlife.

- Policy NR-1.11: On-Going Habitat Protection and Monitoring- Cooperate with local, State, and Federal agencies to ensure that adequate on---going protection and monitoring occurs adjacent to rare and endangered species habitats or within identified significant wetlands.

- Policy NR-1.12: Wetland Avoidance- Avoid or minimize loss of existing wetland resources by careful placement and construction of any necessary new public utilities and facilities, including roads, railroads, high speed rail, sewage disposal ponds, gas lines, electrical lines, and water/wastewater systems.

- Policy NR-1.13: Wetland Setbacks- Require an appropriate setback, to be determined during the development review process, for developed and agricultural uses from the delineated edges of wetlands.

- Policy NR-1.15: Urban Forest Protection and Expansion- Protect existing trees and encourage the planting of new trees in existing communities. Adopt an Oak Woodland Ordinance that requires trees, larger than a specified diameter, that are removed to accommodate development be replaced at a set ratio.

- Policy NR-1.17: Agency Coordination- Coordinate with private, local, State, and Federal agencies to assist in the protection of biological resources and prevention of degradation, encroachment, or loss of resources managed by these agencies.

C.3.9.7 Land Use and Agricultural Resources

Merced County's *2030 General Plan* Land Use Element describes the policies and standards for future land use and agricultural/resource protection for rural and urban land use (Merced County 2013). The Natural Resources Element provides the policy context for open space (Merced County 2013). Titles 16, 17, and 18 of the Merced County Code address regulations related to building and construction, subdivisions, and zoning (Merced County Nd.).

The SLLPIP alternatives with components located in Merced County fall within the Foothill Pasture land use designation. This designation applied to lands in the County that support non-cultivated agricultural practices over larger areas with poor soil quality, limited water availability, and steeper slopes. Specific land use policies included in the General Plan for this designation include:

- Goal LU-2 Preserve, promote, and expand the agricultural industry in Merced County.

  – Policy LU-2.2: Foothill Pasture Designation (RDR) Apply the Foothill Pasture land use designation on agricultural and open space

lands located on the eastern and western edges of the County which are recognized for their value as grazing, cropland, and open space.

– Policy LU-2.3: Land Use Activity Limitations (RDR) Limit allowed land use within Agricultural and Foothill Pasture areas to agricultural crop production, farm support operations, and grazing and open space uses (Merced County 2013).

C.3.9.8 Cultural Resources

The following includes the various goals, policies, actions, programs, implementation strategies, and ordinances that address cultural resources in Merced County. This includes the *2030 Merced County General Plan* (Merced County 2013). Only information considered relevant to the proposed project was included.

Cultural resources in Merced County include archaeological sites (prehistoric and historic) and historic resources. These types of resources include: prehistoric occupations, cemeteries, isolated burials, quarry sites, petroglyph (rock carving) and pictograph (rock painting) sites; historic archaeological sites; and historic structures and landmarks.

Goal 2. Soil, water, mineral, energy, historical, and air resources are properly managed

Objective2.E. Significant archaeological and cultural resources are recognized and managed.

Policy 21. Projects that effect archaeological sites and artifacts should be carefully managed to avoid damage.

Policy 22. The original architectural character of significant historic structures should be maintained whenever possible.

Policy 23. To discourage looting and vandalism, significant historical and archaeological resources should be subject to limited or controlled public access.

C.3.10 Merced County Office of Environmental Services

Emergency preparedness, coordination and direction of wide-scale disasters and emergencies are provided by the Merced County Office of Environmental Services (OES). The Merced County OES coordinates planning, response, recovery, and mitigation activities with many partners including incorporated and unincorporated cities, special districts, and some private agencies. The Merced County OES and their partner agencies coordinate and maintain Emergency Operations Plans according to the National Incident Management System for the County. Contained within the Merced County Emergency

Operations Plan (2013) is guidance for handling and managing large-scale incidents and disasters including public health threats (Merced County 2016).

C.3.11 Pacheco State Park General Plan

The Pacheco State Park (SP) is owned and managed by CDPR. The CDPR approved the *Pacheco SP General Plan* in 2006; however, the final General Plan has not been published due to necessary changes determined during the final comment period of the Final Environmental Impact Report (EIR) (CDPR 2004).

C.3.12 San Joaquin Valley Air Pollution Control District Plans

The current, USEPA-approved SIPs for each federal nonattainment or maintenance pollutant in the San Joaquin Valley Air Pollution Control District (SJVAPCD) are summarized below:

- O_3 – *2007 Ozone Plan*, approved by USEPA for the 1997 8-hour O_3 NAAQS on April 30, 2012 (77 FR 12652)
- CO – *Final Carbon Monoxide Redesignation Request and Maintenance Plan for Ten Federal Planning Areas*, approved by USEPA on June 1, 1998 (63 FR 15305)[6]
- PM_{10} – *2007 PM_{10} Maintenance Plan and Request for Redesignation*, approved by USEPA on November 12, 2008 (73 FR 66759)
- $PM_{2.5}$ – *2012 $PM_{2.5}$ Plan*, partially approved by USEPA on August 31, 2016 (81 FR 59876). In this approval, the USEPA approved in part and disapproved in part SIP revisions to provide for the attainment of the 2006 24-hour $PM_{2.5}$ NAAQS.
- $PM_{2.5}$ – *2008 $PM_{2.5}$ Plan*, partially approved by USEPA on January 9, 2012 (76 FR 69896). In this approval, the USEPA approved in part and disapproved in part SIP revisions to provide for attainment of the 1997 $PM_{2.5}$ NAAQS.[7]

In addition to the SIP-approved *2007 Ozone Plan*, the SJVAPCD adopted the *2016 Plan for the 2008 8-Hour O3 Standard* in June 2016, which was subsequently approved by CARB in July 2016. However, the plan is still pending approval by the USEPA.

The SJVAPCD also adopted the *2004 Extreme Ozone Attainment Demonstration Plan* for the revoked 1-hour 1979 O_3 NAAQS in October 2004,

[6] On July 22, 2004, CARB approved an update to the SIP with the *2004 Revisions to the Carbon Monoxide Maintenance Plan*, which was subsequently submitted to the USEPA for approval on November 8, 2004. Because the USEPA has not yet approved the update, the 1998 plan is the current SIP-approved plan.

[7] On August 28, 2013, the USEPA proposed to approve the SJVAB 1997 $PM_{2.5}$ Contingency Measures and published an interim-final rule to stay and defer sanctions (78 FR 53113).

but the USEPA did not act on the plan until 2010 (75 FR 10420). Because of litigation the EPA withdrew its plan approval in November 2012 (77 FR 70376). In September 2013, the SJVAPCD consequently adopted the *2013 Plan for the Revoked 1-Hour Ozone Standard*, which was approved by the USEPA on February 25, 2016 (81 FR 19492).

The SJVAPCD has prepared several plans for $PM_{2.5}$ that have not yet been approved by the USEPA. These plans are summarized below:

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- Draft *2018 Plan for the 1997, 2006, and 2012 $PM_{2.5}$ Plans*

- *2016 Moderate Area Plan for the 2012 $PM_{2.5}$ Standard* (adopted by SJVAPCD in September 2016; pending approval by CARB and USEPA)

- *2015 Plan for the 1997 $PM_{2.5}$ Standard* (adopted by SJVAPCD in April 2015 and by CARB in May 2015; pending approval by USEPA)

C.3.13 Santa Clara County General Plan

C.3.13.1 Water Quality

The *Santa Clara County General Plan - Resource Conservation Chapter* (Santa Clara County 1994) sets forth countywide strategies and policies applicable to water quality including:

Strategy #1: Reduce Non-Point Source Pollution

- Policy: Countywide, compliance should be achieved with the requirements of the NPDES permit for discharges into San Francisco Bay, and to that end, the Countywide Nonpoint Source Pollution Control Program should receive the full support and participation of each member jurisdiction

- Policy: The countywide Stormwater Management Plan should be routinely reviewed and updated as additional information is collected on the effectiveness of prescribed control measures.

- Policy: Efforts to increase public awareness and education concerning nonpoint source pollution control should be encouraged.

Strategy #2: Restore Wetlands, Riparian Areas, and Other Habitats that Improve Bay Water Quality

- Policy: Wetlands restoration for the purpose of enhancing municipal wastewater treatment processes, improving habitat and passive recreational opportunities should be encouraged and developed where cost-effective and practical.

Strategy #3: Prepare and Implement Comprehensive Watershed Management Plans

- Policy: Comprehensive watershed management plans should be developed and implemented through intergovernmental coordination. Water supply watersheds should receive special consideration and additional protection.

C.3.13.2 Flood Control

Santa Clara County's flood protection-related policies focus on the protection of urban development in flood-prone areas; the protection of existing recreation lands from flood protection projects and related hazards; and flood-related natural disaster relief and prevention (Santa Clara County 1994).

C.3.13.3 Geology, Seismicity and Soils

Book A, Part 2, *Resource Conservation and Health and Safety chapters*, of the *Santa Clara County General Plan* establishes the following applicable policies in relation to mineral resources and natural hazards (Santa Clara County 1994):

- **Policy C-CR 44:** Local supplies of mineral resources should be recognized for their importance to the local, regional, and State economy. Countywide strategies for preserving and managing mineral resources include:
  - Ensuring continued availability of mineral resources to meet long-term demand; and,
  - Mitigating environmental impacts of extraction and transportation.
- **Policy C-CR 45:** Current and future demand for mineral resources in Santa Clara County, particularly construction aggregates, should be ensured by the following means:
  - Preserving deposits and access routes.
- **Policy C-CR 46:** Existing sites and access routes for regionally-significant resources should be protected from incompatible land uses and development that would preclude or unnecessarily limit resource availability."

- **Policy C-HS 28:** Countywide strategies for reducing the threat of natural hazards to life and property should include:

  – Design, locate, and regulate development to avoid or withstand hazards;

  – Reduce the magnitude of the hazard, if feasible; and,

  – Provide public information regarding natural hazards.

Title C, Division C3, Chapter 1 of the county's code describes that the county defers to the 2010 CBSC for its building code regulations.

The Santa Clara County Geologic Ordinance (Division C12, Chapter 4) regulates geologic provisions and establishes minimum requirements for the geologic evaluation of land based on the proposed land uses. It also establishes procedures to enforce these requirements, including rules and regulations for the development of land which is on or adjacent to known hazardous areas, or which has the potential to create or increase the risk of geologic hazard. This chapter fulfills the county's responsibility to comply with State laws regarding geologic hazards including the Alquist-Priolo Earthquake Fault Zoning Act and the Seismic Hazards Mapping Act.

Section 4.10.370 of the Santa Clara County Zoning Ordinance (Title C Appendix I Article 4, Chapter 4.10) describes county requirements for surface mining and management plans and county compliance with SMARA. The county's ordinance was most recently certified by the SMGB in 2000.

C.3.13.4 Visual Resources

The Parks and Recreation and Resource Conservation sections of the Rural Unincorporated Areas component of the *Santa Clara County General Plan* discuss the value of scenic resources in the County (Santa Clara County 1994). The following policies and implementation measures are relevant to the portion of the project that would occur within Santa Clara County.

- The natural scenery which exists along many of Santa Clara County's highways should be protected from land uses and other activities which would diminish its aesthetic qualities (Policy R-PR 39).

- Land use should be controlled along scenic roads so as to relate to the location and functions of these roads and should be subject to design review and conditions to assure the scenic quality of the corridor (Policy R-PR 40).

- The visual integrity of the scenic gateways, which include Pacheco Pass, should be protected (Policy R-PR 41).

- New structures should be located where they will not have a negative impact on the scenic quality of the area, and in rural areas should generally be set back at least 100 feet from scenic roads and highways to minimize their visual impact (Policy R-PR 45).

- Activities along scenic highways that are of a substantially unsightly nature, such as equipment storage or maintenance, fuel tanks, refuse storage or processing, should be screened from view (Policy R-PR 47).

- The scenic and aesthetic qualities of both the natural and built environments should be preserved and enhanced for their importance to the overall quality of life for Santa Clara County (Policy R-RC 95).

- The general approach to scenic resource preservation for the rural unincorporated areas consists of the following strategies (Policy R-RC 96):

  – Minimize scenic impacts in rural areas through control of allowable development densities.

  – Limit development impacts on highly significant scenic resources, such as, ridgelines, prominent hillsides, streams, transportation corridors and county entranceways.

- Scenic qualities of the rural areas of Santa Clara County shall be maintained and enhanced through existing land use and development policies. Development compatible with scenic resource conservation should be encouraged (Policy R-RC 97).

- Hillsides, ridgelines, scenic transportation corridors, major county entryways, stream environments, and other areas designated as being of special scenic significance should receive utmost consideration and protection due to their prominence, visibility, and overall contribution to the quality of life in Santa Clara County (Policy R-RC 98).

- Roads, building sites, structures and public facilities shall not be allowed to create major or lasting visible scars on the landscape (Policy R-RC 101).

- Protect the scenic value of the following major County thoroughfares and entranceways through State scenic highway designation, including Pacheco Pass (SR 152 east of Gilroy), Hecker Pass (SR 152 west of Gilroy), and Route 101 (from the San Jose City limits south to the San Benito County border) (Policy R-RC-(i)-36).

C.3.13.5 Noise and Vibration

The Noise Compatibility Standards in the Safety and Noise Chapter of the *Santa Clara County General Plan* (1994) state that an exterior noise environment of 55 dB Ldn or less is considered satisfactory for residential land use, a level between 55 dB and 65 dB Ldn is considered cautionary, and a level greater than 65 dB Ldn is considered critical. For open space land uses, noise levels of 65 dB Ldn or less are considered satisfactory and noise levels between 65 dB and 80 dB Ldn are considered cautionary.

C.3.13.6 Fisheries and Terrestrial Resources

The *Santa Clara County General Plan Resource Conservation Chapter* (Santa Clara County 1994) sets forth countywide strategies and policies applicable to Habitat and Biodiversity, including:

Strategy #2: Protect the Biological Integrity of Critical Habitat Areas

- Policy: Habitat and other resource areas not suitable or intended for urbanization should be excluded from urbanization, and non-urban development which occurs within resource conservation areas should minimize impacts upon habitat and biodiversity.

- Policy: Areas of habitat richest in biodiversity and necessary for preserving threatened or endangered species should be formally designated to receive greatest priority for preservation, including baylands and riparian areas, serpentine areas, and other habitat types of major significance.

- Policy: Land uses permitted in resource conservation areas should not be allowed to degrade the integrity of natural habitat.

- Policy: Linkages and corridors between habitat areas should be provided to allow for migration and otherwise compensate for the effects of habitat fragmentation.

Strategy #3: Encourage Habitat Restoration

- Policy: Restoration of habitats should be encouraged and utilized where feasible, especially in cases where habitat preservation and flood control, water quality, or other objectives can be successfully combined.

Strategy #4: Evaluate the Effectiveness of Environmental Mitigations

- Policy: The status of various threatened and endangered species and the effectiveness of strategies and programs to preserve biodiversity should be monitored and evaluated on an ongoing basis.

- Policy: Specific project mitigations for the purpose of preserving habitat should be monitored for a period of time to assure the likelihood of their effectiveness.

C.3.13.7 Land Use and Agricultural Resources

Santa Clara County's 1995-2010 *General Plan* includes policies designed to regulate land use and development throughout the county (Santa Clara County 1994). The Pacheco Reservoir Expansion Alternative falls within the Ranchlands land use designation. This designation is applied to lands in the County that are predominantly used as ranches in rural unincorporated areas of the county, remote from urbanized areas and generally less accessible than other mountain lands. Grazing lands are included under this designation.

Specific land use policies included in the General Plan for this designation include:

- R-LU 39: The primary use shall be ranching. Other allowable uses shall be: agriculture; low intensity recreational uses; mineral extraction; land in its natural state; hunting; wildlife refuges; very low density residential development; and very low intensity commercial, industrial, or institutional uses, provided that they primarily support ranching activities or the enhancement, protection, study or appreciation of the natural resources of the area

- R-LU 40: General principles governing development and land division in Ranchlands areas shall be as follows:

  – No large ranches shall be allowed to fully divide into small parcels.

  – The function of allowed subdivisions shall be for the following, provided that very little population is added to Ranchlands areas: help ranchers trade land; raise capital in times of need; help settle estates; and provide for family divisions.

  – The right of ranchers to build residences and to divide "Williamson Act" property under the terms of existing Land Conservation contracts is affirmed.

  – There shall be a limit to the number of parcels created within the Ranchlands area.

  – The rural character of the area shall not be changed, and land use decisions shall prevent an influx of people into the Ranchlands area

C.3.13.8 Cultural Resources

The following policies and strategies related to cultural resources are included in the *Santa Clara County General Plan* and are applicable to the proposed project:

In *Santa Clara County General Plan*, defines heritage resources are those particular types of resources, both natural and man-made, which due to their vulnerability or irreplaceable nature deserve special protection if they are to be preserved for current and future generations. The types of resources addressed as heritage resources include: historical sites, structures, and areas; archeological and paleontological sites and artifacts; and historical and specimen trees.

C-RC 49. Cultural heritage resources within Santa Clara County should be preserved, restored wherever possible, and commemorated as appropriate for their scientific, cultural, historic and place values.

C-RC 50. Countywide, the general approach to heritage resource protection should include the following strategies:

1. Inventory and evaluate heritage resources.

2. Prevent or minimize adverse impacts on heritage resources.

3. Restore, enhance, and commemorate resources as appropriate.

C-RC 51. Inventories of heritage resources should be maintained as the basis for local decision-making regarding such resources.

C-RC 52. Prevention of unnecessary losses to heritage resources should be ensured as much as possible through adequate ordinances, regulations, and standard review procedures. Mitigation efforts, such as relocation of the resource, should be employed where feasible when projects will have a significant adverse impact upon heritage resources.

C-RC 53. Cities should balance plans for urban redevelopment with the objectives of heritage resource preservation in such cases where potential conflicting interests may arise. Care should be taken to integrate heritage resources with new development wherever possible.

C-RC 54. Heritage resources should be restored, enhanced, and commemorated as appropriate to the value and significance of the resource.

C-RC 55. Public awareness and appreciation of existing heritage resources and their significance should be enhanced through community organizations, neighborhood associations, the educational system, and governmental programs.

C-RC(i)24. Update inventories and evaluations of heritage resources. Survey resources as necessary to augment existing inventories.

C-RC(i)25. Review administrative procedures and enforcement for effectiveness.

C-RC(i)26. Explore designation of historic districts to preserve character of areas rich in heritage resources.

R-RC 1. Natural and heritage resources shall be protected and conserved for their ecological, functional, economic, aesthetic, and recreational values.

1. Heritage resources shall be preserved to the maximum extent possible or their scientific, cultural, and "sense of place" values.

R-RC 81. Heritage resources within the rural unincorporated areas of Santa Clara County shall be preserved, restored wherever possible, and commemorated as appropriate for their scientific, cultural, historic and place values.

R-RC 85. No heritage resource shall knowingly be allowed to be destroyed or lost through a discretionary action (zoning, subdivision site approval, grading permit, building permit, etc.) of the County of Santa Clara unless:

1. the site or resource has been reviewed by experts and the County Historic Heritage Commission and has been found to be of insignificant value; or
2. there is an overriding public benefit from the project and compensating mitigation to offset the loss is made part of the project.

R-RC 86. Projects in areas found to have heritage resources shall be conditioned and designed to avoid loss or degradation of the resources. Where conflict with the resource is unavoidable, mitigation measures that offset the impact maybe imposed.

R-RC 90. Heritage and old growth trees, particularly redwoods, should not be cut, except in instances where public safety is jeopardized.

C.3.14 Santa Clara County Ordinance Code

C.3.14.1 Noise and Vibration

Santa Clara County sets maximum permissible sound levels by receiving land use. Table C-10 summarizes the County's exterior noise limits, which are not to be exceeded for more than 30 minutes in any hour. Higher noise levels are allowed for shorter durations (Santa Clara County 2003).

The County also defines allowable interior noise levels for multi-family dwellings. Between 10 p.m. and 7 a.m. this level is 35 dBA (for no more than five minutes in any hour) and between 7 a.m. and 10 p.m. this level is 45 dBA (for no more than five minutes in any hour). Higher noise levels are allowed for shorter durations (Santa Clara County 2003).

Table C-10. Exterior Noise Limits (Santa Clara County)

Receiving Land Use Category	Maximum L_{50} (dBA) 7 a.m. – 10 p.m.	Maximum L_{50} (dBA) 10 p.m. – 7 a.m.
One- and Two-Family Residential	55	45
Multi-Family Dwelling	n/a	50
Residential Public Space	55	n/a
Commercial	65	60
Light Industrial	70	70
Heavy Industrial	75	75

Source: Santa Clara County 2003.
Key:
dBA = A-weighted decibel scale
L_{50} = A-weighted sound level that is exceeded 50 percent of the time
n/a = not applicable

Additionally, the County has established maximum noise levels for construction activities. The ordinance states that the standards (Table C-11) should not be exceeded for mobile equipment where technically and economically feasible.

Table C-11. Noise Limits for Construction Activities (Santa Clara County)

Time Period	Single- and Two-Family Dwelling Residential Area	Multifamily Dwelling Residential Area	Commercial Area
Daily, except Sundays and legal holidays 7 a.m. to 7 p.m.	75 dBA	80 dBA	85 dBA
Daily, 7 p.m. to 7 a.m. and all day Sunday and legal holidays	50 dBA	55 dBA	60 dBA

Source: Santa Clara County 2003.
Key:
dBA = A-weighted decibel scale

Santa Clara County has a perception threshold of 1/100 in/sec (1-100 Hz) defined in their County Code (Section B11-151[dd]). Section B11-154(b)(7) of the County Code prohibits operating or permitting the operation of any device that creates a vibrating effect that a) endangers or injures the safety or health of human beings or animals; or b) annoys or disturbs a person of normal sensitivities; or c) endangers or injures personal or real properties (Santa Clara County 2003).

C.3.14.2 Cultural Resources

The County adopted a Historic Preservation Ordinance, (Ordinance NS-1100.96) in October 2006. Basic components included in the Historic Preservation Ordinance are: 1) purpose and intent; 2) definitions; 3) commission powers and duties (revision of Chapter 5, Division A6-60 through 65); 4) landmark designation criteria and process (including a requirement for owner consent for designation); 5) landmark design review process and findings; 6) appeals; 7) economic hardship; 8) maintenance; and 9) enforcement.

C.3.15 Santa Clara County OES Services

The Santa Clara County OES works with County departments, local cities and special districts to plan for disasters and emergencies. This work includes mitigating against, preparing for, responding to, and recovering from disasters. The Santa Clara County OES is also responsible for operation of the Emergency Operations Centers so they are ready in case of an emergency situation. This involves coordinating and conducting simulated disaster preparedness and response exercises and evaluating staff training. The *Santa Clara County Operational Area Emergency Operations Plan* (2008) provides guidance for emergency management phases: preparedness, response, recovery and mitigation for many types of emergencies and disasters including: major earthquake, wildland urban/interface fire, extreme weather, public health emergency, technological and resource emergency, hazardous materials incident, terrorism, flood and landslide (Santa Clara County 2008).

C.3.16 Santa Clara Valley Habitat Conservation Plan and Natural Communities Conservation Plan

The *Final Santa Clara Valley Habitat Conservation Plan and Natural Communities Conservation Plan (HCP/NCCP)* is a regional partnership between the County of Santa Clara, Santa Clara Valley Transportation Authority, SCVWD, and the Cities of San Jose, Gilroy and Morgan Hill, the CDFW, and the USFWS for the long-term protection of natural ecosystems and biodiversity (Santa Clara County 2012). The proposed HCP/NCCP study area covers approximately 520,000 acres and would create a Reserve System to preserve an estimated 45,000 acres of high-quality habitat for the benefit of covered species, natural communities, biological diversity, and ecosystem function. The plan calls for habitat restoration and enhancement of sensitive habitats including riparian woodlands and wetlands and preservation of major wildlife corridors between key habitat areas and between existing protected areas (Santa Clara County 2012). In-stream construction projects and operations and maintenance along with urban development in Santa Clara County with the potential to affect species covered by the HCP/NCCP can obtain incidental take permits for these actions on the condition that they incorporate the relevant conditions on covered activities described in Chapter 6 of the HCP in order to avoid or minimize impacts to covered species and natural communities.

The Plan includes the following 18 listed and non-listed species: federally threatened Bay checkerspot butterfly (*Euphydryas editha bayensis*); federally and state-threatened California tiger salamander (*Ambystoma californiense*); federally threatened and state species of special concern California red-legged frog (*Rana draytonii*); federal candidate and state species of special concern foothill yellow-legged frog (*Rana boylii*); state species of special concern western pond turtle (*Actinemys marmorata*); state species of special concern western burrowing owl (*Athene cunicularia*); federally endangered Least Bell's vireo (*Vireo bellii pusillus*); state candidate and state species of special concern tricolored blackbird (*Agelaius tricolor*); federally endangered and state threatened San Joaquin kit fox (*Vulpes macrotis mutica*); federally endangered, state threatened, and California Rare Plant Rank 1B.2 listed Tiburon paintbrush (*Castilleja affinis* ssp. *neglecta*); federally endangered and California Rare Plant Rank 1B.1 listed coyote ceanothus (*Ceanothus ferrisiae*); California Rare Plant Rank 1B.2 listed Mount Hamilton thistle (*Cirsium fontinale* var. *campylon*); federally endangered and California Rare Plant Rank 1B.1 listed Santa Clara Valley dudleya (*Dudleya abramsii* ssp. *setchellii*); California Rare Plant Rank 1B.2 listed fragrant fritillary (*Fritillaria liliacea*); California Rare Plant Rank 1B.1 listed Loma Prieta hoita (*Hoita strobilina*); California Rare Plant Rank 1B.2 listed smooth lessingia (*Lessingia micradenia* var. *glabrata*); federally endangered and California Rare Plant Rank 1B.1 listed Metcalf Canyon jewelflower (*Streptanthus albidus* ssp. *albidus*); and California Rare Plant Rank 1B.1 listed Most beautiful jewelflower (*Streptanthus albidus* ssp. *peramoenus*).

C.3.17 Santa Clara Valley Water District Flood Control

SCVWD prepared the Draft Flood Protection & Stream Stewardship Master Plan in 2010, an update to the current master plan that was last updated in 2000. The Flood Protection and Stream Stewardship Master Plan provides guidance for public funds investment supporting the SCVWD's Flood Protection and Stream Stewardship Program. The update will extend the planning horizon to 2025 (SCVWD 2010a). The Safe, Clean Water and Natural Flood Protection Program helps to protect water resources in Santa Clara County. The 5-year implementation plan started in 2014 includes projects in key priority areas including priority C for the protection of water supply form earthquakes and other natural disasters (SCVWD 2016a).

The SCVWD participates in the Santa Clara Valley Urban Runoff Pollution Prevention Program with the thirteen cities and towns and Santa Clara County that are covered under the same NPDES Municipal Regional Stormwater Permit (MRP) for controlling the quality of stormwater discharge to South San Francisco Bay. The other co-permittees in addition to SCVWAD include: Campbell, Cupertino, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, Sunnyvale and Santa Clara County. The C.3 Handbook provides guidance for project post-construction stormwater controls (Provision C.3 of the MRP) to be implemented in order to meet the requirements of the MRP (Santa Clara Valley [SCV] Urban

Runoff Pollution Prevention Program [URPPP] 2012). In addition to influencing the quality of stormwater discharge, these controls influence the volume and velocity of discharge from construction sites.

C.3.18 Santa Clara Valley Water District Groundwater Management Plan

Assembly Bill 3030, the Groundwater Management Act and SB 1938 encourages local water agencies to establish local GMPs. The SCVWD GMP was developed to assist in managing the groundwater basins underlying Santa Clara County. The following programs are documented in this GMP (SCVWD 2016b):

- Groundwater supply management programs that replenish the groundwater basins, sustain the basin's water supplies, help to mitigate groundwater overdraft, and sustain storage reserves for use during dry periods.

- Groundwater monitoring programs that provide data to assist SCVWD in evaluating and managing the groundwater basin.

- Groundwater quality management programs that identify and evaluate threats to groundwater quality and prevent or mitigate contamination associated with those threats.

SCVWD has developed the following outcome measures to gauge performance in meeting the groundwater basin management objectives (SCVWD 2016b):

- Projected end of year groundwater storage is greater than 278,000 AF in the Santa Clara Plain subbasin, 5,000 in Coyote Valley (due to different land use and management characteristics, SCVWD delineates the DWR's Santa Clara Subbasin [subbasin 2-9.02] into two groundwater management areas: the Santa Clara Plain and the Coyote Valley), and 17,000 AF in the Llagas Subbasin.

- Groundwater levels are above subsidence thresholds at the subsidence index wells (see Figure 6-3 for index well locations). SCVWD has established an acceptable subsidence rate of no more than 0.01 feet per year on average, which has been endorsed by the Water Retailer Groundwater Subcommittee.

- At least 95 percent of countywide water supply wells meet primary drinking water standards and at least 90 percent of wells in the southern part of the valley (South County) meet Basin Plan agricultural water quality objectives.

- At least 90 percent of wells have stable or decreasing concentrations of nitrate, chloride, and total dissolved solids (TDS).

C.3.19 Santa Clara Valley Water District Water Resources Protection Ordinance

This ordinance protects water resources managed by the SCVWD by regulating modifications, entry, use or access to water district facilities and/or direct easements. This ordinance States that none of these activities may be performed on or within a SCVWD facility or easement without prior issuance of an encroachment permit (SCVWD 2010b).

C.3.20 San Luis Reservoir SRA Resource Management Plan/ General Plan

The *San Luis Reservoir SRA RMP/GP* (Reclamation and CDPR 2013) sets forth the following goals for the protection, management, and restoration of vegetation and wildlife:

- Vegetation Goal RES-V1: Protect, maintain, and, where appropriate, restore the site's locally and regionally important native plant communities.

- Vegetation Goal RES-V2: Document and protect special-status plants and communities and manage for their perpetuation and enhancement.

- Vegetation Goal RES-V3: Control invasive and non-native species.

- Vegetation Goal RES-V4: Restore the project area's native grasslands through the use of best management practices.

- Wildlife Goal RES-W1: Maintain, protect, and enhance wildlife habitat for common, sensitive, and special-status wildlife species.

The following goals are related to recreational resources:

- Goal VIS-F1 - Maintain and provide new visitor facilities and uses that enhance recreational enjoyment of the site's history and character while avoiding resource degradation.

  – Plan for recreational opportunities within a regional context and in coordination with other plans (e.g., the Millerton Lake RMP, Pacheco State Park, Hollister Hills State Vehicular Recreation Area, and Merced County and Santa Clara County parks) so that facilities are balanced within the region and are compatible with the location and resources.

  - Provide for a variety of day-use activities and overnight camping facilities that accommodate visitors of varying abilities.

- Goal VIS-F2 - Provide adequate shoreline and upland support facilities and management at each reservoir and use area to address current and future demand for permitted recreational uses, consistent with management zones and natural and cultural resource goals and guidelines.

  - Ensure that campground and day use additions and improvements respond to and are prioritized based on user demand.

- Goal VIS-F3 - Manage water surfaces and use areas to accommodate a variety of different user groups and minimize resource degradation and conflicts among users.

  - Resolve water surface use conflicts using a variety of methods, such as but not limited to seasonal and time-of-day restrictions and "no wake" or "reduced speed" zones.

  - Optimize and coordinate water and land based recreational uses by development of a boating management plan.

- Goal VIS-T1 - Provide an appropriate amount and variety of trails in a range of locations throughout the Plan Area as well as improved connectivity from existing trails.

  - Maintain a system of multi-use trails to meet visitor demand.

- Goal VIS-T2 - Balance the optimum visitor experience while avoiding habitat fragmentation or other site degradation.

  - Use BMPs to maintain trails and minimize erosion.

C.3.21 Traffic and Transportation Regulations

Traffic analysis in the State of California is guided by standards set at the State level by Caltrans, and by local jurisdictions. State highways fall under the jurisdiction of Caltrans. Other roadways fall under the local jurisdiction, either city or county, in which they are located.

Each jurisdiction has adopted standards regarding the desired performance level of traffic conditions on the circulation system within its jurisdiction. A performance measure called "Level of Service" (LOS) is used to characterize traffic operating conditions of a circulation element. Progressively worsening traffic operating conditions are given the letter grades "A" through "F". Table C-12 summarizes the traffic operating conditions associated with each LOS

designation. Table C-13 provides LOS criteria for freeways in Santa Clara County, while Table C-14 exhibits LOS criteria for Merced County roadways.

Table C-12. Level of Service Characteristics

LOS	Traffic Condition
A	Free flow conditions; Low volumes; high operating speeds; uninterrupted flow; no restriction on maneuverability; drivers maintain desired speeds; little or no delays.
B	Stable flow conditions; operating speeds beginning to be restricted.
C	Stable flow but speed and maneuverability restricted by higher traffic volumes; satisfactory operating speed for urban conditions; delays at signals.
D	Approaching unstable flow; low speeds; major delays at signals; little freedom to maneuver.
E	Lower operating speeds; volume at or near capacity; unstable flow; major delays and stoppages.
F	Forced flow conditions; low speeds; volumes below capacity, may be zero; stoppages for long periods because of downstream congestion.

Source: Transportation Research Board 2000

Table C-13. Level of Service Criteria for Freeways – Santa Clara County

LOS	Density (passenger cars/mile/lane)	Speed (miles/hour)
A	≤ 11.0	≥ 67.0
B	11.0 – 18.1	66.5 – 67.0
C	18.0 – 26.0	66.0 – 66.5
D	26.0 – 46.0	46.0 – 66.0
E	46.0 – 58.0	35.0 – 46.0
F	> 58.0	< 35.0

Source: Santa Clara Valley Transportation Authority 2003

Table C-14. Level of Service Criteria for Roadways – Merced County

#	Area	Facility	Interchanges	Intersections	Flow	Lanes	Median	Level of Service (Average Annual Daily Traffic)				
								A	B	C	D	E
1	Urban	Freeway	< 2 miles apart	-	-	4	N/A	22,000	36,000	52,000	67,000	76,500
2	Urban	Expressway	-	-	-	4	Divided	-	-	21,400	31,100	32,900
3	Urban	Highway	-	-	Uninterrupted	2	Undivided	2,000	7,000	13,800	19,600	27,000
4	Urban	Highway	-	< 2/mile	-	2	Undivided	-	4,200	13,800	16,400	16,900
5	Urban	Highway	-	< 4.5/mile	-	2	Undivided	-	1,900	11,200	15,400	16,300
6	Urban	Collector	-	-	-	2	Undivided	-	-	4,800	10,000	12,600
7	Urban	Highway	-	< 4.5/mile	-	4	Undivided	-	3,500	23,200	29,100	30,600
8	Urban	Arterial	-	-	-	4	Undivided	-	-	15,600	27,800	29,400
9	Urban	Highway	-	< 2/mile	-	4	Undivided	3,500	20,900	24,600	25,700	-
10	Urban	Collector	-	-	-	4	Undivided	-	-	9,800	19,200	22,800
11	Urban	Highway	-	< 2/mile	-	2	Undivided	-	4,000	13,100	15,500	16,300
12	Urban	Arterial	-	-	-	2	Undivided	-	-	7,000	13,600	14,600
13	Transition	Freeway	-	-	-	4	-	23,500	38,700	52,500	62,200	69,100
14	Transition	Collector	-	-	-	2	Undivided	-	-	4,400	9,400	12,000
15	Rural	Freeway	-	-	-	6	-	33,100	54,300	73,900	87,400	97,200
16	Rural	Freeway	-	-	-	4	-	21,300	35,300	47,900	56,600	63,000
17	Rural	Non-Freeway	-	-	Uninterrupted	4	Divided	17,500	28,600	40,800	52,400	58,300
18	Rural	Non-Freeway	-	-	Isolated Stops	4	-	-	2,900	17,400	23,000	25,200
19	Rural	Non-Freeway	-	-	Uninterrupted	2	Undivided	2,600	5,300	8,600	13,800	22,300
20	Rural	Non-Freeway	-	-	Isolated Stops	2	Undivided	-	1,900	8,000	10,700	12,100
21	Suburban	Non-Freeway	-	-	Interrupted	4	Divided	-	5,300	25,200	29,400	31,200
22	Suburban	Highway	-	-	Uninterrupted	2	Undivided	2,500	7,200	12,700	17,300	23,500
23	Suburban	Arterial	-	-	Interrupted	2	Undivided	-	2,200	11,000	13,900	14,900
24	Suburban	Collector	-	-	-	2	Undivided	-	-	1,900	7,600	10,100

Source: *Merced County 2013.*

While most motorists consider LOS A, B, and C as satisfactory travel conditions, LOS D is considered marginally acceptable. Congestion and delay are considered unacceptable to most motorists and are given the LOS E or F ratings. Table C-15 presents local and regional LOS standards established by each jurisdiction within the study area.

Table C-15. LOS Standards of Significance

Regulatory Agency	LOS Thresholds
Caltrans[1]	LOS C for rural interregional routes and LOS D for urban interregional routes
Merced County[2]	LOS D for freeways and urban roadways, LOS C for other rural roadways
Santa Clara County[3]	LOS E for Congestion Management Program (CMP) facilities and LOS D for other facilities
City of Los Banos[4]	LOS C for roadway segments
City of Gustine[5]	LOS D for major roadways
City of Gilroy[6]	LOS C for roadways and LOS D for some commercial and industrial areas

Notes:
[1] Source: Merced County Association of Governments 2014
[2] Source: Merced County 2013
[3] Source: Santa Clara Valley Transportation Authority (VTA) 2014
[4] Source: City of Los Banos 2009
[5] Source: City of Gustine 2002
[6] Source: City of Gilroy 2002

C.3.22 Tree Protection Ordinances

Multiple cities and counties within the area of analyses have local regulations pertaining to the protection of native or locally important trees and/or street trees in public areas. The general plan policies and municipal codes typically include requirements for the protection of street trees and establish a permit or review process for the evaluation of potential impacts on street trees. The tree protection ordinances apply to all trees over specific size thresholds, and native tree species including oaks, cottonwood, sycamore, madrone, and other species. In addition, some trees are considered significant because of history, girth, height, or other unique quality and can be designated a heritage trees and protected under these ordinance. The cities and counties with applicable ordinances include:

- County of Santa Clara – The County of Santa Clara requires a permit for removing trees of varying sizes in different sections of the unicorporated portions of the county. The ordinance includes exceptions for trees that are irreversibly diseased or dead, or that present a hazard to life and/or personal property. Permit application requirements include a written justification for the removal, and a replanting plan (Santa Clara County 2002).

- City of San Jose – The City of San Jose requires a permit for the pruning or removal of any tree within 12 feet of a public right of way, any tree identified on the City's Heritage Tree List, or any tree on a multifamily, commercial or industrial property. In addition, a permit is required for the removal of any tree within the City with a circumference larger than 56 inches at 2 feet above the ground. Dead, dying and diseased trees are not exempt from the permit and still require permit for removal. Removal of any ordinance sized tree requires replacement on site (City of San Jose 2017).

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San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix D: Water Quality Technical Appendix

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Appendix D
Water Quality Technical Appendix

The Water Quality Technical Appendix supplements Section 4.1 Water Quality in the San Luis Low Point Improvement Project (SLLPIP) Environmental Impact Statement/Environmental Impact Report (EIS/EIR). The sections below provide detailed information about constituents of concern listed in the Clean Water Act (CWA) and beneficial uses of California waters defined in the California Water Code. This section also discusses water quality in the San Joaquin-Sacramento Delta, and general water quality characteristics of reservoirs. Water quality monitoring and water quality modeling results are also included.

D.1 Clean Water Act Section 303(d) Listed Water Bodies

Various water bodies within the SLLPIP area of analysis have been identified as impaired for certain constituents of concern, as listed on the 2016 303(d) list under the CWA. CWA Section 303(d) requires States to identify water bodies that do not meet applicable water quality standards after the application of certain technology-based controls on point source discharges. As defined in the CWA and Federal regulations, water quality standards include the designated beneficial uses of a water body, the adopted water quality criteria necessary to protect those uses, and an anti-degradation policy. As defined in the Porter-Cologne Act, water quality standards are associated with designated beneficial uses of a water body, the established water quality objectives (both narrative and numeric), and California's non-degradation policy (State Water Resources Control Board [SWRCB] Resolution No. 68-16). Appendix C, Regulatory Setting, contains a description of the CWA and the 303(d) listing process.

Certain water bodies in the area of analysis are listed as water quality limited (impaired) for one or more of the constituents of concern. Table D-1 presents the 2016 303(d) listed water bodies within the SLLPIP area of analysis and information about the constituents of concern contributing to their impairment. Some water quality constituents are also of concern with respect to drinking water. Section D.2 provides information on the constituents concern listed in Table D-1.

Table D-1. 303(d) Listed Water Bodies Within the SLLPIP Area of Analysis and Associated Constituents of Concern

Name	Constituent	Potential Sources	Estimated Area Affected [1]	Proposed TMDL Completion Year	Region
Guadalupe Creek	Mercury	Source Unknown	8.1 miles	2008[2]	Santa Clara County
Guadalupe Reservoir	Mercury	Source Unknown	63 acres	2008[2]	Santa Clara County
Guadalupe River	Diazinon Mercury	Source Unknown Source Unknown	18 miles 18 miles	2007[3] 2008	Santa Clara County
O'Neill Forebay	Mercury	Source Unknown	2,254 acres	2012	Merced County
Pacheco Creek	Dissolved Oxygen Turbidity	Source Unknown Source Unknown	26 miles 26 miles	2005 2005	Santa Clara and San Benito Counties
Sacramento-San Joaquin River Delta	Chlordane	Nonpoint Source	41,736 acres	2013	Contra Costa, Sacramento, San Joaquin, Solano and Yolo Counties
	DDT	Nonpoint Source	41,736 acres	2013	
	Dieldrin	Nonpoint Source	41,736 acres	2013	
	Dioxin compounds (including 2,3,7,8-TCDD)	Atmospheric Deposition	41,736 acres	2019	
	Furan Compounds	Atmospheric Deposition	41,736 acres	2019	
	Invasive Species	Ballast Water	41,736 acres	2019	
	Mercury	Industrial Point Sources, Unknown Nonpoint Source, Municipal Point Sources, Resource Extraction	41,736 acres	2008	
	PCBs	Nonpoint Source	41,736 acres	2008	
	PCBs (dioxin-like)	Municipal Point Sources	41,736 acres	2008	
	Selenium	Resource Extraction, Atmospheric Deposition, Unknown Nonpoint Source	41,736 acres	2008	
San Francisco Bay, South	Chlordane	Source Unknown	9,204 acres	2013	Santa Clara County
	DDT	Source Unknown	9,204 acres	2013	
	Dieldrin	Source Unknown	9,204 acres	2013	
	Dioxin Compounds (2,3,7,8-TCDD)	Source Unknown	9,204 acres	2019	
	Furan Compounds	Source Unknown	9,204 acres	2019	
	Invasive Species	Source Unknown	9,204 acres	2019	
	Mercury	Gold mining sediments Mercury mining	9,204 acres	2008[3]	
	PCBs	Source Unknown	9,204 acres	2008	
	PCBs (dioxin-like)	Source Unknown	9,204 acres	2008	
	Selenium	Source Unknown	9,204 acres	2019	

Table D-1. 303(d) Listed Water Bodies Within the SLLPIP Area of Analysis and Associated Constituents of Concern

Name	Constituent	Potential Sources	Estimated Area Affected [1]	Proposed TMDL Completion Year	Region
San Luis Reservoir	Mercury	Source Unknown	13,007 acres	2021	Merced County
Saratoga Creek	Diazinon	Source Unknown	18 miles	2007[2]	Santa Clara County

Source: SWRCB 2018

DDT = dichlorodiphenyltrichloroethane; PCB = polychlorinated biphenyl

[1] Estimated area affected is given as the surface area (acres) of lakes or estuaries or length (river miles) for river systems.

[2] USEPA TMDL was approved 6/1/2010.

[3] USEPA TMDL was approved 5/16/2007. For 2006, diazinon was moved by USEPA from the 303(d) list to the being addressed list because of a completed USEPA approved TMDL.

[4] USEPA TMDL was approved 2/29/2008

D.2 Constitutes of Concern

D.2.1 Chlordane

Chlordane is a manufactured chemical that was used as a pesticide in the United States from 1948 to 1988. Technically, chlordane is not a single chemical, but is actually a mixture of pure chlordane mixed with many related chemicals. It does not occur naturally in the environment. It is a thick liquid whose color ranges from colorless to amber. Chlordane has a mild, irritating smell. Some of its trade names are Octachlor and Velsicol 1068. Until 1983, chlordane was used as a pesticide on crops like corn and citrus and on home lawns and gardens. Because of concern about damage to the environment and harm to human health, the USEPA banned all uses of chlordane in 1983 except to control termites. In 1988, The United States Environmental Protection Agency (USEPA) banned all uses (Agency for Toxic Substances and Disease Registry [ATSDR] 1995).

Chlordane entered the environment through its use as a pesticide on and as termite control. Chlordane sticks strongly to soil particles at the surface and is not likely to enter groundwater. It can stay in the soil for over 20 years. Most chlordane leaves soil by evaporation to the air, where it breaks down very slowly. Chlordane doesn't dissolve easily in water. It builds up in the tissues of fish, birds, and mammals. Exposure to chlordane could occur by eating crops grown in soil that contains chlordane; eating fish or shellfish caught in water that is contaminated by chlordane; breathing air or touching soil near homes treated for termites with chlordane; and by breathing air or by touching soil near waste sites or landfills.

Chlordane affects the nervous system, the digestive system, and the liver in people and animals. Headaches, irritability, confusion, weakness, vision problems, vomiting, stomach cramps, diarrhea, and jaundice have occurred in people who breathed air containing high concentrations of chlordane or accidentally swallowed small amounts of chlordane. Large amounts of chlordane taken by mouth can cause convulsions and death in people. Federal agencies have made several recommendations to protect human health, including:

- The USEPA recommends that a child should not drink water with more than 60 parts of chlordane per billion parts of drinking water (60 ppb) for longer than 1 day. The USEPA has set a limit in drinking water of 2 ppb.

- The USEPA requires spills or releases of chlordane into the environment of 1 pound or more to be reported to the USEPA (ATSDR 1995).

- The United States Food and Drug Administration (FDA) limits the amount of chlordane and its breakdown products in most fruits and vegetables to less than 300 ppb and in animal fat and fish to less than 100 ppb (ATSDR 1995).

- The Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), and the American Conference of Governmental Industrial Hygienists (ACGIH) set a maximum level of 0.5 milligrams of chlordane per cubic meter (mg/m^3) in workplace air for an 8-hour workday, 40-hour workweek. These agencies have advised that eye and skin contact should be avoided because this may be a significant route of exposure (ATSDR 1995).

The USEPA has established the following freshwater and saltwater aquatic life criteria for chlordane:

- 2.4 micrograms per liter (µg/L) maximum concentration; 0.0043 µg/L continuous concentration for freshwater aquatic life (USEPA 2010a).

- 0.09 µg/L maximum concentration; 0.004 µg/L continuous concentration for saltwater aquatic life (USEPA 2010a).

D.2.2 DDT

Dichlorodiphenyltrichloroethane (DDT) is a pesticide once widely used to control insects in agriculture and insects that carry diseases such as malaria. DDT is a white, crystalline solid with no odor or taste. Its use in the U.S. was banned in 1972 because of damage to wildlife, but is still used in some countries. Dichlorodiphenyldichloroethylene (DDE) and dichlorodiphenyldichloroethane (DDD) are chemicals similar to DDT that contaminate commercial DDT preparations (ATSDR 2002a).

DDT entered the environment when it was used as a pesticide; it still enters the environment due to current use in other countries. DDT sticks strongly to soil; most DDT in soil is broken down slowly to DDE and DDD by microorganisms. Half the DDT in soil will break down in 2-15 years, depending on the type of soil. Only a small amount will go through the soil into groundwater; DDT does not dissolve easily in water. Exposure to DDT occurs through eating contaminated foods, such as root and leafy vegetable, fatty meat, fish, and poultry, but levels are very low; eating contaminated imported foods from countries that still allow the use of DDT to control pests; breathing contaminated air or drinking contaminated water near waste sites and landfills that may contain higher levels of these chemicals; infants fed on breast milk from mothers who have been exposed; and breathing or swallowing soil particles near waste sites or landfills that contain these chemicals.

DDT affects the nervous system. People who accidentally swallowed large amounts of DDT became excitable and had tremors and seizures. These effects went away after the exposure stopped. No effects were seen in people who took small daily doses of DDT by capsule for 18 months. A study in humans showed that women who had high amounts of a form of DDE in their breast milk were unable to breast feed their babies for as long as women who had little DDE in the breast milk. Another study in humans showed that women who had high amounts of DDE in breast milk had an increased chance of having premature babies. Federal agencies have made several recommendations to protect human health, including:

- OSHA sets a limit of 1 milligram of DDT per cubic meter of air (1 mg/m^3) in the workplace for an 8-hour shift, 40-hour workweek (ATSDR 2002a).

- The FDA has set limits for DDT, DDE, and DDD in foodstuff at or above which the agency will take legal action to remove the products from the market (ATSDR 2002a).

DDT, and especially DDE, builds up in plants and in fatty tissues of fish, birds, and other animals. In animals, short-term exposure to large amounts of DDT in food affected the nervous system, while long-term exposure to smaller amounts affected the liver. Short-term oral exposure to small amounts of DDT or its breakdown products may also have harmful effects on animal reproduction.

The USEPA has established the following freshwater and saltwater aquatic life criteria for DDT:

- 1.1 µg/L maximum concentration; 0.001 µg/L continuous concentration for freshwater aquatic life (USEPA 2010a).

- 0.13 µg/L maximum concentration; 0.001 µg/L continuous concentration for saltwater aquatic life (USEPA 2010a).

D.2.3 Diazinon

Diazinon is the common name of an organophosphorus insecticide used to control pest insects in soil, on ornamental plants, and on fruit and vegetable field crops. It is also used to control household pests such as flies, fleas, and cockroaches. This chemical is manufactured and does not occur naturally in the environment. The pure chemical is colorless and practically odorless oil. Most of the diazinon used is in liquid form, but it is possible to be exposed to the chemical in a solid form. Diazinon does not burn easily and does not dissolve easily in water (ATSDR 2008).

Most environmental diazinon contamination comes from agricultural and household application to control insects. Sales of home and garden products ceased in the United States in 2004 for products containing Diazinon, however, some people may still have these products stored at their homes. Diazinon may also enter the environment during the manufacturing process. It is often sprayed on crops and plants, so small particles of the chemical may be carried away from the field or yard before falling to the ground. After diazinon has been applied, it may be present in the soil, surface waters, and on the surface of the plants. Diazinon on soil and plant surfaces may be washed into surface waters by rain. In the environment, diazinon is rapidly broken down into a variety of other chemicals. It can move through the soil and contaminate ground water. Diazinon is not likely to build up to high or dangerous levels in animal or plant foods. Exposure to diazinon occurs through contact with contaminated soils or contaminated runoff water or groundwater. People who work in the manufacture and professional application of diazinon have the most significant exposure to this insecticide.

Most cases of unintentional diazinon poisoning in people have resulted from short exposures to very high concentrations of the material. Diazinon affects the nervous system. Some mild symptoms include headache, dizziness, weakness, feelings of anxiety, constriction of the pupils of the eye, and not being able to see clearly. More severe symptoms include nausea and vomiting, abdominal cramps, slow pulse, diarrhea, pinpoint pupils, difficulty breathing, and coma. The USEPA has developed the following recommendations to protect human health.

- No harmful effects in a child are expected with exposure to Diazinon in drinking water at a concentration of 20 µg/L for up to 10 days.

- Lifetime exposure to 1 µg/L Diazinon in drinking water is not expected to cause harmful effects.

D.2.4 Dieldrin

Pure dieldrin is a white powder with a mild chemical odor. The less pure commercial powders have a tan color. Neither substance occurs naturally in the environment. From the 1950s until 1970, dieldrin was a widely used pesticide for crops like corn and cotton. Because of concerns about damage to the environment and potentially to human health, the USEPA banned all uses of dieldrin in 1974, except to control termites. In 1987, the USEPA banned all uses (ATSDR 2002b).

Sunlight and bacteria change aldrin to dieldrin so that dieldrin is the compound more likely to be found in the environment. They bind tightly to soil and slowly evaporate to the air. Dieldrin in soil and water breaks down very slowly. Plants take in and store aldrin and dieldrin from the soil. Aldrin also rapidly changes to dieldrin in plants and animals. Dieldrin is stored in the fat and leaves the body very slowly. Dieldrin is everywhere in the environment, but at very low levels. Exposure could occur through eating food like fish or shellfish from lakes or streams contaminated with either chemical or contaminated root crops, dairy products, or meats. Air, surface water, or soil near waste sites may contain higher levels.

People who have ingested large amounts of aldrin or dieldrin suffered convulsions and some died. Health effects may also occur after a longer period of exposure to smaller amounts because these chemicals build up in the body. Some workers exposed to moderate levels in the air for a long time had headaches, dizziness, irritability, vomiting, and uncontrolled muscle movements. Workers removed from the source of exposure rapidly recovered from most of these effects. Animals exposed to high amounts of aldrin or dieldrin also had nervous system effects. In animals, oral exposure to lower levels for a long period also affected the liver and decreased their ability to fight infections. Federal agencies have made several recommendations to protect human health, including:

- The USEPA limits the amount of aldrin and dieldrin that may be present in drinking water to 0.001 and 0.002 milligrams per liter (mg/L) of water, respectively, for protection against health effects other than cancer. The USEPA has determined that a maximum concentration of aldrin and dieldrin of 0.0002 mg/L in drinking water limits the lifetime risk of developing cancer from exposure to each compound to 1 in 10,000 (ATSDR 2002b).

- OSHA sets a maximum average of 0.25 milligrams of aldrin and dieldrin per cubic meter of air (0.25 mg/m^3) in the workplace during an 8-hour shift, 40-hour workweek. NIOSH also recommends a limit of 0.25 mg/m^3 for both compounds for up to a 10-hour work day, 40-hour week (ATSDR 2002b).

- The FDA regulates the residues of aldrin and dieldrin in raw foods. The allowable range is from 0 to 0.1 parts per million (ppm), depending on the type of food product (ATSDR 2002b).

The USEPA has established the following freshwater and saltwater aquatic life criteria for aldrin and dieldrin:

- Dieldrin – 2.5 µg/L maximum concentration; 0.0019 µg/L continuous concentration for freshwater aquatic life (USEPA 2010a).

- Dieldrin – 0.71 µg/L maximum concentration; 0.0019 µg/L continuous concentration for saltwater aquatic life (USEPA 2010a).

D.2.5 Dioxin and Furan Compounds

Dioxins and furans is the abbreviated or short name for a family of toxic substances that all share a similar chemical structure. Most dioxins and furans are not man-made or produced intentionally, but are created when other chemicals or products are made

The chlorinated dibenzo-p-dioxins (CDDs) are a class of compounds that are loosely referred to as dioxins. There are 75 possible dioxins. One of these compounds is called 2,3,7,8-TCDD. It is one of the most toxic of the CDDs and is the one most studied. In the pure form, CDDs are crystals or colorless solids. CDDs enter the environment as mixtures containing a number of individual components. 2,3,7,8-TCDD is odorless and the odors of the other CDDs are not known. CDDs are not intentionally manufactured by industry except for research purposes or as by-products. They (mainly 2,3,7,8-TCDD) may be formed during the chlorine bleaching process at pulp and paper mills. CDDs are also formed during chlorination by waste and drinking water treatment plants. They can occur as contaminants in the manufacture of certain organic chemicals. CDDs are released into the air in emissions from municipal solid waste and industrial incinerators (ATSDR 1999a).

When released into the air, some CDDs may be transported long distances, even around the globe. When released in waste waters, some CDDs are broken down by sunlight, some evaporate to air, but most attach to soil and settle to the bottom sediment in water. CDD concentrations may build up in the food chain, resulting in measurable levels in animals. Eating food, primarily meat, dairy products, and fish makes up more than 90 percent of the intake of CDDs for the general population. Exposure could also occur by breathing low levels in air

and drinking low levels in water; skin contact with certain pesticides and herbicides; living near an uncontrolled hazardous waste site containing CDDs or incinerators releasing CDDs; and working in industries involved in producing certain pesticides containing CDDs as impurities, working at paper and pulp mills, or operating incinerators.

The most noted health effect in people exposed to large amounts of 2,3,7,8-TCDD is chloracne. Chloracne is a severe skin disease with acne-like lesions that occur mainly on the face and upper body. Other skin effects noted in people exposed to high doses of 2,3,7,8-TCDD include skin rashes, discoloration, and excessive body hair. Changes in blood and urine that may indicate liver damage also are seen in people. Exposure to high concentrations of CDDs may induce long-term alterations in glucose metabolism and subtle changes in hormonal levels. In certain animal species, 2,3,7,8-TCDD is especially harmful and can cause death after a single exposure. Exposure to lower levels can cause a variety of effects in animals, such as weight loss, liver damage, and disruption of the endocrine system. In many species of animals, 2,3,7,8-TCDD weakens the immune system and causes a decrease in the system's ability to fight bacteria and viruses. In other animal studies, exposure to 2,3,7,8-TCDD has caused reproductive damage and birth defects.

- The USEPA has set a limit of 0.00003 µg/L of 2,3,7,8-TCDD in drinking water (ATSDR 1999a).
- Discharges, spills, or accidental releases of 1 pound or more of 2,3,7,8-TCDD must be reported to the USEPA.
- The FDA recommends against eating fish and shellfish with levels of 2,3,7,8-TCDD greater than 50 parts per trillion (ppt) (ATSDR 1999a).

D.2.6 Invasive Species

The introduction of invasive species is the leading cause of biodiversity loss in aquatic systems. Non-native plants or animals existing within a habitat are considered exotic species and can either be deliberately or accidentally introduced. Exotic species include plants, fishes, algae, mollusks, crustaceans, bacteria and viruses. These species do or are likely to cause harm to the economy, environment, or human health in their non-native environment.

There are several different ways of introducing invasive species into freshwater sources including ballast water, hull fouling, aquaculture escapes, and accidental and/or intentional introductions, among others (USEPA 2010b). Vessels can be a significant pathway for the introduction or spread of invasive species through the discharge of ballast water containing invasive species or the transport of invasive species that have accumulated on ships' hulls. The USEPA and its federal partners, such as the United States Coast Guard, are working together and using their authorities to help address the environmental and

economic threats associated with ship-related introductions of invasive species (USEPA 2012).

Invasive species can affect aquatic ecosystems directly or by affecting the land in ways that harm aquatic ecosystems. Invasive species represent the second leading cause of species extinction and loss of biodiversity in aquatic environments worldwide. They also result in considerable economic effects through direct economic losses and management/control costs, while dramatically altering ecosystems supporting commercial and recreational activities. Effects on aquatic ecosystems result in decreased native populations, modified water tables, changes in run-off dynamics and fire frequency, among other alterations. These ecological changes in turn impact many recreational and commercial activities dependent on aquatic ecosystems (USEPA 2012).

D.2.7 Mercury

Mercury is a naturally occurring metal that has several forms. The metallic mercury is a shiny, silver-white, odorless liquid. If heated, it is a colorless, odorless gas. Mercury combines with other elements, such as chlorine, sulfur, or oxygen, to form inorganic mercury compounds or "salts," which are usually white powders or crystals. Mercury also combines with carbon to make organic mercury compounds. The most common one, methylmercury, is produced mainly by microscopic organisms in the water and soil. More mercury in the environment can increase the amounts of methylmercury that these small organisms make. Metallic mercury is used to produce chlorine gas and caustic soda, and is also used in thermometers, dental fillings, and batteries. Mercury salts are sometimes used in skin lightening creams and as antiseptic creams and ointments (ATSDR 1999b).

Inorganic mercury (metallic mercury and inorganic mercury compounds) enters the air from mining ore deposits, burning coal and waste, and from manufacturing plants. It enters the water or soil from natural deposits, disposal of wastes, and volcanic activity. Methylmercury may be formed in water and soil by bacteria. Exposure to mercury can occur through eating fish or shellfish contaminated with methylmercury; breathing vapors in air from spills, incinerators, and industries that burn mercury-containing fuels, release of mercury from dental work and medical treatments; and breathing contaminated workplace air or skin contact during use in the workplace (from businesses and industries that use mercury).

The nervous system is very sensitive to all forms of mercury. Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems. Short-term exposure to high levels of metallic mercury vapors may cause effects

including lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation. Federal agencies have made several recommendations to protect human health, including:

- The USEPA has set a limit of 2 ppb of mercury in drinking water (2 ppb) (ATSDR 1999b).

- The FDA has set a maximum permissible level of 1 ppm of methylmercury in seafood (ATSDR 1999b).

- OSHA has set limits of 0.1 mg/m^3 of organic mercury in workplace air (0.1 mg/m^3) and 0.05 mg/m^3 of metallic mercury vapor for 8-hour shifts and 40-hour workweeks (ATSDR 1999b).

Various studies have shown that mercury is a mutagen, teratogen, and carcinogen. It bioaccumulates and biomagnifies in food chains. The inorganic forms of mercury are not as toxic as the organic forms (Eisler 1987). Mammalian species tend to absorb organic forms of mercury through the respiratory tract, gastrointestinal tract, and skin. The organic forms can cross placental barriers.

Methylmercury builds up in the tissues of fish. Larger and older fish tend to have the highest levels of mercury. Chronic mercury poisoning in fish can cause emaciation due to appetite loss, brain lesions, diminished response to light intensity, inability to capture food, and abnormal muscle coordination (Eisler 1987). In general, aquatic species accumulate mercury rapidly and excretion is slow.

In mammals, subchronic exposure to mercury can cause deleterious effects on reproduction, growth and development, behavior, blood and serum chemistry, histology, and metabolism. Methylmercury irreversibly destroys neurons of the central nervous system. Symptoms to mercury exposure may not be evident for years after initial exposure (Eisler 1987). Smaller mammals are more sensitive to mercury exposure. Also, carnivorous mammals have been found to have greater concentrations of mercury within the liver and kidney than herbivorous species. The USEPA has established the following freshwater and saltwater aquatic life criteria for mercury:

- 2.1 µg/L maximum concentration; 0.012 µg/L continuous concentration for freshwater aquatic life (USEPA 2010a).

- 1.8 µg/L maximum concentration; 0.025 µg/L continuous concentration for saltwater aquatic life (USEPA 2010a).

D.2.8 Polychlorinated Biphenyls

Polychlorinated Biphenyls (PCBs) are made up of up to 209 individual chlorinated compounds known as congeners. No known natural sources of PCBs exist. They are in the form of either oily liquids or solids that may be colorless to light yellow or as vapor in air. No known smell or taste is associated with PCBs. In the United States, some commercial PCB mixtures are known by the trade name of Aroclor. They are used as coolants and lubricants in transformers, capacitors, and other electrical equipment since they do not burn easily and are good insulators. In 1977 manufacturing of PCBs was stopped in the United States because of links to harmful effects. Products older than 1977 containing PCBs include old florescent lighting fixtures and electrical devices containing PCB capacitors, and old microscope and hydraulic oils (ATSDR 2001).

During their manufacture, use and disposal, PCBs entered the air, water and soil caused from accidental spills and leaks during their transport, and from leaks or fires in products containing PCBs. PCBs are also released from hazardous waste sites, illegal or improper disposal of industrial wastes and consumer products; leaks from old electrical transformers containing PCBs; and burning of some wastes incinerators. Since PCBs do not break down easily they may remain in the environment for long periods of time. PCBs in air can travel long distances and deposited in areas far away from the source. Most PCBs in water stick to organic particles and bottom sediments, however, a few may remain dissolved. They will bind strongly with soil. Small organisms and fish will take up PCBs in water as well as other animals who ingest them. PCBs accumulate in fish and marine mammals and may reach levels many thousands of times higher than in water (ATSDR 2001).

PCBs exposure to humans is through the use of things that leak PCBs into the air when they get hot including fluorescent lighting fixtures and electrical devices and appliances such as television sets and refrigerators that were made 30 or more years ago. They could also be a source of skin exposure. Ingesting contaminated food especially fish, meat or dairy products. Air near hazardous waste sites and contaminated well water are also sources of PCB contamination. Workplace exposure is prevalent during repair and maintenance of PCB transformers; accidents, fires or spills involving transformers, fluorescent lights, and other old electrical devices; and disposal of PCB materials (ATSDR 2001).

Harmful health effects from PCB exposure to humans includes skin conditions such as acne and rashes. In other studies of workers exposed to PCBs changes in blood and urine occurred that may indicate liver damage, however PCB exposure in the general population are not likely to cause skin and liver effects. The Department of Health and Human Services has concluded that PCBs may reasonably be anticipated to be carcinogens and the USEPA and the International Agency for Research on Cancer have determined that PCBs are probably carcinogenic to humans (ATSDR 2001).

Federal and state agencies have made several recommendations to protect human health, including:

- The USEPA limits PCBs in drinking water to 0.5 ppb (ATSDR 2006).
- The USEPA requires that discharges, spills or accidental releases of 1 pound or more into the environment must be reported (ATSDR 2006).
- The USEPA standard for eating the fish or shellfish and/or drinking the water from lakes or streams contaminated with PCBs is 0.17 ppt due to bioaccumulation (ATSDR 2006).
- The FDA requires that infant and junior foods, eggs, milk, other dairy products, fish and shellfish, poultry, and red meat contain no more than 0.2-3 ppm (ATSDR 2006).
- OSHA limits worker inhalation over a period of 8 hours for 5 days per week of 42 percent chlorine PCBs to 1 mg/m^3 of air, and for 54 percent chlorine PCBs to 0.5 mg/m^3 of air (ATSDR 2006).
- Fish and wildlife consumption advisories for PCBs have been established my many states (ATSDR 2001).

D.2.9 Selenium

Selenium is a metal commonly found in rocks and soil. In the environment, selenium is not often found in the pure form. Much of the selenium in rocks is combined with sulfide minerals or with silver, copper, lead, and nickel minerals. Selenium and oxygen combine to form several compounds. Selenium sulfide is a bright red-yellow powder used in anti-dandruff shampoo. Processed selenium is used in the electronics industry; as a nutritional supplement, in the glass industry; as a component of pigments in plastics, paints, enamels, inks and rubber; in the preparation of pharmaceuticals; as a nutritional feed additive for poultry and livestock; in pesticide formulations; in rubber production; and as a constituent of fungicides (ATSDR 2003).

Small selenium particles in the air settle to the ground or are taken out of the air in rain. Selenium dust can enter the air from burning coal and oil. Soluble selenium compounds in agricultural fields can leave the field in irrigation drainage water and can also enter water from rocks, soil and industrial waste. Some compounds dissolve in water and some will settle to the bottom as particles. Selenium can collect in animals that live in water containing high levels of it. It can accumulate up the food chain. Exposure to selenium occurs by breathing air that contains it and by eating food, drinking water, or taking dietary supplements that contain it (ATSDR 2003).

People exposed to very high levels of selenium orally over the short-term have reported nausea, vomiting, and diarrhea. Chronic oral exposure to high concentrations have been known to cause a disease called selenosis which include hair loss, nail brittleness and neurological abnormalities (such as numbness and other odd sensations in the extremities). Respiratory tract irritation, bronchitis, difficulty breathing, and stomach pains can be experiences with brief exposures to high levels of elemental selenium or selenium dioxide in air (ATSDR 2003). Federal agencies have made several recommendations to protect human health, including:

- The USEPA maximum contaminant level (MCL) for selenium in drinking water is 50 parts of selenium per billion parts of water (50 ppb) (ATSDR 2003).

- OSHA exposure limit for selenium compounds in workplace air is 0.2 mg/m^3 of selenium in air for an 8-hour day over a 40-hour workweek (ATSDR 2003).

- ATSDR and USEPA have determined that 5 micrograms of selenium per kilogram of body weight taken daily would not be expected to cause any adverse health effects over the lifetime of such intake (ATSDR 2003).

Selenium bioaccumulates in aquatic food chains and causes toxic effects on fish and bird embryos (Lemly 1998). In aquatic organisms, selenium can result in loss of equilibrium and other neurological disorders, liver damage, reproductive failure, reduced growth, reduced movement rate, chromosomal aberrations, reduced hemoglobin and increased white blood cell count, and necrosis of the ovaries (USEPA 2006). The USEPA has established the following freshwater and saltwater aquatic life criteria for selenium:

- 20 µg/L maximum concentration; 5 µg/L continuous concentration for freshwater aquatic life (USEPA 2010a).

- 290 µg/L maximum concentration; 71 µg/L continuous concentration for saltwater aquatic life (USEPA 2010a).

D.2.10 Unknown Toxicity

An unknown toxicity is defined as a toxicity that has been found within a waterbody, but further testing has not been done to discover what the toxicity specifically is (Richard 2002). Unknown toxicities are found within waterbodies that have been monitored, tested, and sampled for toxicity in general and during testing, organism within the tested water have died.

D.3 Beneficial Uses

Application of water quality objectives (i.e. standards) to protect designated beneficial uses is critical to water quality management in California. State law defines beneficial uses to include (but not be limited to) "...domestic; municipal; agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves" (Water Code Section 13050(f)). Protection and enhancement of existing and potential beneficial uses are primary goals of water quality planning. Significant points concerning the concept of beneficial uses are:

1. All water quality problems can generally be stated in terms of whether there is water of sufficient quantity or quality to protect or enhance beneficial uses (Central Valley Regional Water Quality Control Board [RWQCB] 2018).

2. Beneficial uses do not include all of the reasonable uses of water. For example, disposal of wastewaters is not included as a beneficial use. This is not to say that disposal of wastewaters is a prohibited use; it is merely a use that cannot be satisfied to the detriment of beneficial uses. Similarly, the use of water for the dilution of salts is not a beneficial use although it may, in some cases, be a reasonable and desirable use of water (Central Valley RWQCB 2018).

3. The protection and enhancement of beneficial uses require that certain quality and quantity objectives be met for surface and ground waters (Central Valley RWQCB 2018).

4. Fish, plants, and other wildlife, as well as humans, use water beneficially.

The Porter Cologne Water Quality Control Act defines water quality objectives as, "…the limits or levels of water quality constituents or characteristics which are established for the reasonable protections of the beneficial uses of water or the preventions of nuisance within a specified area" (Water Code 13050(H)). The Basin Plans present water quality objectives in numerical or narrative format for specified water bodies or for protection of specified beneficial uses throughout a specific basin or region.

Beneficial use designation (and water quality objectives) must be reviewed at least once during each three-year period for the purpose of modification as appropriate (40 CFR 131.20). The beneficial uses, and abbreviations, listed below are standard basin plan designations (Central Valley RWQCB 2018).

Municipal and Domestic Supply (MUN) - Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

Agricultural Supply (AGR) - Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing.

Industrial Service Supply (IND) - Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.

Industrial Process Supply (PRO) - Uses of water for industrial activities that depend primarily on water quality.

Ground Water Recharge (GWR) - Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

Freshwater Replenishment (FRSH) - Uses of water for natural or artificial maintenance of surface water quantity or quality.

Navigation (NAV) - Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Hydropower Generation (POW) - Uses of water for hydropower generation.

Water Contact Recreation (REC-1) - Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, canoeing, white water activities, fishing, or use of natural hot springs.

Non-contact Water Recreation (REC-2) - Uses of water for recreational activities involving proximity to water, but where there is generally no body contact with water, nor any likelihood of ingestion of water. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Commercial and Sport Fishing (COMM) - Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

Aquaculture (AQUA) - Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes.

Warm Freshwater Habitat (WARM) - Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Cold Freshwater Habitat (COLD) - Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Estuarine Habitat (EST) - Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

Wildlife Habitat (WILD) - Uses of water that support terrestrial or wetland ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Preservation of Biological Habitats of Special Significance (BIOL) - Uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance, where the preservation or enhancement of natural resources requires special protection.

Rare, Threatened, or Endangered Species (RARE) - Uses of water that support aquatic habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under State or Federal law as rare, threatened or endangered.

Migration of Aquatic Organisms (MIGR) - Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.

Spawning, Reproduction, and/or Early Development (SPWN) - Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

Shellfish Harvesting (SHELL) - Uses of water that support habitats suitable for the collection of filter feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.

The beneficial uses designated for waters within the area of analysis are presented in Table D-2 (San Luis Region), Table D-3 (San Felipe Division Region), Table D-4 (Pacheco Region) and in Table D-5 (Sacramento-San Joaquin River Delta Region). The beneficial uses designated for any specifically-identified water body generally also apply to its tributary streams. In some cases, a beneficial use may not be applicable to the entire body of water. In these cases, RWQCB judgment is applied. Water bodies within the

basins that do not have beneficial uses designated are assigned municipal and domestic supply designations in accordance with the provisions of SWRCB Resolution No. 88-63. These municipal and domestic supply designations in no way affect the presence or absence of other beneficial uses in these water bodies.

Table D-2. Beneficial Uses of Water Bodies in the San Luis Region

Beneficial Use Designation	San Luis Reservoir	O'Neill Forebay
Municipal and Domestic Supply (MUN)	X	X
Agricultural Supply - Irrigation (AGR)	X	X
Agricultural Supply – Stock Watering (AGR)	X	X
Industrial Process Supply (PROC)		
Industrial Service Supply (IND)	X	
Industrial Power (POW)	X	
Water Contact Recreation (REC-1)	X	X
Canoeing and Rafting Recreation (REC-1)		
Non-contact Water Recreation (REC-2)	X	X
Wildlife Habitat (WILD)	X	X
Navigation (NAV)		
Cold Freshwater Habitat (COLD)		
Warm Freshwater Habitat (WARM)	X	X
Cold Migration (MIGR)		
Warm Migration (MIGR)		
Cold Spawning (SPWN)		
Warm Spawning (SPWN)		

Source: Central Valley RWQCB 2014.

Table D-3. Beneficial Uses of Water Bodies in the San Felipe Division Region

Beneficial Use Designation	Guadalupe River	Coyote Creek	Upper Penitencia Creek	Lower Penitencia Creek	Saratoga Creek
Municipal and Domestic Supply (MUN)					
Agricultural Supply (AGR)					X
Industrial Process Supply (PROC)					
Industrial Service Supply (IND)					
Groundwater Recharge (GWR)	X	X	X		X
Water Contact Recreation (REC-1)	X	X	X	X	X
Non-contact Water Recreation (REC-2)	X	X	X	X	X
Wildlife Habitat (WILD)	X	X	X	X	X
Cold Freshwater Habitat (COLD)	X	X	X		X
Warm Freshwater Habitat (WARM)	X	X	X	X	X
Marine and Aquatic Organisms (MIGR)	X	X	X		

Table D-3. Beneficial Uses of Water Bodies in the San Felipe Division Region

Beneficial Use Designation	Guadalupe River	Coyote Creek	Upper Penitencia Creek	Lower Penitencia Creek	Saratoga Creek
Spawning, Reproduction, and/or Early Development (SPWN)	X	X	X		
Preservation of biological Habitats of Special Significance (BIOL)					
Preservation of Rare and Endangered Species (RARE)	X	X	X		
Estuarine Habitat (EST)					
Freshwater Replenishment (FRSH)			X		X
Navigation (NAV)					
Hydropower Generation (POW)					
Commercial and Sport Fishing (COMM)		X			
Aquaculture (AQUA)					
Inland Saline Water Habitat (SAL)					
Shellfish Harvesting (SHELL)					

Source: San Francisco Bay Regional Water Quality Control Board 2015.

Table D-4. Beneficial Uses of Water Bodies in the Pacheco Region

Beneficial Use Designation	Pacheco Creek	Pacheco Lake
Municipal and Domestic Supply (MUN)	X	X
Agricultural Supply (AGR)	X	X
Industrial Process Supply (PROC)		
Industrial Service Supply (IND)		
Groundwater Recharge (GWR)	X	
Fresh Water Replenishment (FRSH)	X	
Navigation (NAV)		X
Hydropower Generation (POW)		
Water Contact Recreation (REC-1)	X	X
Non-contact Water Recreation (REC-2)	X	X
Commercial and Sport Fishing (COMM)	X	X
Aquaculture (AQUA)		
Warm Freshwater Habitat (WARM)	X	X
Cold Freshwater Habitat (COLD)	X	X
Inland Saline Water Habitat (SAL)		
Estuarine Habitat (EST)		
Marine Habitat (MAR)		
Wildlife Habitat (WILD)	X	X
Preservation of Biological Habitats of Special Significance (BIOL)	X	
Rare, Threatened, or Endangered Species (RARE)		

Table D-4. Beneficial Uses of Water Bodies in the Pacheco Region

Beneficial Use Designation	Pacheco Creek	Pacheco Lake
Migration of Aquatic Organisms (MIGR)	X	
Spawning, Reproduction, and/or Early Development (SPWN)	X	X
Shellfish Harvesting (SHELL)		

Source: Central Coast Region RWQCB 2017.

Table D-5. Beneficial Uses of Water Bodies in the Sacramento-San Joaquin River Delta

Beneficial Use Designation	Sacramento-San Joaquin River Delta
Municipal and Domestic Supply (MUN)	X
Agricultural Supply - Irrigation (AGR)	X
Industrial Process Supply (PRO)	X
Industrial Service Supply (IND)	X
Agricultural Supply (AGR)	X
Groundwater Recharge (GWR)	X
Navigation (NAV)	X
Water Contact Recreation (REC-1)	X
Non-contact Water Recreation (REC-2)	X
Shellfish Harvesting (SHELL)	X
Commercial and Sport Fishing (COMM)	X
Warm Freshwater Habitat (WARM)	X
Cold Freshwater Habitat (COLD)	X
Migration of aquatic organisms (MIGR)	X
Spawning, Reproduction, and/or Early Development (SPWN)	X
Estuarine Habitat (EST)	X
Wildlife Habitat (WILD)	X
Rare, Threatened, or Endangered Species (RARE)	X

Source: SWRCB 2006.

D.4 Reservoir Water Quality

This section describes how lakes and reservoirs function, and the limnological processes that occur within them to provide a better understanding of water quality.

D.4.1 Physiochemical Reservoir Processes

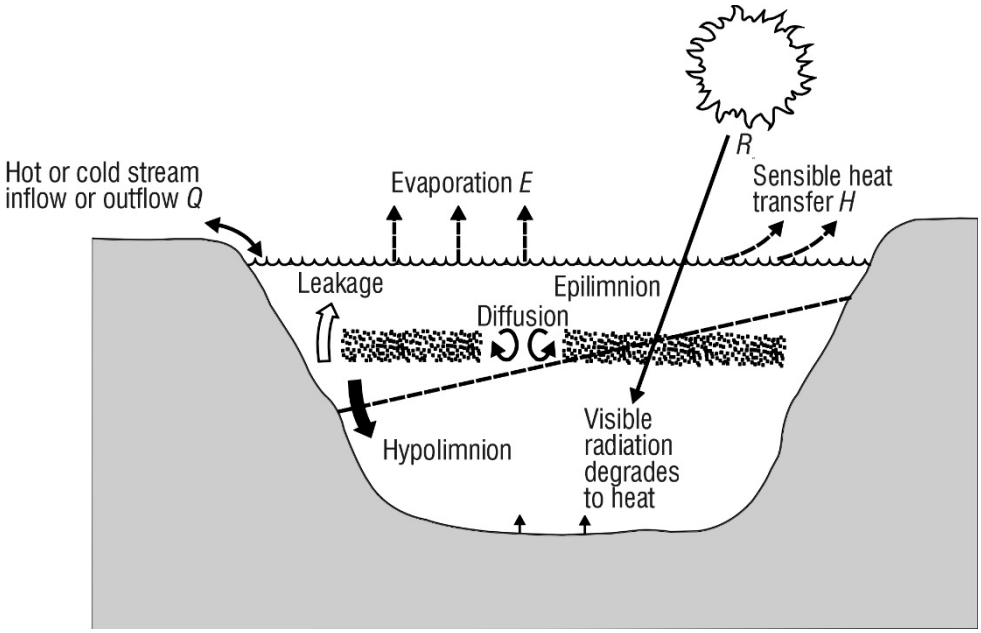
Certain physiochemical parameters (water temperature and dissolved oxygen) associated with lakes and reservoirs typically exhibit direct relationships to depth. Because water density changes with water temperature, most water

bodies have a temperature gradient that decreases with depth. In reservoirs, warmer water generally is found near the surface and the volume of warm water tends to gradually decrease down through the water column. Conversely, a greater volume of cold water is found near the bottom of the reservoir, and this is often known as the coldwater pool (Horne and Goldman 1994, Wetzel 1983, and Moss 1998).

Because the solubility of dissolved oxygen in water is related to changes in pressure and temperature, cold water generally contains a greater percentage of dissolved oxygen as compared to warm water. However, in most systems there are additional demands that may affect this relationship. Plant and animal respiration can consume large amounts of dissolved oxygen but the major consumption of oxygen in lakes and reservoirs is attributed to bacterial respiration associated with the decomposition of organic matter settling out of the water column. Additionally, wind action across the surface of lakes promotes mixing, which generally results in greater dissolved oxygen concentrations near the surface (Horne and Goldman 1994, Wetzel 1983, and Moss 1998).

D.4.2 Summer/Winter - Stratification/Mixing

In the spring and early summer, water near the lake surface begins to warm as it absorbs energy from increased solar radiation associated with longer daylight hours (Figure E-1). Because of the thermal properties associated with water, the warmer layers of water remain near the surface while denser, colder water sinks deeper into the water column. Over time, this creates distinct thermal layers (known as the epilimnion, metalimnion/thermocline and hypolimnion) within the water column. Once the spring thermocline is established, it is thermodynamically stable and usually can be destroyed only by cooling of the epilimnion. At this point, the hypolimnion is effectively isolated from the surface and dissolved oxygen cannot be replenished except by diffusion from the metalimnion, which is very slow (Horne and Goldman 1994, Wetzel 1983, and Moss 1998).



Source: Horne and Goldman 1994.

Figure D-1. Horizontal Cross-Sectional View of the Physiochemical Processes and Stratification Layers Occurring in Lakes and Reservoirs

In the fall, less solar radiation reaches the lake surface during the day, while heat losses at the surface of the water are greater at night than they are deeper in the water column. Cooling water at the surface is denser than warmer water below and so it sinks, causing the warmer water to rise up to the surface. These convective currents and wind-induced mixing begin to weaken the thermocline. The epilimnion increases in depth as water temperature decreases. Eventually the water temperature and density differences between adjacent water layers are so slight that a strong wind can overcome the remaining resistance to mixing in the water column and the lake undergoes fall overturn, mixing from top to bottom. Fall overturn causes oxygen-saturated water at the surface to be distributed throughout the various depths of the epilimnetic and hypolimnetic layers. When circulation is complete, dissolved oxygen continues at saturation in accordance with solubility at existing temperatures. These mixing events are important because they enable low or depleted oxygen stores in the hypolimnion and near the lakebed to be replenished. This also ensures that aerobic activities associated with bacterial decomposition in and above the lake sediments continue to occur. Additionally, mixing distributes organic nutrients (e.g., nitrogen and phosphorous) which are accumulated at the bottom of the lake throughout the summer, through the water column (Horne and Goldman 1994, Wetzel 1983, and Moss 1998).

D.4.3 Potential Lake Pollutants: Nutrients/Metals/Sedimentation

Healthy lake ecosystems contain small quantities of nutrients from natural sources. An increased or accelerated input of nutrients (primarily nitrogen and phosphorous) may disrupt the balance of lake ecosystems by altering physical, chemical and biological processes within the system. Excessive nutrients can stimulate increased productivity, which can lead to short-term population explosions of algae and aquatic macrophytes. Eventually the algae and other vegetation die off and sink to the bottom of the lake where it undergoes bacterial decomposition. As the bacteria continue to break down the organic matter, the decomposition process elicits a high biochemical oxygen demand, which can deplete dissolved oxygen in the water. At a substantial level, this may deprive fish and other aquatic organisms of oxygen, which in turn can lead to fish kills or produce foul odors in the water (Horne and Goldman 1994, Wetzel 1983, and Moss 1998).

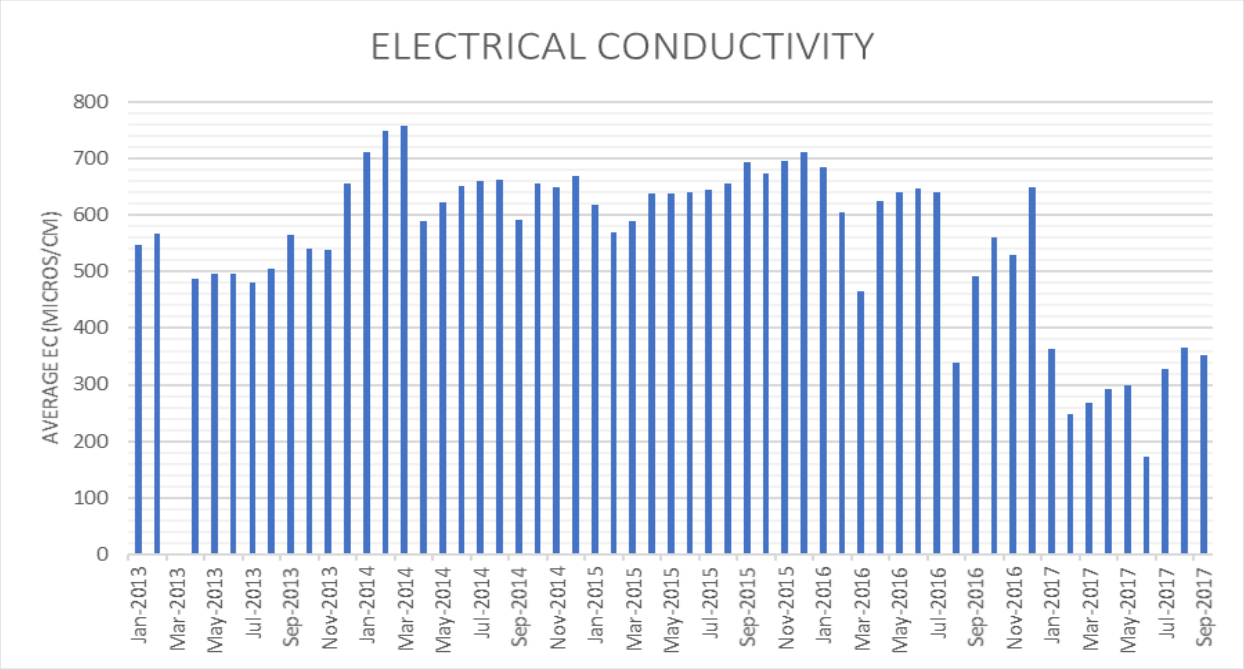
After nutrient loading, metals are typically the second most common lake pollutant of concern and are often found to accumulate in lake sediments. These substances are a concern because many of them are harmful to humans and aquatic organisms. While many metals become concentrated in the sediment, they generally remain there unless disturbed and re-suspended in the water column. Reservoir drawdown has the potential to alter the concentration and mobility of metals found in the sediment within and around the reservoir by reducing the volume of the storage pool. Additionally, exposing a greater amount of the shoreline acreage surrounding the waterbody could potentially lead to increased shoreline erosion, which may increase the amount of sediment loading and suspended solids within the reservoir. In addition to concerns associated with metals, increased sedimentation may reduce water clarity or impair physiological mechanisms associated with aquatic organisms (Horne and Goldman 1994, Wetzel 1983, and Moss 1998).

Reservoir and river management objectives may have conflicting resource goals, which require management coordination to ensure that the needs of both resources are being adequately met. In some situations, trade-offs may need to occur between the upstream reservoir and river reaches downstream. Management actions may call for increased reservoir releases to provide for downstream requirements. Providing downstream benefits (e.g., flow and habitat improvements for fish and wildlife, power generation, agricultural and municipal water diversions) from increases in reservoir flow releases may lead to reductions to reservoir storage and could negatively affect reservoir-related water quality parameters by resulting in: 1) lower surface water elevations within the reservoir; 2) reductions in the volume of the cold water pool; and 3) alteration of pollutant concentrations. Such changes to reservoir water quality could also result in direct and indirect affects to reservoir-dependent aquatic and human uses such as fisheries and primary and secondary contact recreational use.

D.5 Water Quality Monitoring

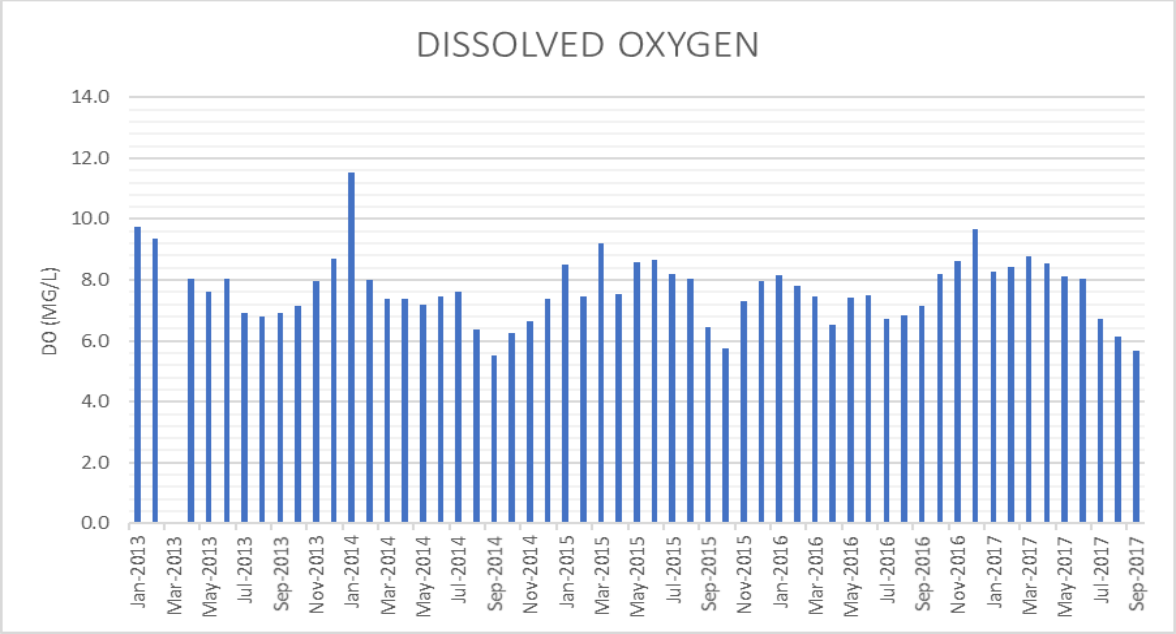
Water quality samples are routinely collected through automated monitoring at O'Neill Forebay at Gianelli Pumping Plant. Electrical Conductivity (EC), Dissolved Oxygen (DO) and Dissolved Nitrate data from this sampling location is presented in Figures D-2 through D-4. Periodic boat-based in lake sampling also occurs at multiple locations on San Luis Reservoir. Historic algae count data collected at Pacheco Pumping Plant indicates greatest algae cell counts during mid- to late-summer months, peaking in some years above 70,000 algae cell counts.

EC is directly related to the concentration of dissolved solids in the water. Salinity is related to EC in that dissolved ions that increase conductivity also increase salinity. Historic water quality data at O'Neill Forebay from 2013 thru 2017 is within the typical range of EC values for tap water in the United States.



Source: DWR California Data Exchange Center (CDEC) 2017

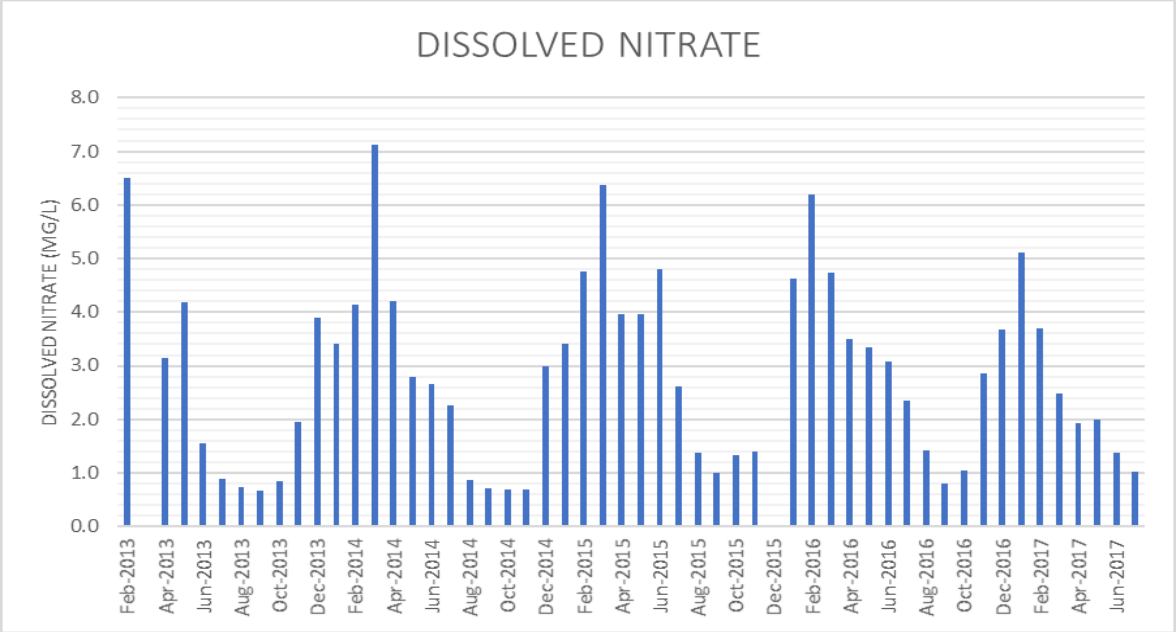
Figure D-2. Electrical Conductivity in O'Neill Forebay as Measured at Gianelli Pumping Plant



Source: DWR CDEC 2017

Figure D-3. Dissolved Oxygen in O'Neill Forebay as Measured at Gianelli Pumping Plant

As seen in Figure D-3, DO concentrations in O'Neil Forebay vary between 5 and 10 milligrams per liter (mg/L) from 2013 through 2017. DO is often lowest in the late summer and fall following excessive algae growth. As algae dies and creates decomposing organic matter the process consumes dissolved oxygen, indicated by the low late summer DO levels in O'Neill Forebay.



Source: DWR CDEC 2017

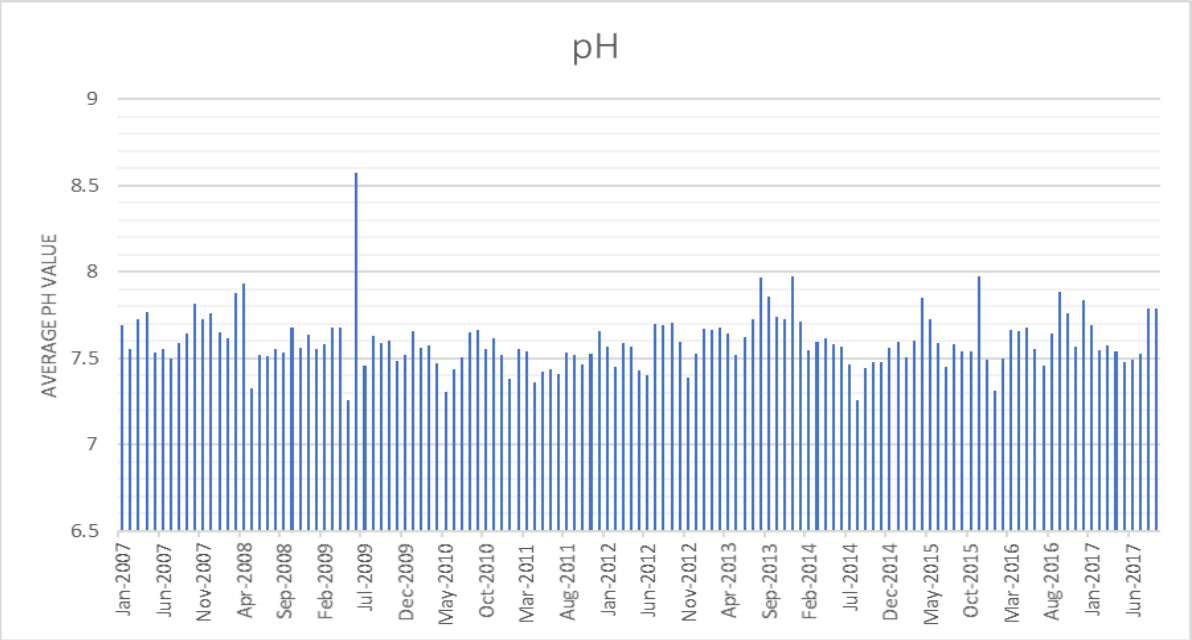
Figure D-4. Dissolved Nitrate in O'Neill Forebay as Measured at Gianelli Pumping Plant

Nitrate levels in O'Neill Forebay from 2013 through 2017 indicate late winter/Early spring peaks when algae growth is limited due to low temperatures. Nitrate levels drop beginning in late spring as algae begins to form and depletes nitrate levels through late fall. Despite annual fluctuations of approximately 5 mg/L, nitrate levels remain below the USEPA National Primary Drinking Water Regulations of 10 mg/L even in its raw water form (USEPA 2016).

The existing water quality constituents of concern in the Delta can be categorized broadly as metals, pesticides, nutrient enrichment and associated eutrophication, constituents associated with suspended sediments and turbidity, salinity, bromide, and organic carbon. The relative concentrations of these constituents over time is closely related to the hydrodynamic conditions, including the position of X2, described above. Other physical parameters (including pH, temperature, and EC), monitored daily at Clifton Court Forebay (where Banks Pumping Plant diverts from the Delta and near the Jones Pumping Plant diversion), can provide a demonstration of how change in these hydrodynamic conditions can affect water quality conditions in the Delta over time. Figures D-5 through D-7 present historical data from 2007-2017 for pH, temperature, and EC.

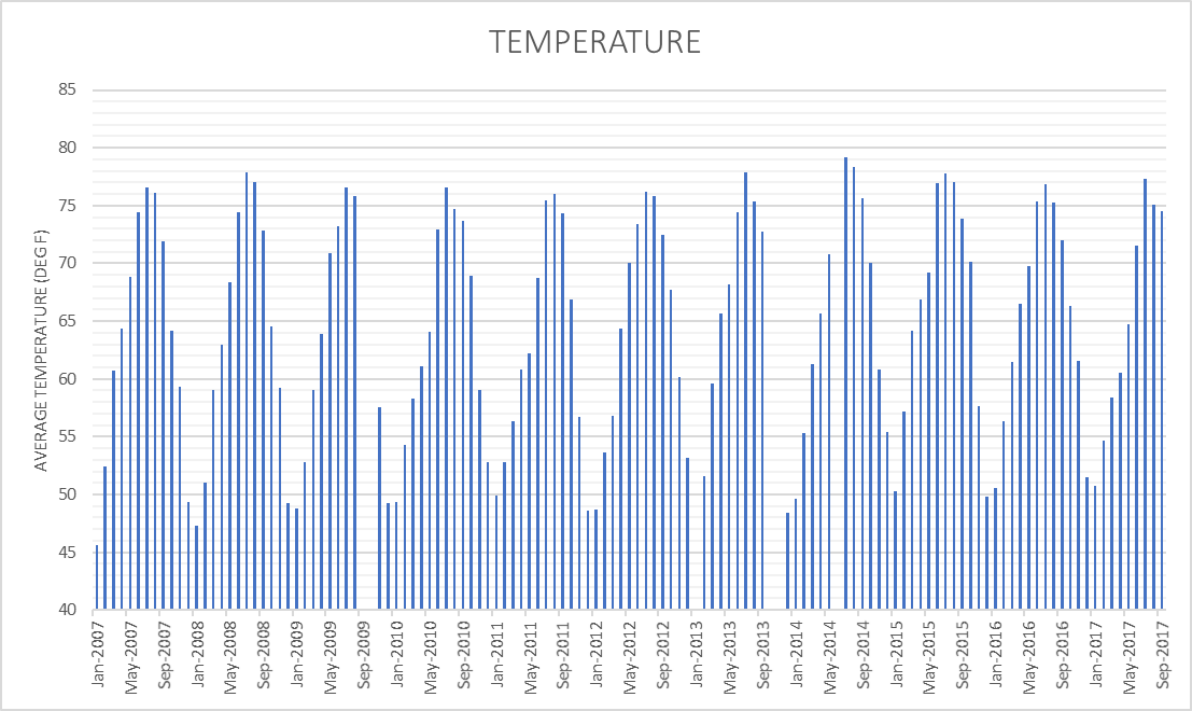
The Jones Pumping Plant diverts water from the Delta into the Delta-Mendota Canal that conveys Central Valley Project (CVP) water to users in the Central Valley and includes San Luis Reservoir as a storage feature. The influence of hydrodynamic conditions in the Delta described above for Clifton Court Forebay and indicated in Figures D-5 through D-7, is similar at the Jones Pumping Plant. Similar to the Delta Region water quality constituents of concern in the Delta-Mendota Canal can be categorized broadly as metals, pesticides, constituents associated with suspended sediments and turbidity, salinity, bromide, and organic carbon.

The Banks Pumping Plant diverts water from the Delta into Bethany Reservoir and then the California Aqueduct. Water diverted to the California Aqueduct is conveyed south to State Water Project (SWP) water users via the O'Neill Forebay and San Luis Reservoir. Water quality constituents of concern in the south-of-Delta SWP, similar to the Delta Region and Delta-Mendota Canal, include metals, pesticides, constituents associated with suspended sediments and turbidity, salinity, bromide, and organic carbon.



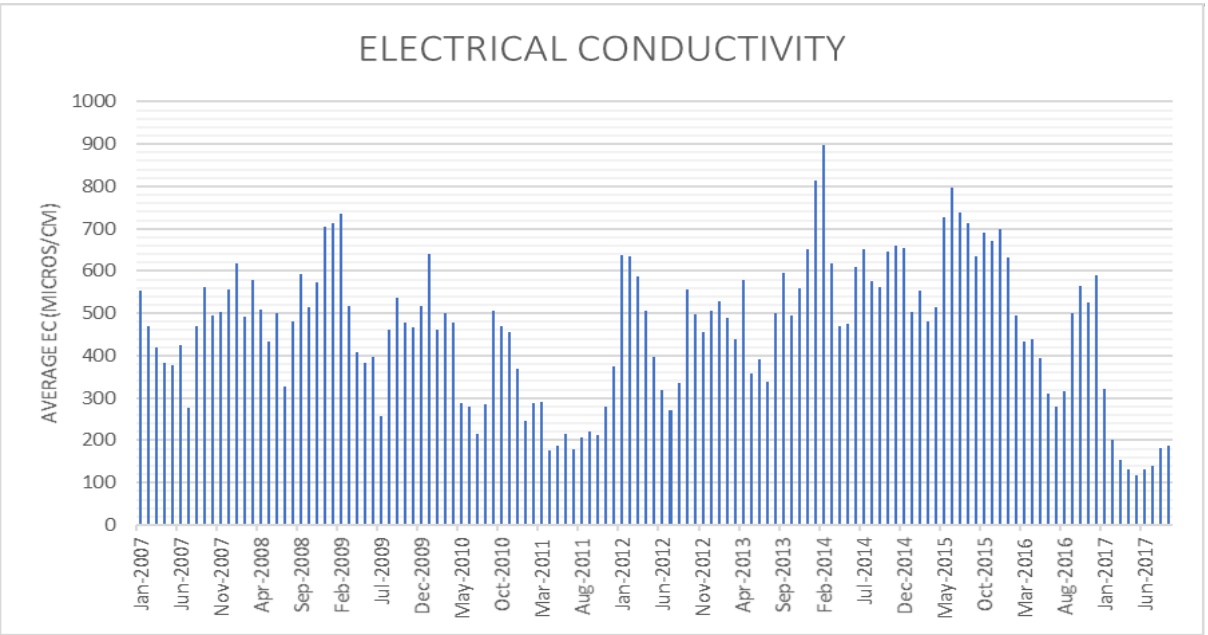
Source: DWR CDEC 2017

Figure D-5. pH in Clifton Court Forebay



Source: DWR CDEC 2017

Figure D-6. Temperature in Clifton Court Forebay



Source: DWR CDEC 2017

Figure D-7. Electrical Conductivity in Clifton Court Forebay

D.6 Water Quality Modeling Results

Water quality monitoring data and computer modeling were used to aid in evaluating potential impacts. Both temporary, construction-related effects and long-term operational effects were considered as part of this evaluation. Temporary construction impacts were evaluated qualitatively based on anticipated construction practices, materials, locations, and duration of construction and related activities. Long-term effects were evaluated using results from computer modeling tools. Specifically, the California Simulation Model II (CalSim II) was used to estimate both existing (short term) and future (long term) changes in reservoir storage and stream flow within the area of analysis.

Hydrodynamic and water quality modeling of the Delta was performed using the Delta Simulation Model-2 (DSM2). Where modeling is not available, effects are evaluated based on changes in CVP deliveries, anticipated changes in flow through the Delta (increases or decreases), and the timing of the changes.

D.6.1 X2 Results

X2 calculations were completed to determine the movement of salinity throughout the Delta. The "X2" water quality parameter represents the distance from the Golden Gate to the location of 2 parts per thousand (ppt) salinity concentration in the Delta. Larger values indicate that the salinity concentrations are increasing in the Delta as a result of reductions in outflow in the movement of the salinity zone further into the Delta, and smaller values

indicate lower salinity concentrations as the salinity zone is pushed out of the Delta.

Under the Lower San Felipe Intake Alternative, X2 results indicate that on average there are very slight changes to Delta water quality resulting from changes in Delta outflows. Table D-5 summarizes X2 results which modeled potential changes in salinity in comparison to the No Action/No Project Alternative. Positive values indicate movement of the salinity zone into the Delta while negative values indicate the zones movement out of the Delta.

Under the Treatment Alternative, changes to X2 would be similar to effects under the Lower San Felipe Intake Alternative.

Under the San Luis Reservoir Expansion Alternative, although monthly minimum and maximum impacts over the 82-year modeling period of record indicate a slightly larger range of changes in X2, on average there are immeasurable changes to Delta water quality resulting from changes in Delta outflows compared to the No Action Alternative. Table D-6 summarizes X2 results which modeled potential changes in salinity in comparison to the No Action/No Project Alternative.

Under the Pacheco Reservoir Expansion Alternative, changes to X2 would be similar to effects under the Lower San Felipe Intake Alternative.

Table D-5. Modeled Difference in Delta X2 between the No Action/No Project Conditions and the Lower San Felipe Intake Alternative (km change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AN	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01

Notes: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table D-6. Modeled Difference in Delta X2 between the No Action/No Project Conditions and the San Luis Reservoir Expansion Alternative (km change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.01	0.01	-0.01	0.00	0.00	0.00	0.04	0.01	0.01	0.00	-0.01	-0.01
AN	-0.01	-0.01	0.04	0.00	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.00
BN	0.00	0.00	0.02	0.01	-0.02	-0.01	-0.01	-0.02	0.00	0.00	0.00	0.00
D	0.00	0.00	-0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

D.6.2 South-of-Delta Export Results

As noted above, water quality in the Delta and the south-of-Delta CVP and SWP is closely related to changes in hydrodynamics. Changes in south-of-Delta exports are directly linked to changes in Delta outflow, which can impact water quality conditions (e.g. salinity and TDS levels) in the south Delta and south-of-Delta CVP and SWP.

As shown in Tables D-7, the changes in south-of-Delta export of CVP and SWP water under the Lower San Felipe Intake Alternative would be minimal. Under the Treatment Alternative, changes to Delta exports would be similar to effects under the Lower San Felipe Intake Alternative.

Under the San Luis Reservoir Expansion Alternative, south-of-Delta exports are expected to increase during wet and above normal year types as increased San Luis Reservoir storage will require greater exports to fill the reservoir. Exports are expected to increase by as much as 26,000 acre-feet (AF) annually under wet water year types. On the other hand, exports will decrease slightly during below normal and dry water year types by as much as 4,000 AF annually. Table D-8 shows the change in south-of-Delta exports under this alternative.

Under the Pacheco Reservoir Expansion Alternative, south-of-Delta exports are expected to increase slightly during all water years, as shown in Table D-9.

Table D-7. Modeled Difference in Total South-of-Delta Exports between the No Action/No Project Conditions and Lower San Felipe Intake Alternative (1,000 acre-feet)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	1	0	0	0	0	0	0	0	0	0	0	0	2
AN	-1	0	0	1	0	0	0	0	0	0	0	1	1
BN	0	-1	0	0	1	0	0	0	0	0	1	0	2
D	0	0	1	0	0	0	0	0	0	0	0	2	1
C	0	0	0	0	0	0	0	0	0	0	-1	2	1
All	0	0	0	0	0	0	0	0	0	0	0	1	1

Notes: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table D-8. Modeled Difference in Total South-of-Delta Exports between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative (1,000 acre-feet)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	1	-1	0	2	6	15	1	0	0	1	1	0	26
AN	7	0	-3	6	10	1	0	0	0	0	0	-1	21
BN	1	-4	1	0	-4	0	0	0	0	0	0	2	-4
D	4	-5	0	0	0	0	0	0	0	2	-1	-1	-1
C	0	0	0	0	0	0	0	0	0	0	0	0	0
All	2	-2	0	2	3	5	0	0	0	1	0	0	10

Notes: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table D-9. Modeled Difference in Total South-of-Delta Exports between the No Action/No Project Conditions and the Pacheco Reservoir Expansion Alternative (1,000 acre-feet)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	1	0	0	0	0	0	0	0	0	0	0	0	2
AN	-1	0	0	1	0	0	0	0	0	0	0	1	1
BN	0	-1	0	0	1	0	0	0	0	0	1	0	1
D	0	0	0	0	0	0	0	0	0	0	0	2	1
C	0	0	0	0	0	0	0	0	0	0	-1	2	1
All	0	0	0	0	0	0	0	0	0	0	0	1	1

Notes: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

D.6.3 Delta Outflow Results

As shown in Tables D-10 and D-11, the changes in Delta outflow under the Lower San Felipe Intake Alternative would be minimal. Under the Treatment Alternative, changes to Delta outflow would be similar to effects under the Lower San Felipe Intake Alternative.

Under the San Luis Reservoir Expansion Alternative, Delta outflows generally decrease, especially during wet and above normal year types due to increased storage capacity in San Luis Reservoir. During wet and above normal water year types, exports would increase in months when surplus flows are available in the Delta to fill this new available San Luis Reservoir capacity, resulting in decreases in Delta outflows as high as 434 cubic feet per second (cfs) annually in some water year types. On the contrary, during below normal and dry year types Delta outflow will increase by as much as 99 cfs annually in certain water year types, when some CVP deliveries that would be supported directly by Delta exports are instead supplied from the expanded San Luis Reservoir. Tables D-12 and D-13 summarizes the change in Delta outflow as a result of this alternative.

Under the Pacheco Reservoir Expansion Alternative, Delta outflows generally decrease under all water years, except during critical water years when Delta outflows would increase slightly, as shown in Table D-14 and D-15.

Table D-10. Modeled Difference in Delta Outflow between the No Action/No Project Conditions and Lower San Felipe Intake Alternative (cubic feet per second)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	3	1	6	-18	-17	-3	0	0	0	0	0	0	-28
AN	5	11	-1	-6	-9	-7	1	0	0	-2	0	0	-8
BN	4	0	-1	0	-13	1	-24	1	0	-1	0	2	-32
D	1	-1	-1	-1	-8	-2	1	0	0	0	-1	5	-7
C	0	0	0	0	-1	0	0	0	0	0	5	0	5
All	3	2	1	-7	-11	-2	-4	0	0	0	0	1	-16

Notes: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table D-11. Modeled Difference in Delta Outflow between the No Action/No Project Conditions and Lower San Felipe Intake Alternative (% change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BN	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
D	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
All	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Notes: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table D-12. Modeled Difference in Delta Outflow between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative (cfs)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0	10	-24	-44	-111	-242	-22	1	-3	12	0	-12	-434
AN	0	-82	-2	-130	-197	-19	0	3	-1	-3	0	0	-431
BN	0	-14	30	32	5	12	30	-2	0	1	0	5	99
D	2	4	-13	0	0	14	0	0	0	0	-2	-1	4
C	0	0	-3	3	0	0	0	0	0	0	0	0	1
All	0	-10	-6	-27	-63	-74	-2	0	-1	3	0	-3	-183

Notes: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W - Wet

Table D-13. Modeled Difference in Delta Outflow between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative (% change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.0%	0.1%	-0.1%	-0.1%	-0.1%	-0.3%	0.0%	0.0%	0.0%	0.1%	0.0%	-0.1%	-0.1%
AN	0.0%	-0.7%	0.0%	-0.3%	-0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
BN	0.0%	-0.2%	0.3%	0.1%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
D	0.0%	0.0%	-0.2%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All	0.0%	-0.1%	0.0%	-0.1%	-0.1%	-0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%

Notes: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W - Wet

Table D-14. Modeled Difference in Delta Outflow between the No Action/No Project Conditions and the Pacheco Reservoir Expansion Alternative (cfs)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	3	1	3	-18	-17	-4	0	0	0	0	0	0	-31
AN	5	11	-1	-5	-7	-7	1	0	0	-2	0	0	-5
BN	4	0	-2	0	-14	-1	-24	1	0	-1	0	2	-35
D	1	-1	-1	-1	-8	-2	1	0	0	0	-1	5	-6
C	0	0	0	0	-1	0	0	0	0	0	5	0	5
All	3	2	0	-7	-11	-3	-4	0	0	0	1	1	-17

Notes: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table D-15. Modeled Difference in Delta Outflow between the No Action/No Project Conditions and the Pacheco Reservoir Expansion Alternative (cfs)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BN	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
D	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
All	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Notes: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

D.6.4 San Luis Reservoir Storage Results

Under the Lower San Felipe Intake Alternative, Santa Clara Valley Water District (SCVWD) would be able to fully divert its CVP allocation and would not have to leave water in San Luis storage as it does in the No Action/No Project Alternative; therefore, reservoir levels would be lower.

Based on the CalSim II modeling results detailed in Appendix B, annual average reservoir storage levels would decrease by less than 17,000 AF or less than one percent of the water that is typically in storage. Additionally, reservoir levels are expected to refill to levels similar to existing conditions during the late winter and early spring months. Based on the small changes in overall reservoir storage, as well as the regular refill during fall and winter, neither water quality nor beneficial uses are expected to be substantially changed as a result of the lower intake. Table D-16 summarizes the charge in total San Luis Reservoir storage as a result of this alternative.

Table D-16. Modeled Difference in Total San Luis Reservoir Storage between the No Action/No Project Conditions and Lower San Felipe Intake Alternative (1,000 AF)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-2	-2	-2	-2	-1	-1	-1	-1	-1	-1	-1	-1	-15
AN	-3	-5	-5	-5	-4	-4	-4	-3	-2	-1	-2	-1	-39
BN	-1	-3	-3	-3	-2	-2	-2	-2	-1	-1	-2	-3	-23
D	-1	-1	-1	-1	-1	-1	-1	0	0	0	0	0	-7
C	0	-1	-1	0	0	0	0	0	0	0	-1	-3	-8
All	-2	-2	-2	-2	-2	-1	-1	-1	-1	-1	-1	-1	-17

Notes: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Under the Treatment Alternative, SCVWD would be able to fully divert its CVP allocation and would not have to leave water in San Luis storage as it does in the No Action/No Project Alternative; therefore, reservoir levels would be lower. The change in reservoir levels would be the same as described for the

Lower San Felipe Intake Alternative in Table D-16; the changes in reservoir levels would be minor.

Under the San Luis Reservoir Expansion Alternative, additional storage would be available for treatment without concerns regarding water quality impacts resulting from algae laden water reaching the treatment system. The ten-foot maximum reservoir surface raise under this alternative would increase the water storage capacity at San Luis Reservoir by approximately 120,000 AF.

Based on CalSim II modeling results, the San Luis Reservoir Expansion Alternative would lead to monthly increases in storage of an average one percent throughout the year. Increased storage would be most apparent during spring months of wet water year types, when storage would increase by approximately 28,000 AF, or 2-percent of total storage. Table D-17 summarizes the charge in total San Luis Reservoir storage as a result of this alternative.

Table D-17. Modeled Difference in Total San Luis Reservoir Storage between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative (1,000 AF)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	11	9	9	9	14	28	28	26	22	18	15	15	203
AN	6	5	2	8	17	17	16	14	11	7	5	3	111
BN	4	0	1	1	7	12	10	9	6	2	-1	2	53
D	9	4	4	3	2	2	3	3	2	4	2	1	39
C	0	0	0	0	0	0	0	0	0	0	0	0	1
All	7	5	4	5	9	14	14	12	10	8	6	6	98

Notes: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Under the Pacheco Reservoir Expansion Alternative, the new reservoir would be filled partially by CVP water allocated to SCVWD through its CVP contract with deliveries being routed through San Luis Reservoir. Under the Pacheco Reservoir Expansion Alternative, SCVWD would be able to fully divert its CVP allocation and would not have to leave water in San Luis storage as it does in the No Action/No Project Alternative; therefore, reservoir levels would be lower. The change in reservoir levels would be the same as described for the Lower San Felipe Intake Alternative in Table D-16; the changes in reservoir levels would be minor.

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San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix E1: Noise and Vibration Supporting Information

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Appendix E1
Noise and Vibration Supporting Information

This appendix supports the Noise and Vibration analysis and contains area of analysis figures and presents a framework for understanding noise and vibration levels. In addition, this appendix provides a detailed description, summarized in the Noise and Vibration Affected Environment, of existing noise and vibration levels and sensitive receptors with the potential to be affected by the action alternatives.

E1.1 Noise and Vibration Terminology

E1.1.1 Noise

Noise can be generally defined as unwanted sound. Sound, traveling in the form of waves from a source, is characterized by various parameters that include the rate of oscillation of sound waves (frequency), the speed of propagation, and the pressure level or energy content (amplitude). In particular, the sound pressure level (referred to as sound level) is the most common descriptor used to characterize the loudness of an ambient sound level. It is measured in decibels (dB), with zero dB corresponding roughly to the threshold of human hearing and 120 to 140 dB corresponding to the threshold of pain.

Sound pressure fluctuations can be measured in units of hertz (Hz), which correspond to the frequency of a particular sound. Typically, sound does not consist of a single frequency, but rather a broad band of frequencies varying in levels of magnitude (sound power). The sound pressure level, therefore, constitutes the additive force exerted by a sound corresponding to the frequency/sound power level spectrum. The typical human ear is not equally sensitive to all frequencies of the audible sound spectrum. Consequently, when assessing potential noise impacts, sound is measured using an electronic filter that de-emphasizes the frequencies below 1,000 Hz and above 5,000 Hz in a manner corresponding to the human ear's decreased sensitivity to low and extremely high frequencies and greater sensitivity to mid-range frequencies. This method of frequency weighting is referred to as A-weighting and is expressed in units of A-weighted dB (dBA). Frequency A-weighting follows an international standard methodology of frequency de-emphasis and is typically applied to community noise measurements. Some representative noise sources and their corresponding A-weighted noise levels are shown in Table E1-1.

TableE1-1. Typical Noise Levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	110	Rock band
Jet flyover at 1,000 feet		
	100	
Gas lawnmower at 3 feet		
	90	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	80	Garbage disposal at 3 feet
Noise urban area, daytime		
Gas lawnmower, 100 feet	70	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	60	
		Large business office
Quiet urban daytime	50	Dishwasher in next room
Quiet urban nighttime	40	Theater, large conference room (background)
Quite suburban nighttime		
	30	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	20	
		Broadcast/recording studio
	10	
	0	

Source: California Department of Transportation (Caltrans) 2013a.
Key:
dBA = A-weighted decibel scale
mph = miles per hour

A key concept in evaluating potential noise impacts is the perceived effect of incremental increase in existing noise levels. Table E1-2 presents the effect of increasing noise levels. For example, the table shows that an increase of 3 dBA is barely perceptible, an increase of 5 dBA is noticeable, and that a 10 dBA increase would be perceived by someone to be a doubling of noise.

Table E1-2. Decibel Changes, Loudness, and Energy Loss

Sound Level Change (dBA)	Relative Loudness/ Impact	Acoustical Energy Gain (%)
0	Reference	0
+3	Barely Perceptible Change	50
+5	Noticeable Change	67
+10	Twice as Loud	90
+20	Four Times as Loud	99

Source: Federal Highway Administration (FHWA) 2011.
Key:
dBA = A-weighted decibel scale

Noise analyses and regulations use the following terms:

- **L_{eq}: Equivalent energy level** - A-weighted sound level corresponding to a steady-state sound level that contains the same total energy as a varying signal over a given sample period. This is typically computed over 1-, 8-, and 24-hour sample periods.

- **L_{dn}: Day-night average level** - the energy average sound level for a 24-hour day determined after the addition of a 10 dBA penalty to all noise events occurring at night between 10 p.m. and 7 a.m. This is a useful measure for community noise impact because people in their homes are much more sensitive to noise at night when they are relaxing or sleeping than they are in the daytime.

- **L_{max}: Maximum noise level** - representing the highest sound level measured for a given period.

- **L_{min}: Minimum noise level** - representing the lowest sound level measured for a given period.

- **L_x: Statistical noise descriptor** – the noise level exceeded X% of a specified time period. For example, L_{10} indicates the noise level that is exceeded 10% of the time during a given period.

- **CNEL: Community Noise Equivalent Level** - a 24-hour average L_{eq} that includes the addition of five dBA to sound levels from 7 p.m. to 10 p.m. and an addition of 10 dBA to sound levels from 10 p.m. to 7 a.m. The CNEL is commonly used in California instead of the L_{dn}.

Noise effects on humans can range from annoyance to physical discomfort and harm. Sleeping patterns, speech communication, mental acuity, and heart and breathing rates can all be disturbed by noise. Perception of the noise is affected by its pitch, loudness, and character.

Sound levels from isolated point sources of noise typically decrease by about 6 dBA for every doubling of distance from the noise source. When the noise source is a continuous line, such as vehicle traffic on a highway, sound levels decrease by about 3 dBA for every doubling of distance. Noise levels can also be affected by several factors other than the distance from the noise source. Topographic features and structural barriers that absorb, reflect, or scatter sound waves can affect the reduction of noise levels. Atmospheric conditions (wind speed and direction, humidity levels, and temperatures) and the presence of dense vegetation can also affect the degree to which sound is attenuated over distance.

E1.1.2 Vibration

Vibration refers to groundborne noise and perceptible motion. The most common impacts from groundborne vibration include annoyance, movement of the building floors, rattling of windows, shaking of items on shelves or hanging on walls, disruption of vibration-sensitive operations or activities, and triggering of landslides. Vibrations caused by construction can be interpreted as energy transmitted in waves through the soil mass. These energy waves generally dissipate with distance from the vibration source, due to spreading of the energy and frictional losses. Thus, groundborne vibrations from most construction activities very rarely reach the levels that can damage structures but can achieve the perceptible ranges in buildings very close to construction sites (Federal Transit Authority [FTA] 2006).

In extreme cases, vibration can cause damage to buildings or equipment. In most circumstances, common ground-induced vibrations related to roadway traffic and construction activities pose no threat to buildings or structures, with the occasional exception of blasting and sheet pile-driving during construction. In order to assess the potential for structural damage associated with vibration, the vibratory ground motion in the vicinity of the affected structure is measured in terms of peak particle velocity (PPV) in the vertical and horizontal directions, typically in units of inches per second (in/sec). The PPV is defined as the maximum instantaneous peak of the vibration signal. California Department of Transportation (Caltrans) estimates that frequent generation of vibration at levels exceeding 0.3 in/sec can damage older residential structures and cause annoyance to humans (Caltrans 2013b).

Annoyance from vibration often occurs when the vibration exceeds the threshold of perception. A vibration level that causes annoyance would be well below the damage threshold for normal buildings. Generally, groundborne vibration does not provoke adverse human reaction to those who are outdoors as the effects associated with the shaking of building are absent.

Construction activities can either result in continuous or single-impact (transient) vibration impacts. Typical equipment or activities that could result in continuous vibration impacts include excavation equipment, traffic, vibratory pile drivers, and vibratory compaction equipment; examples of transient vibration sources include blasting and drop balls. Some construction activities, like jackhammers or impact pile drivers, can continually generate single transient events at a high frequency; however, for evaluation purposes, these equipment would be regarded as having frequent or continuous vibration impacts.

E1.1.2.1 Area of Analysis

The area of analysis for noise includes the following study areas where construction would occur:

- San Luis Reservoir (in Merced County)
- Santa Teresa Water Treatment Plant (in Santa Clara County)
- Pacheco Reservoir (in Santa Clara County)

Figure E1-1 illustrates the area of analysis.

E1.2 Existing Conditions

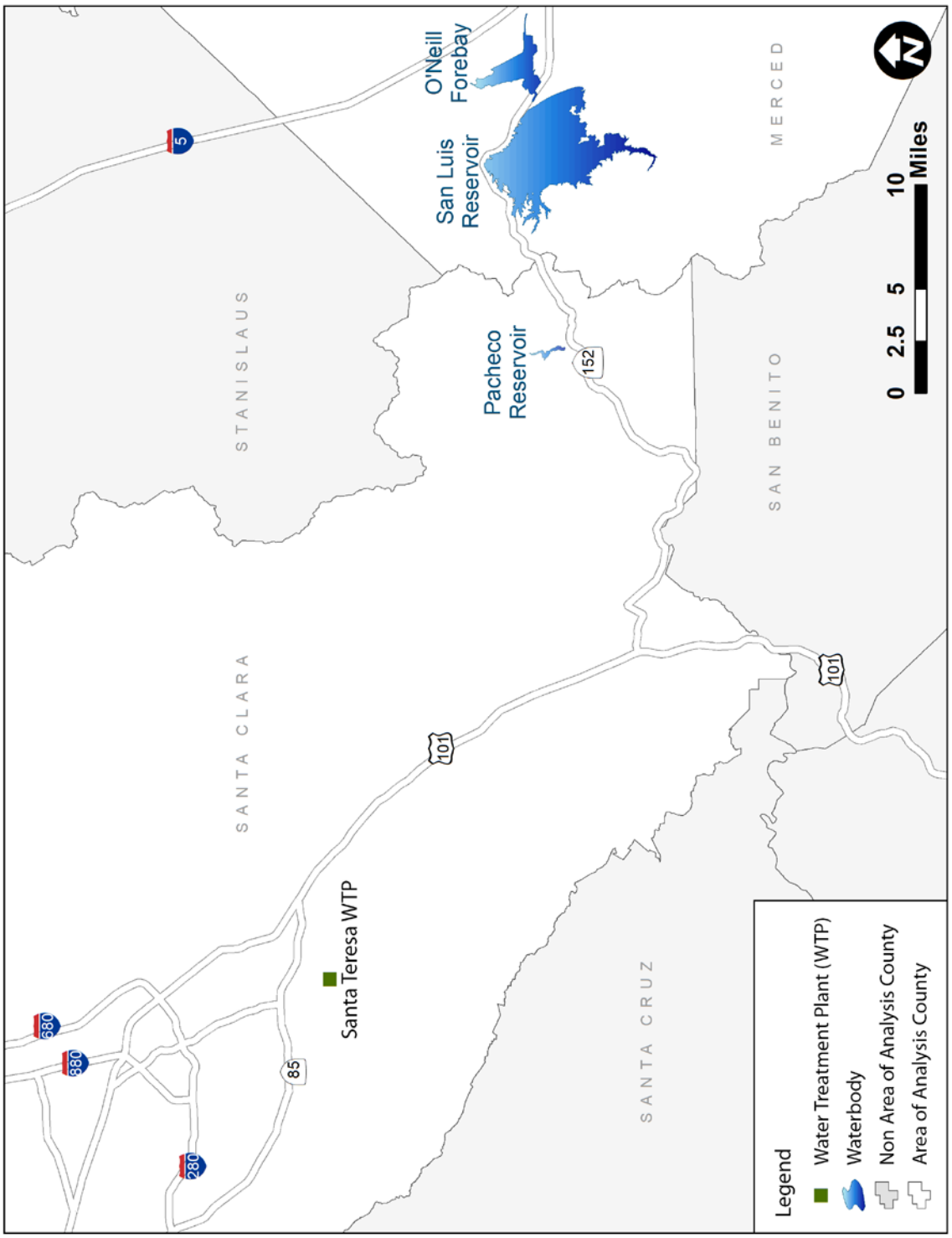
Noise sources currently existing in the area of analysis are of three general types: agricultural noise, general stationary noise, and general mobile noise. No major sources of vibration are known to exist in the area of the San Luis Reservoir.

Farm operations produce noise from a variety of sources. These include heavy equipment for plowing and harvesting, dairy equipment, crop-spraying aircraft, wind turbines for frost protection, on-site processing equipment, and irrigation water pumps. In addition to affecting the farmers and farm laborers, agricultural noise also affects those living in or near agricultural areas.

General stationary noises (i.e., those emanating from fixed locations) are associated with a variety of land uses. Stationary sources include air conditioning units, power tools, motors, generators, appliances, and manufacturing and industrial facilities. Noise-sensitive receptors may have stationary noise sources at their locations.

General mobile noise sources include vehicles, aircraft, and trains. Mobile noise is usually temporary and variable, but can be intense and annoying because of its abruptness and intensity. In urban areas, these mobile sources contribute to the ambient noise.

The counties in the area of analysis vary from rural to urban environments, and include farming, industrial, residential, and commercial noise sources. The sections below describe the prevailing noise conditions (and vibration conditions, if unusual) and noise-and vibration-sensitive receptors in the area of analysis. On the whole, no major long-term sources of vibration are known to exist in the area of analysis.



FigureE1-1. Noise and Vibration Area of Analysis

E1.2.1 Merced County

As summarized in the Noise and Vibration Affected Environment, in specific areas of Merced County, transportation noise is the dominant noise source. These sources include railroads, vehicular traffic, and airports (Merced County has five general aviation airports). Other areas of the county are dominated by agricultural land uses, and are relatively quiet. Freight and passenger trains pass through Merced County frequently, and constitute a primary source of noise. The county's rail traffic includes both high- and low-speed lines.

Specific noise sources throughout Merced County include sand and gravel excavation; a biomass electrical generating plant; trucking companies; chicken farms; fruit, nut, and vegetable processing and packaging plants; dog kennels; auto wreckers; winery processing facilities; dairies; recreational boating; and an auto racetrack.

The noise source closest to the proposed alternatives in the vicinity of the San Luis Reservoir is the O'Neill Forebay Recreational Boating area. Motor boats are the main source of noise at O'Neill Forebay.

The *2030 Merced County General Plan Draft Program Environmental Impact Report (EIR)* (2012) includes predicted traffic noise levels and traffic noise level increases expected with buildout associated with the General Plan. The FHWA Highway Traffic Noise Prediction Model was used in the General Plan to predict hourly L_{eq} values for free-flowing traffic conditions. To predict L_{dn} values, the input volume was adjusted to account for the day/night distribution of traffic. Table E1-9 summarizes these findings for 2010 and estimated 2030 traffic noise levels along roadways near San Luis Reservoir in Merced County. 2015 traffic volume data from Caltrans (2016) shows annual average daily traffic (AADT) volumes on State Route (SR) 152 that are similar to those listed in Table E1-3. This indicates that traffic noise levels on SR 152 near San Luis Reservoir have not changed appreciably from the data in Table E1-9.

Table E1-3. Traffic Noise Level Data, Merced County

SR 152 Segment	Existing (2010) AADT	Existing (2010) L_{dn} @ 100 Feet (dB)	2030 No Project L_{dn} @ 100 Feet (dB)	Change from Existing (dB)	2030 Buildout L_{dn} @ 100 Feet (dB)	Change from Existing (dB)
Santa Clara County Line to SR 33	23,800	74	78	5	78	5
SR 33 to Interstate 5	23,000	74	79	5	79	5
Interstate 5 to Ortigalita Rd. (West Los Banos)	21,600	72	77	5	77	5
Ortigalita Rd. to SR 165	26,500	73	74	1	74	1
SR 165 to Ward Rd. (East Los Banos)	32,000	74	74	0	74	0
Ward Rd. to SR 33 (Dos Palos)	17,500	72	75	3	75	3
SR 33 to SR 59	15,300	72	73	2	73	2
SR 59 to Madera County Line	15,400	71	73	2	73	2

Source: Merced County 2012.
Key:
AADT = annual average daily traffic
dB = decibel
L_{dn} = day-night average noise level
SR = state route

Merced County performed a community noise survey in 2006 for the General Plan *Background Report* (2013) in order to quantify existing noise levels in the quieter parts of the county. The survey included a monitoring location in the unincorporated town of Santa Nella, approximately two miles northeast of the reservoir. Based on the noise measurement results summarized in Table E1-4, an L_{dn} of 56 dBA was estimated for this location. Noise sources included traffic noise from the interstate and natural sounds.

Table E1-4. Merced County Noise Survey Data for the Town of Santa Nella

Time Period	L_{eq} (dB)	L_{max} (dB)
Morning	45.9	52.6
Afternoon	51.9	61.8
Nighttime	49.6	57.2

Source: Merced County 2013.
Key:
dB = decibel
L_{eq} = equivalent (average) noise level
L_{max} = maximum noise levels

E1.2.2 San Luis Reservoir

Noise monitoring conducted for the project consisted of continuous 24-hour noise readings at the San Luis Creek Use Area and campground on O'Neill Forebay. Additionally, spot-check noise readings were taken at several recreational locations at San Luis Reservoir. Table E1-5 lists the 24-hour noise readings taken at the San Luis Creek campground. The quietest noise levels were measured during the early afternoon during periods of calm winds; these measured 36 to 38 dBA 1-hour L_{eq} at the San Luis Creek Use Area. The noise levels increased at night from wind rustling the leaves in surrounding trees. Nighttime noise levels increased to 42 dBA 1-hour L_{eq} around the San Luis Creek Use Area.

Table E1-5. 24-Hour Baseline Noise Monitoring Results in Proposed Project Area (at San Luis Creek Campground)

Date	Time	1-hour L_{eq} (dBA)
9/11/2003	13:00	46
	14:00	38
	15:00	38
	16:00	37
	17:00	36
	18:00	36
	19:00	38
	20:00	37
	21:00	40
	22:00	40
	23:00	38
9/12/2003	0:00	38
	1:00	38
	2:00	37
	3:00	42
	4:00	39
	5:00	40
	6:00	41
	7:00	39
	8:00	44
	9:00	41
	10:00	40
	11:00	40

Source: Santa Clara Valley Water District 2003.
Key:
dBA = A-weighted decibel scale
L_{eq} = equivalent energy level

Table E1-6 summarizes the findings from noise monitoring completed at recreational sites around San Luis Reservoir and O'Neill Forebay. Measured daytime noise levels at campgrounds and picnic areas were low, ranging from 39 to 43 dBA L_{eq} (5-minute, 10-minute, and 15-minute durations), with most of the observed noise generated by cars traveling on nearby park roads. Power boats on the reservoir are an additional noise source.

Table E1-6. Baseline Noise Monitoring Results

Location	Date	Start Time	Duration (minutes)	L_{eq} (dBA)	Dominant Noise Sources
Medeiros Picnic Area	9/11/2003	3:35 p.m.	10	43	Cars on local park road
Basalt Area Campground #5	9/11/2003	2:55 p.m.	10	42	Cars on campground road
Dinosaur Point Picnic Area	9/12/2003	10:14 a.m.	10	40	Very quiet
Visitor Center	9/11/2003	9:46 a.m.	15	48	Traffic on SR 152, cars in parking lot
San Luis Creek Area Boat Launch	9/11/2003	11:07 a.m.	10	42	Cars in parking lot, airplanes
Pacheco State Park (at gate to Dinosaur Point)	9/12/2003	10:45 a.m.	5	39	Very quiet; some wind noise

Source: Santa Clara Valley Water District 2003.
Key:
dBA = A-weighted decibel scale
L_{eq} = equivalent energy level
SR = scenic route

The *San Luis Reservoir Resource State Recreation Area Final Resource Management Plan/General Plan and Final Environmental Impact Statement/Environmental Impact Report* (United States Department of the Interior, Bureau of Reclamation [Reclamation] and CDPR 2013) identifies noise-sensitive land uses around the reservoir. The Basalt Use Area and the Dinosaur Point Use Area would be closed during construction and are not included as noise-sensitive receptors in this analysis. Additionally, the Operations and Maintenance facilities for the Department of Water Resources (DWR) and the Gianelli Pumping Plant were not included as noise-sensitive receptors because they are onsite workers and are covered by Occupational Safety and Health Administration (OSHA) noise regulations to protect workers from excessive noise exposure. The receptors analyzed include:

- Romero Visitor Center (located along SR 152 west of the Gonzaga Road entrance).
- San Luis Wildlife Area (managed by the Department of Fish and Wildlife, located at the western edge of the Reservoir, north of Pacheco State Park), this area is designated for hiking, bird watching, and hunting. There are no developed facilities in this area.

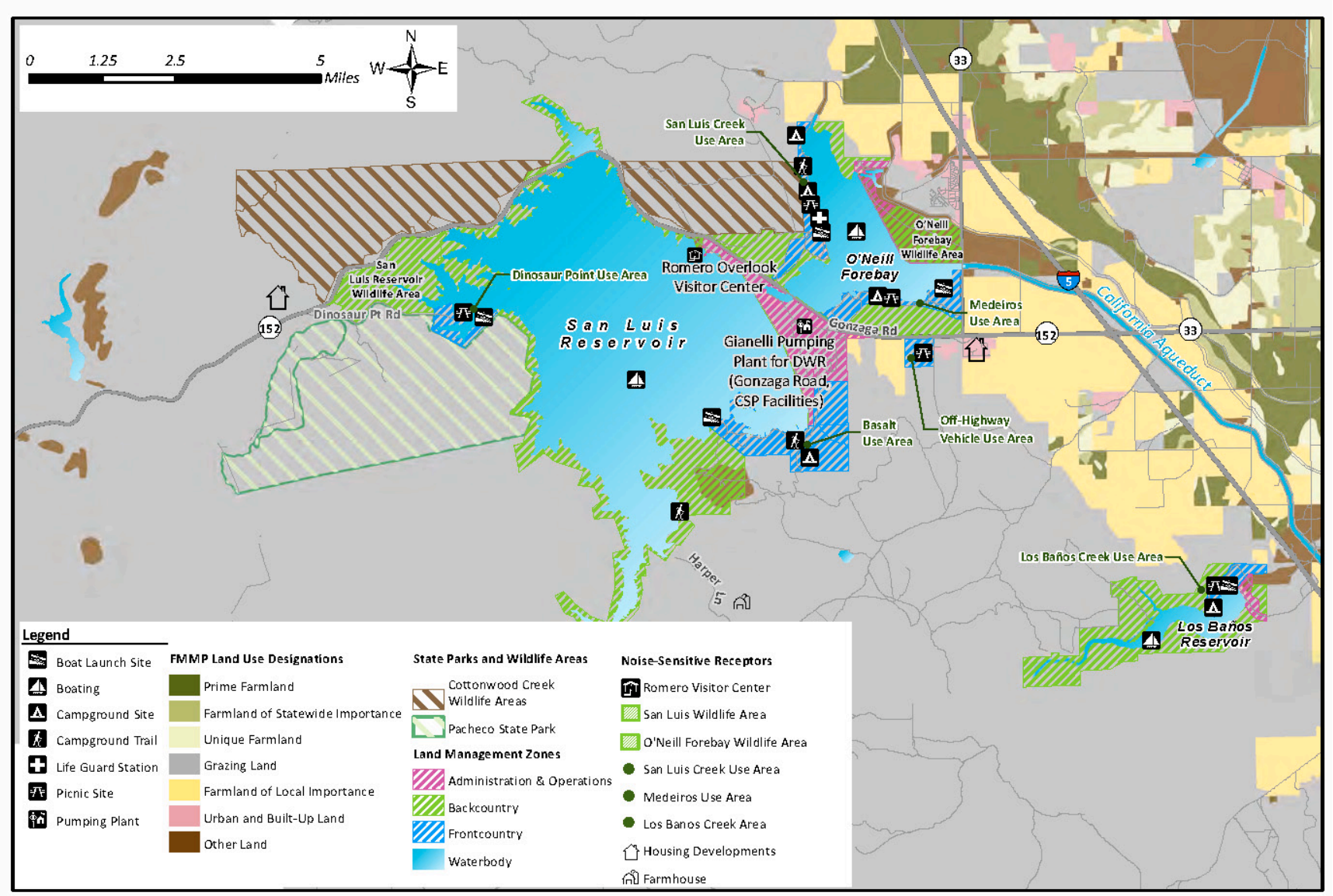
- O'Neill Forebay Wildlife Area (located northeast of the O'Neill Forebay), this area is used for hunting and passive recreation.

- San Luis Creek Use Area (located on the north side of SR 152, west of O'Neill Forebay), this area is the most developed within the project area and contains group and recreational vehicle camping, a swimming beach, boat launch site, and picnic areas.

- Medeiros Use Area (located on the south side of the O'Neill Forebay and north of SR 152) this area is predominantly used for windsurfing and camping.

- Los Banos Creek Use Area (located southeast of the San Luis Reservoir approximately one and a half miles west of Interstate 5), this area contains flood management facilities, hiking trails, camping, and picnic areas, among other recreational uses.

Land uses surrounding San Luis Reservoir consist mainly of publicly owned parkland and wildlife areas maintained and managed by the State of California. Several campgrounds and day-use picnic areas present along the shores of the reservoir and forebay are relatively close to areas where construction activities would take place under some project alternatives. The residences nearest potential construction sites at San Luis Reservoir include a cluster of homes on Dinosaur Point Road between SR 152 and Whiskey Flat Trail, and a farmhouse located approximately one mile southeast of the reservoir along Harper Lane. Northeast of O'Neill Forebay, housing tracts face SR 33, which would be a travel route for workers and haul trucks. Figure E1-2 depicts these noise-sensitive land uses around San Luis Reservoir.



Source: Reclamation and CDPR 2013.

Figure E1-2. Noise-Sensitive Land Uses Near San Luis Reservoir

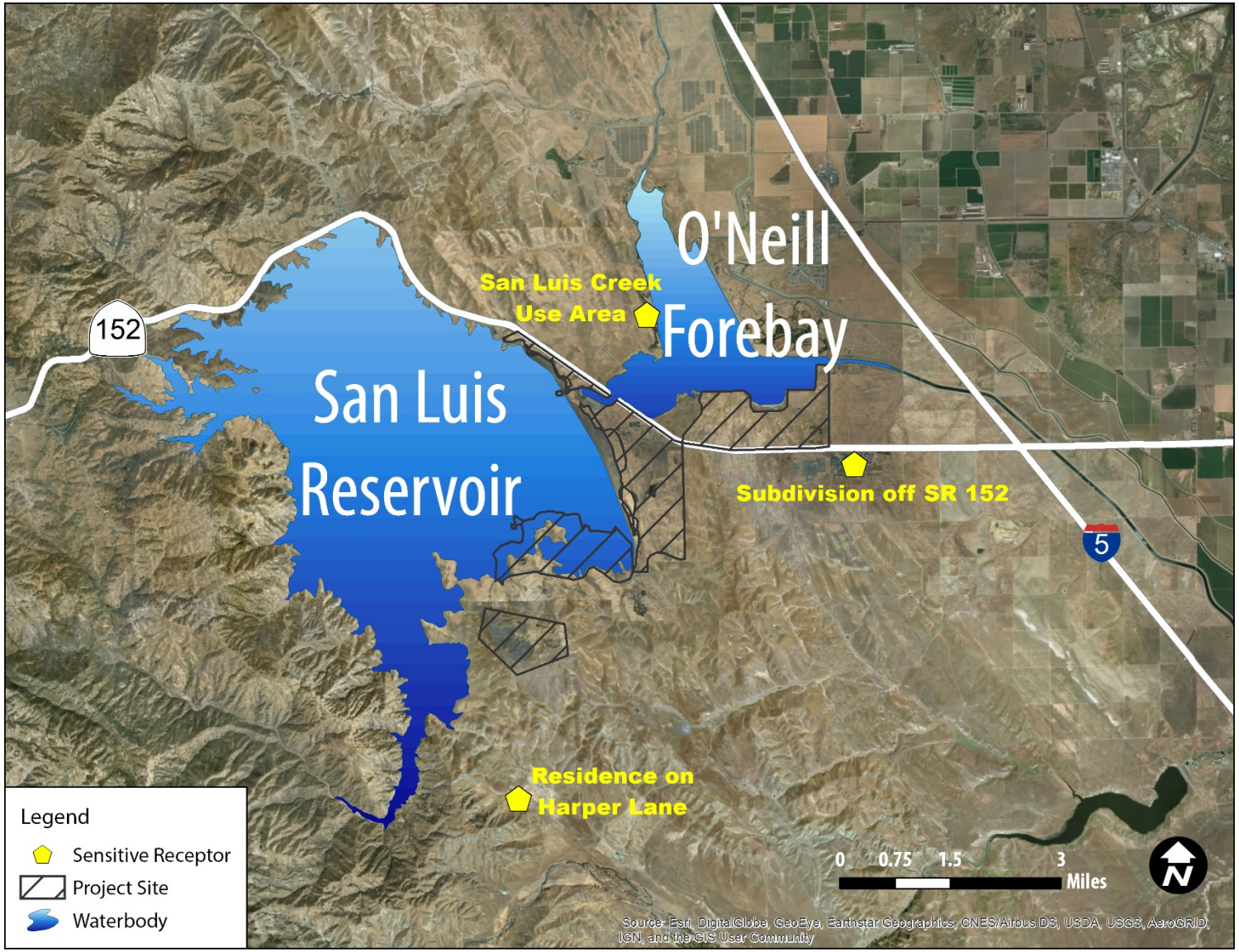


Figure E1-3. Noise Sensitive Receptors (Alternative 4)

E1.2.3 Santa Clara Valley Water District Service Area

Existing conditions are described for the Santa Teresa Water Treatment Plant (WTP), which is within the Santa Clara Valley Water District (SCVWD) Service Area.

The WTP is in developed to partly-developed areas of Santa Clara County in the City of San Jose. The noise sensitive land uses are residences, schools, churches and other noise-sensitive receivers near the WTP.

As summarized in the Noise and Vibration Affected Environment, at the SCVWD Santa Teresa WTP in San Jose, the estimated noise level is an L_{dn} of 55 dBA. This is based on noise monitoring data in the *Envision San Jose 2040 General Plan Comprehensive Update Environmental Noise Assessment* (Illingworth & Rodkin, Inc. 2010). At the closest monitored location to the water treatment plant, a L_{dn} of 56 dBA was measured 110 feet from the nearest lane of the Almaden Expressway. The Santa Teresa WTP is located in an open space area adjacent to a residential neighborhood. Figure E1-4 identifies the sensitive receptors closest to the Santa Teresa WTP.

E1.2.4 Pacheco Reservoir Region

As summarized in the Noise and Vibration Affected Environment, Pacheco Reservoir is in a largely undeveloped portion of Santa Clara County. The noise sensitive land uses are residences. At Pacheco Reservoir, the estimated noise level is an L_{dn} 40 dBA. This is based on the United States Environmental Protection agency (USEPA) *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (USEPA 1974). Pacheco Reservoir is located in an open space area adjacent to rural, grazing land use. The following are the sensitive receptors closest to Pacheco Reservoir:

- Residence on El Toro Road
- Residence on unnamed access road
- Residence off SR 152

Figure E1-5 identifies the sensitive receptors closest to the construction areas associated with the Pacheco Reservoir Expansion Alternative.

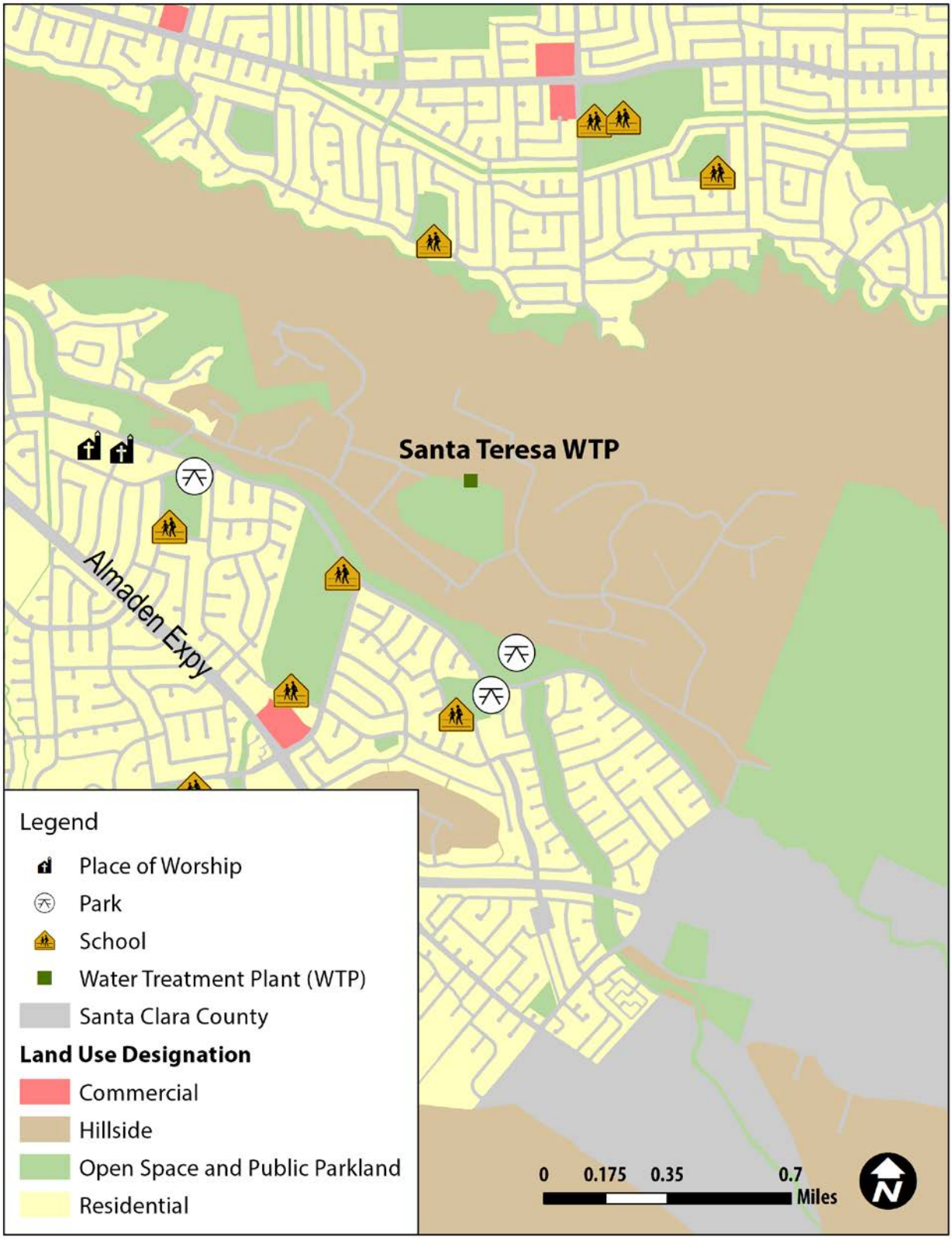


Figure E1-4. Noise-Sensitive Land Uses Near Santa Teresa WTP

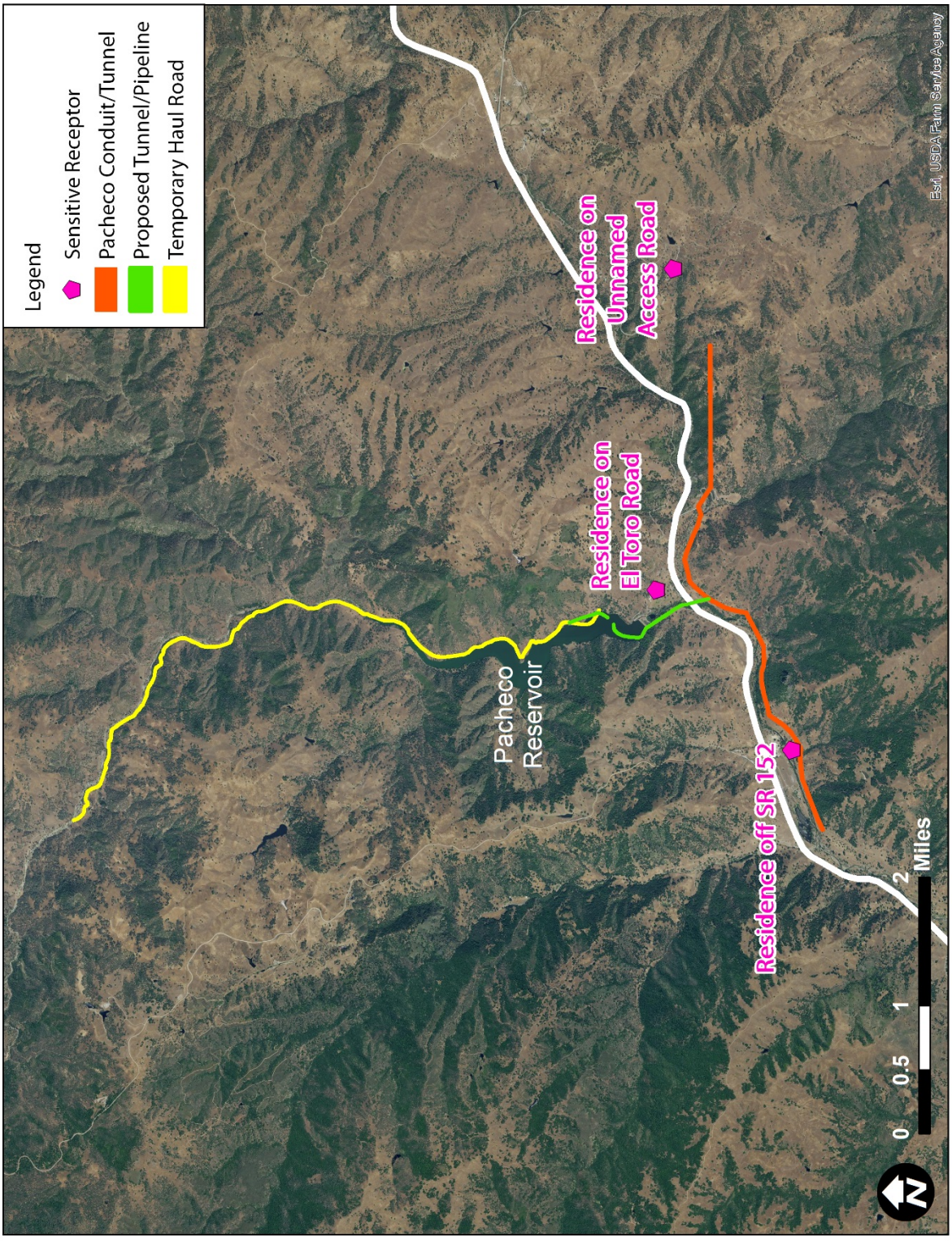


Figure E1-5. Noise Sensitive Receptors Near Pacheco Reservoir

E1.3 Assessment Methods

This section describes the approach and methods used to analyze the noise and vibration impacts related to construction and operation of the project alternatives. The focus of this analysis is on potential temporary construction and long-term impacts to local noise-sensitive receptor sites located near the proposed alternatives. Off-site vehicle trip assumptions are consistent with those used in Chapter 15, Traffic and Transportation, and construction and operational activities are consistent with those used in Chapter 10 Air Quality.

Activities with the potential for generating short-term, temporary increases in noise levels include construction activities and construction-related traffic. Long-term noise impacts could occur from operation of new facilities or new water treatment equipment. Activities that would have no, or negligible, noise impacts include the implementation of operational measures like facilitation and delivery of Central Valley Project (CVP) water using the South Bay Aqueduct.

The noise level at nearby sensitive receptors during the construction of each alternative was calculated by (1) attenuating the construction sound level for distance to the receptor and (2) logarithmically adding the attenuated construction noise source level to the ambient noise level. Construction noise was predicted using the equations and guiding principles from the FHWA Roadway Construction Noise Model (RCNM). The RCNM database provides maximum noise levels for various pieces of construction equipment at a reference distance of 50 feet. The types of construction equipment that could be used during the construction of each alternative, the percentage of time that the equipment would operate at full power (usage factor) during an hour and each piece's maximum noise level are presented in Table E1-7. The construction equipment is anticipated to operate only during weekdays and during daylight hours with the exception of Lower San Felipe Intake Alternative. For the Lower San Felipe Intake Alternative tunnel option, it was assumed that tunnel boring operations would continue 24 hours per day; therefore, 12 employees would work in the tunnel each day (assumes four workers per 8-hour shift).

Table E1-7. Construction Equipment Types and Noise Levels

Equipment Type	Usage Factor	L_{max} at 50 Feet
All Other Equipment Greater than 5 hp	50%	85
Auger Drill Rig	20%	84
Compactor (ground)	20%	83
Concrete Mixer Truck	40%	79
Concrete Pump Truck	20%	81
Concrete Saw	20%	90
Crane	16%	81

Equipment Type	Usage Factor	L_{max} at 50 Feet
Dozer	40%	82
Drill Rig Truck	20%	79
Dump Truck	40%	76
Excavator	40%	81
Flat Bed Truck	40%	74
Front End Loader	40%	79
Generator	50%	81
Grader	40%	85
Roller	20%	80
Scraper	40%	84
Slurry Trenching Machine	50%	80

Source: FHWA 2006.
hp = horsepower
L_{max} = maximum noise level measured during a monitoring period

E1.4 Significance Criteria

The significance criteria described below were developed consistent with the CEQA Guidelines (applicable to this project) to determine the significance of potential impacts on noise that could result from implementation of the project. As summarized in the Noise and Vibration Impacts section, impacts on noise would be considered potentially significant if the project would result in:

- Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies;
- Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels;
- For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels.

For the purpose of this analysis, noise levels in excess of standards established in the local general plan or noise ordinance vary for each alternative. For Alternatives 2 and 4, the Merced County Code (See Section C.3.8 in Appendix C) sets sound level limitations that no sound source should exceed the background sound level at the receiving property line by 10 dBA or more during the daytime hours (7 a.m. to 10 p.m.) and by 5 dBA or more during the nighttime hours (10 p.m. to 7 a.m.). However, the county's ordinance exempts construction activities during the daytime hours between 7 a.m. and 6 p.m. Therefore, for Alternatives 2 and 4, noise levels would be significant if they exceed the background sound level by 5 dBA or more during the nighttime hours.

For Alternative 3, Section 20.100.450 of the San Jose Municipal Code (See Section C.3.7 in Appendix C) limits hours of construction within 500 feet of a residential unit to Monday through Friday 7 a.m. to 7 p.m. In addition, the San Jose 2040 General Plan considers significant construction noise impacts to occur if a project located within 500 feet of a residential use or 200 feet of a commercial or office uses would involve substantial noise generating activities continuing for more than 12 months. Therefore, noise levels would be significant if construction took place within 500 feet of a residential unit outside of the designated hours and/or substantial noise generating activities continued for more than 12 months.

For Alternative 5, the Santa Clara County Ordinance (See Section C.3.14 in Appendix C) sets maximum permissible sound levels by receiving land use (See Table C-10). Additionally, the County has established maximum noise levels for construction activities (See Table C-11). Noise levels would be significant if they exceed the Santa Clara County maximum daytime noise level standard of 55 dBA from 7:00 a.m.- 10:00 p.m. or exceed the maximum nighttime noise level standard of 45 dBA from 10:00 p.m. – 7:00 a.m.

Project construction and operation that produce vibration levels that exceed 0.3 in/sec would be significant (Caltrans 2013b). Santa Clara County Code (Section B.11-194.2.7) prohibits operating any device that creates a vibrating effect that a) endangers or injures the safety or health of human beings or animals; or b) annoys or disturbs a person of normal sensitivities; or c) endangers or injures personal or real properties. These two criteria were utilized to evaluate the second bullet.

The significance criteria described above apply to the noise receptors that could be affected by the project. Changes in noise are determined relative to existing conditions and the No Action/No Project Alternative.

E1.5 Noise and Vibration Calculation Summary Tables

E1.5.1 Alternative 2- Lower San Felipe Intake

Table E1-8 summarizes the results of possible vibration effects from each construction phase for Alternative 2 (Tunnel Option). Detailed calculations are provided in Appendix E3.

Table E1-8. Summary of Vibration Effects from Lower San Felipe Intake Alternative (Tunnel Option)

Phase	Residence on Harper Lane (PPV, in/sec)	San Luis Creek Use Area (PPV, in/sec)	Subdivision off SR 152 (PPV, in/sec)
Mobilization	0.000060	0.000137	0.000091
Site Improvements	0.000060	0.000137	0.000091
Construct Vertical Shaft	0.000123	0.000279	0.000185
Set up TBM	0.000014	0.000031	0.000020
Tunneling and Spreading of Soils	0.000050	0.000113	0.000075
Cofferdam and TBM Out	0.000014	0.000031	0.000020
Connect to Existing Intake	0.000118	0.000267	0.000177
Fabricate Inlet	0.000118	0.000267	0.000177
Set Inlet and Flood Tunnel	0.000014	0.000031	0.000020
Construct Aeration Facility	0.000127	0.000287	0.000190
Fabricate and Set Air Tubing	0.000041	0.000092	0.000061
Final Work and Testing	0.000014	0.000031	0.000020
Demobilization	0.000050	0.000113	0.000075
Maximum	**0.000127**	**0.000287**	**0.000190**
Significant?	No	No	No

Key:
in/sec = inches per second
PPV = peak particle velocity
TBM = tunnel boring machine

Table E1-9 summarizes the daytime unmitigated L_{eq} that would occur at the nearest sensitive receptor from each construction area for Alternative 2 (Tunnel Option). Detailed calculations are provided in Appendix E2.

Table E1-9. Maximum 1-Hour Construction Phase L_{eq} (dBA) Increase Over No Action/No Project Alternative – Lower San Felipe Intake Alternative (Tunnel Option)

Construction Phase	Total from Residence on Harper Lane[1]	Increase from Residence on Harper Lane	Total from San Luis Creek Use Area[1]	Increase from San Luis Creek Use Area	Total from Residence off Dinosaur Point Road[1]	Increase from Residence off Dinosaur Point Road
Mobilization	40	0	41	1	40	0
Site Improvements	40	0	42	2	41	1
Construct Vertical Shaft	40	0	42	2	41	1
Set up TBM	40	0	41	1	40	0
Tunneling and Spreading of Soils	40	0	42	1	41	1
Cofferdam and TBM Out	40	0	41	1	40	0
Connect to Existing Intake	40	0	42	2	41	1
Fabricate Inlet	40	0	42	2	41	1

Construction Phase	Total from Residence on Harper Lane[1]	Increase from Residence on Harper Lane	Total from San Luis Creek Use Area[1]	Increase from San Luis Creek Use Area	Total from Residence off Dinosaur Point Road[1]	Increase from Residence off Dinosaur Point Road
Set Inlet and Flood Tunnel	40	0	41	1	40	0
Construct Aeration Facility	40	0	42	2	41	1
Fabricate and Set Air Tubing	40	0	41	1	40	0
Final Work and Testing	40	0	41	1	40	0
Demobilization	40	0	41	1	41	1
Maximum Construction Phase	**40**	**0**	**42**	**2**	**41**	**1**
Significant?	n/a	No	n/a	No	n/a	No

Note:

[1] Ambient (background) noise level during existing conditions equal to 40 dBA (see Table E-10 and Table E1-11 for baseline noise monitoring data).

Key:

dBA = A-weighted decibel scale

L_{eq} = equivalent energy level

TBM = tunnel boring machine

Table E1-10 summarizes the results of possible vibration effects from each construction phase for Alternative 2 (Pipeline Option). Detailed calculations are provided in Appendix E3.

Table E1-10. Summary of Vibration Effects from Lower San Felipe Intake Alternative (Pipeline Option)

Phase	Residence on Harper Lane (PPV, in/sec)	San Luis Creek Use Area (PPV, in/sec)	Subdivision off SR 152 (PPV, in/sec)
Mobilization	0.000033	0.000075	0.000050
Site Improvements	0.000074	0.000168	0.000111
Fabricate Inlet	0.000014	0.000031	0.000020
Build Cofferdam and Set Lower Inlet	0.000014	0.000031	0.000020
Lay Pipe	0.000041	0.000092	0.000061
Connect to Existing Intake	0.000014	0.000031	0.000020
Construct Aeration Facility	0.000063	0.000144	0.000095
Fabricate and Set Air Tubing	0.000014	0.000031	0.000020
Final Work and Testing	0.000014	0.000031	0.000020
Demobilization	0.000050	0.000113	0.000075
Maximum	**0.000074**	**0.000168**	**0.000111**
Significant?	No	No	No

Key: in/sec = inches per second; PPV = peak particle velocity

Table E1-11 summarizes the daytime unmitigated Leq that would occur at the nearest sensitive receptor from each construction area. Detailed calculations are provided in Appendix E2.

Table E1-11. Maximum 1-Hour Construction Phase L_{eq} (dBA) Increase Over No Action/No Project Alternative – Lower San Felipe Intake Alternative (Pipeline Option)

Construction Phase	Total from Residence on Harper Lane[1]	Increase from Residence on Harper Lane	Total from San Luis Creek Use Area[1]	Increase from San Luis Creek Use Area	Total from Residence off Dinosaur Point Road[1]	Increase from Residence off Dinosaur Point Road
Mobilization	40	0	41	1	40	1
Site Improvements	40	0	42	2	41	1
Fabricate Inlet	40	0	41	1	40	0
Build Cofferdam and Set Lower Inlet	40	0	41	1	40	0
Lay Pipe	40	0	41	1	40	0
Connect to Existing Intake	40	0	41	1	40	0
Construct Aeration Facility	40	0	42	2	41	1
Fab and Set Air Tubing	40	0	41	1	40	0
Final Work and Testing	40	0	41	1	40	0
Demobilization	40	0	41	1	40	0
Maximum Construction Phase	**40**	**0**	**42**	**2**	**41**	**1**
Significant?	n/a	No	n/a	No	n/a	No

Note: [1]Ambient (background) noise level during existing conditions equal to 40 dBA (see Table E1-10 and Table E1-11 for baseline noise monitoring data).

E1.5.2 Alternative 4- San Luis Reservoir Expansion

Table E1-12 summarizes the daytime and nighttime unmitigated Leq that would occur at the nearest sensitive receptor from each construction area for Alternative 4. Detailed calculations are provided in Appendix E2.

Table E1-12. Maximum 1-Hour Construction Phase L_{eq} (dBA) Increase Over No Action/No Project Alternative – San Luis Reservoir Expansion Alternative

Sensitive Receptor	Total Noise Level[1] (dBA)	Increased Noise Level (dBA)	Significant?
Daytime			
Residence on Harper Lane	40	0	No
San Luis Creek Use Area	49	9	No
Subdivision off SR 152	44	4	No

Sensitive Receptor	Total Noise Level[1] (dBA)	Increased Noise Level (dBA)	Significant?
Nighttime			
Residence on Harper Lane	33	3	No
San Luis Creek Use Area	48	18	Yes
Subdivision off SR 152	43	13	Yes

Note: [1] Ambient (background) noise level during existing conditions equal to 40 dBA during the day and 30 dBA at night.
Key: dBA = A-weighted decibel scale

E1.5.3 Alternative 5- Pacheco Reservoir Expansion

Table E1-13 summarizes the total daytime unmitigated L_{eq} that would occur at the nearest sensitive receptor from the construction area and whether these noise levels exceed Santa Clara County maximum noise limits.

Table E1-13. Maximum 1-Hour Construction Phase L_{eq} (dBA) and Exceedance of Maximum Noise Level Standards– Pacheco Reservoir Expansion Alternative

Sensitive Receptor	Total Noise Level[1] (dBA)	Exceed Maximum Daytime Noise Levels[2]?	Exceed Maximum Nighttime Noise Levels[3]?
Residence on El Toro Road	69	Yes	Yes
Residence on unnamed access road	44	No	No
Residence off SR 152	50	No	Yes

Note:[1] Ambient (background) noise level during existing conditions equal to 40 dBA during the day and 30 dBA at night.
[2] 55 dBA from 7:00 a.m.- 10:00 p.m.
[3] 45 dBA from 10:00 p.m.- 7:00 a.m.
Key: dBA = A-weighted decibel scale

Table E1-14 summarizes the peak day maximum PPV (in/sec) at sensitive receptors for the Pacheco Reservoir Expansion Alternative.

Table E1-14. Peak Day Maximum PPV at Sensitive Receptors

Sensitive Receptor	Maximum PPV (in/sec)	Significant?
Residence on El Toro Road	0.156440	No
Residence on unnamed access road	0.005428	No
Residence off SR 152	0.011805	No

Notes: Reference distance for blasting is 2,500 feet
Significance Threshold: 0.3 in/sec
Key: in/sec= inches per second; PPV= peak particle velocity

Table E1-15 summarizes the total daytime unmitigated L_{eq} that would occur at the nearest sensitive receptor from each construction/ staging area for Alternative 5. Table E1-16 summarizes operational noise levels at sensitive receptors. Detailed calculations are provided in Appendix E2.

Table E1-15. Maximum 1-Hour Construction Phase Leq (dBA) Increase Over No Action/No Project Alternative – Pacheco Reservoir Expansion Alternative

Sensitive Receptor	Total Noise Level[1] (dBA)	Increased Noise Level (dBA)	Significant?
Residence on El Toro Road	69	29	Yes
Residence on unnamed access road	44	4	No
Residence off SR 152	50	10	Yes

Note: [1] Ambient (background) noise level during existing conditions equal to 40 dBA during the day and 30 dBA at night.
Key: dBA = A-weighted decibel scale

Table E1-16. 1-Hour Operational Noise Level at Sensitive Receptors (dBA)- Pacheco Reservoir Expansion Alternative

Sensitive Receptor	Distance from Pumping Plant (ft)	Total Noise Level[1] (dBA)	Increased Noise Level (dBA)	Significant?
Residence on El Toro Road	2,130	54	14	Yes
Residence on unnamed access road	14,600	40	0	No
Residence off SR 152	9,120	41	1	No

Note: [1]Ambient (background) noise level during existing conditions equal to 40 dBA.
Key: dBA = A-weighted decibel scale

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San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix E2: Construction Noise Calculations

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Operational Noise Levels
Lower San Felipe Intake Alternative

Table 1. Air Compressor Noise Levels

Equipment	Compressor (air)
Usage Factor	100%
Equipment Lmax @ 3'	75
Equipment Leq(h) @ 3'	75
Distance from the Center of Operational Activity to a Receptor (ft)	800
Distance Divergence (dBA)	48.5
Atmospheric Attenuation (dBA)	0.66
8-Hour Operational Noise Level at the Receptor (dBA)	26
Daytime Unmitigated Leq (Operational Noise + Existing) (dBA)	40
Daytime Increase Over Existing (dBA)	0.16
Significant?	No

Equipment Specifications: Mattei Air Compressor, Model No. MAXIMA 160 X, 200 hp
http://cdn2.hubspot.net/hub/377802/file-703884676-pdf/docs/maxima_160kw_usa.pdf?t=1404151772000

County
Merced

Existing Noise Levels
Land Use Type Rural Residential
Background Noise (dBA) 40

Significance Level
10 dBA
(daytime increase over existing noise levels)

Construction Noise - Equipment
Lower San Felipe Intake Alternative - Tunneling Option

Table 2. 1-Hour Construction Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'	Equipment Leq(h) @ 50'	Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
Mobilization	Bulldozer	Dozer	40%	82	78	2	3	85	81
	Concrete Pumpers	Concrete Pump Truck	20%	81	74	-	-	-	-
	Concrete Trucks	Concrete Mixer Truck	40%	79	75	-	-	-	-
	Cranes	Crane	16%	81	73	-	-	-	-
	Drill Rig	Auger Drill Rig	20%	84	77	-	-	-	-
	Dump Truck	Dump Truck	40%	76	72	6	8	84	80
	Excavator	Excavator	40%	81	77	-	-	-	-
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70	3	5	79	75
	Grader	Grader	40%	85	81	-	-	-	-
	Loaders	Front End Loader	40%	79	75	2	3	82	78
	Portable Diesel Generators	Generator	50%	81	78	7	8	89	86
	Scraper	Scraper	40%	84	80	-	-	-	-
	Water Truck	Dump Truck	40%	76	72	2	3	79	75
							Mobilization Total	**92**	**89**
Site Improvements	Bulldozer	Dozer	40%	82	78	2	3	85	81
	Concrete Pumpers	Concrete Pump Truck	20%	81	74	-	-	-	-
	Concrete Trucks	Concrete Mixer Truck	40%	79	75	-	-	-	-
	Cranes	Crane	16%	81	73	-	-	-	-
	Drill Rig	Auger Drill Rig	20%	84	77	-	-	-	-
	Dump Truck	Dump Truck	40%	76	72	6	8	84	80
	Excavator	Excavator	40%	81	77	1	0	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70	3	5	79	75
	Grader	Grader	40%	85	81	2	3	88	84
	Loaders	Front End Loader	40%	79	75	2	3	82	78
	Portable Diesel Generators	Generator	50%	81	78	7	8	89	86
	Scraper	Scraper	40%	84	80	1	0	84	80
	Water Truck	Dump Truck	40%	76	72	2	3	79	75
							Site Improvements Total	**94**	**91**
Construct Vertical Shaft	Bulldozer	Dozer	40%	82	78	-	-	-	-
	Concrete Pumpers	Concrete Pump Truck	20%	81	74	2	3	84	77
	Concrete Trucks	Concrete Mixer Truck	40%	79	75	15	12	91	87
	Cranes	Crane	16%	81	73	4	6	87	79
	Drill Rig	Auger Drill Rig	20%	84	77	1	0	84	77
	Dump Truck	Dump Truck	40%	76	72	6	8	84	80
	Excavator	Excavator	40%	81	77	1	0	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70	3	5	79	75
	Grader	Grader	40%	85	81	-	-	-	-
	Loaders	Front End Loader	40%	79	75	-	-	-	-
	Portable Diesel Generators	Generator	50%	81	78	7	8	89	86
	Scraper	Scraper	40%	84	80	-	-	-	-
	Water Truck	Dump Truck	40%	76	72	-	-	-	-
							Construct Vertical Shaft Total	**95**	**91**
Set up TBM	Bulldozer	Dozer	40%	82	78	-	-	-	-
	Concrete Pumpers	Concrete Pump Truck	20%	81	74	-	-	-	-
	Concrete Trucks	Concrete Mixer Truck	40%	79	75	-	-	-	-
	Cranes	Crane	16%	81	73	4	6	87	79
	Drill Rig	Auger Drill Rig	20%	84	77	-	-	-	-
	Dump Truck	Dump Truck	40%	76	72	-	-	-	-
	Excavator	Excavator	40%	81	77	-	-	-	-
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70	3	5	79	75
	Grader	Grader	40%	85	81	-	-	-	-
	Loaders	Front End Loader	40%	79	75	-	-	-	-
	Portable Diesel Generators	Generator	50%	81	78	7	8	89	86
	Scraper	Scraper	40%	84	80	-	-	-	-
	Water Truck	Dump Truck	40%	76	72	-	-	-	-
							Set up TBM Total	**92**	**87**

Construction Noise - Equipment
Lower San Felipe Intake Alternative - Tunneling Option

Table 2. 1-Hour Construction Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'	Equipment Leq(h) @ 50'	Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
Tunneling and Spreading of Soils	Bulldozer	Dozer	40%	82	78	-	-	-	-
	Concrete Pumpers	Concrete Pump Truck	20%	81	74	-	-	-	-
	Concrete Trucks	Concrete Mixer Truck	40%	79	75	-	-	-	-
	Cranes	Crane	16%	81	73	-	-	-	-
	Drill Rig	Auger Drill Rig	20%	84	77	-	-	-	-
	Dump Truck	Dump Truck	40%	76	72	6	8	84	80
	Excavator	Excavator	40%	81	77	-	-	-	-
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70	3	5	79	75
	Grader	Grader	40%	85	81	2	3	88	84
	Loaders	Front End Loader	40%	79	75	-	-	-	-
	Portable Diesel Generators	Generator	50%	81	78	7	8	89	86
	Scraper	Scraper	40%	84	80	1	0	84	80
	Water Truck	Dump Truck	40%	76	72	2	3	79	75
							Tunneling and Spreading of Soils Total	**93**	**90**
Cofferdam and TBM Out	Bulldozer	Dozer	40%	82	78	-	-	-	-
	Concrete Pumpers	Concrete Pump Truck	20%	81	74	-	-	-	-
	Concrete Trucks	Concrete Mixer Truck	40%	79	75	-	-	-	-
	Cranes	Crane	16%	81	73	4	6	87	79
	Drill Rig	Auger Drill Rig	20%	84	77	-	-	-	-
	Dump Truck	Dump Truck	40%	76	72	-	-	-	-
	Excavator	Excavator	40%	81	77	-	-	-	-
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70	3	5	79	75
	Grader	Grader	40%	85	81	-	-	-	-
	Loaders	Front End Loader	40%	79	75	-	-	-	-
	Portable Diesel Generators	Generator	50%	81	78	7	8	89	86
	Scraper	Scraper	40%	84	80	-	-	-	-
	Water Truck	Dump Truck	40%	76	72	-	-	-	-
							Cofferdam and TBM Out Total	**92**	**87**
Connect to Existing Intake	Bulldozer	Dozer	40%	82	78	-	-	-	-
	Concrete Pumpers	Concrete Pump Truck	20%	81	74	2	3	84	77
	Concrete Trucks	Concrete Mixer Truck	40%	79	75	15	12	91	87
	Cranes	Crane	16%	81	73	-	-	-	-
	Drill Rig	Auger Drill Rig	20%	84	77	-	-	-	-
	Dump Truck	Dump Truck	40%	76	72	6	8	84	80
	Excavator	Excavator	40%	81	77	-	-	-	-
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70	3	5	79	75
	Grader	Grader	40%	85	81	-	-	-	-
	Loaders	Front End Loader	40%	79	75	-	-	-	-
	Portable Diesel Generators	Generator	50%	81	78	7	8	89	86
	Scraper	Scraper	40%	84	80	-	-	-	-
	Water Truck	Dump Truck	40%	76	72	-	-	-	-
							Connect to Existing Intake Total	**94**	**90**
Fabricate Inlet	Bulldozer	Dozer	40%	82	78	-	-	-	-
	Concrete Pumpers	Concrete Pump Truck	20%	81	74	2	3	84	77
	Concrete Trucks	Concrete Mixer Truck	40%	79	75	15	12	91	87
	Cranes	Crane	16%	81	73	4	6	87	79
	Drill Rig	Auger Drill Rig	20%	84	77	-	-	-	-
	Dump Truck	Dump Truck	40%	76	72	6	8	84	80
	Excavator	Excavator	40%	81	77	-	-	-	-
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70	3	5	79	75
	Grader	Grader	40%	85	81	-	-	-	-
	Loaders	Front End Loader	40%	79	75	-	-	-	-
	Portable Diesel Generators	Generator	50%	81	78	7	8	89	86
	Scraper	Scraper	40%	84	80	-	-	-	-
	Water Truck	Dump Truck	40%	76	72	-	-	-	-
							Fabricate Inlet Total	**95**	**91**

Construction Noise - Equipment
Lower San Felipe Intake Alternative - Tunneling Option

Table 2. 1-Hour Construction Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'	Equipment Leq(h) @ 50'	Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
Set Inlet and Flood Tunnel	Bulldozer	Dozer	40%	82	78	-	-	-	-
	Concrete Pumpers	Concrete Pump Truck	20%	81	74	-	-	-	-
	Concrete Trucks	Concrete Mixer Truck	40%	79	75	-	-	-	-
	Cranes	Crane	16%	81	73	4	6	87	79
	Drill Rig	Auger Drill Rig	20%	84	77	-	-	-	-
	Dump Truck	Dump Truck	40%	76	72	-	-	-	-
	Excavator	Excavator	40%	81	77	-	-	-	-
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70	3	5	79	75
	Grader	Grader	40%	85	81	-	-	-	-
	Loaders	Front End Loader	40%	79	75	-	-	-	-
	Portable Diesel Generators	Generator	50%	81	78	7	8	89	86
	Scraper	Scraper	40%	84	80	-	-	-	-
	Water Truck	Dump Truck	40%	76	72	-	-	-	-
							Set Inlet and Flood Tunnel Total	**92**	**87**
Construct Aeration Facility	Bulldozer	Dozer	40%	82	78	-	-	-	-
	Concrete Pumpers	Concrete Pump Truck	20%	81	74	2	3	84	77
	Concrete Trucks	Concrete Mixer Truck	40%	79	75	15	12	91	87
	Cranes	Crane	16%	81	73	4	6	87	79
	Drill Rig	Auger Drill Rig	20%	84	77	-	-	-	-
	Dump Truck	Dump Truck	40%	76	72	6	8	84	80
	Excavator	Excavator	40%	81	77	1	0	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70	3	5	79	75
	Grader	Grader	40%	85	81	2	3	88	84
	Loaders	Front End Loader	40%	79	75	2	3	82	78
	Portable Diesel Generators	Generator	50%	81	78	7	8	89	86
	Scraper	Scraper	40%	84	80	1	0	84	80
	Water Truck	Dump Truck	40%	76	72	2	3	79	75
							Construct Aeration Facility Total	**96**	**92**
Fab and Set Air Tubing	Bulldozer	Dozer	40%	82	78	-	-	-	-
	Concrete Pumpers	Concrete Pump Truck	20%	81	74	-	-	-	-
	Concrete Trucks	Concrete Mixer Truck	40%	79	75	-	-	-	-
	Cranes	Crane	16%	81	73	-	-	-	-
	Drill Rig	Auger Drill Rig	20%	84	77	-	-	-	-
	Dump Truck	Dump Truck	40%	76	72	6	8	84	80
	Excavator	Excavator	40%	81	77	-	-	-	-
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70	3	5	79	75
	Grader	Grader	40%	85	81	-	-	-	-
	Loaders	Front End Loader	40%	79	75	-	-	-	-
	Portable Diesel Generators	Generator	50%	81	78	7	8	89	86
	Scraper	Scraper	40%	84	80	-	-	-	-
	Water Truck	Dump Truck	40%	76	72	-	-	-	-
							Fab and Set Air Tubing Total	**91**	**88**
Final Work and Testing	Bulldozer	Dozer	40%	82	78	-	-	-	-
	Concrete Pumpers	Concrete Pump Truck	20%	81	74	-	-	-	-
	Concrete Trucks	Concrete Mixer Truck	40%	79	75	-	-	-	-
	Cranes	Crane	16%	81	73	-	-	-	-
	Drill Rig	Auger Drill Rig	20%	84	77	-	-	-	-
	Dump Truck	Dump Truck	40%	76	72	-	-	-	-
	Excavator	Excavator	40%	81	77	-	-	-	-
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70	3	5	79	75
	Grader	Grader	40%	85	81	-	-	-	-
	Loaders	Front End Loader	40%	79	75	-	-	-	-
	Portable Diesel Generators	Generator	50%	81	78	7	8	89	86
	Scraper	Scraper	40%	84	80	-	-	-	-
	Water Truck	Dump Truck	40%	76	72	-	-	-	-
							Final Work and Testing Total	**90**	**87**

Construction Noise - Equipment
Lower San Felipe Intake Alternative - Tunneling Option

Table 2. 1-Hour Construction Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'	Equipment Leq(h) @ 50'	Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
Demobilization	Bulldozer	Dozer	40%	82	78	-	-	-	-
	Concrete Pumpers	Concrete Pump Truck	20%	81	74	-	-	-	-
	Concrete Trucks	Concrete Mixer Truck	40%	79	75	-	-	-	-
	Cranes	Crane	16%	81	73	-	-	-	-
	Drill Rig	Auger Drill Rig	20%	84	77	-	-	-	-
	Dump Truck	Dump Truck	40%	76	72	6	8	84	80
	Excavator	Excavator	40%	81	77	-	-	-	-
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70	3	5	79	75
	Grader	Grader	40%	85	81	2	3	88	84
	Loaders	Front End Loader	40%	79	75	-	-	-	-
	Portable Diesel Generators	Generator	50%	81	78	7	8	89	86
	Scraper	Scraper	40%	84	80	-	-	-	-
	Water Truck	Dump Truck	40%	76	72	2	3	79	75
							Demobilization Total	**93**	**89**

Table 3. 1-Hour Construction Noise Level at the Receptor (dBA) - Residence on Harper Lane

Phase Type	Mobilization	Site Improvements	Construct Vertical Shaft	Set up TBM	Tunneling and Spreading of Soils	Cofferdam and TBM Out	Connect to Existing Intake	Fabricate Inlet
Distance from the Center of Construction Activity to a Receptor (ft)	16,400	16,400	16,400	16,400	16,400	16,400	16,400	16,400
1-Hour Construction Noise Level at 50 ft (dBA)	89	91	91	87	90	87	90	91
Distance Divergence (dBA)	50.3	50.3	50.3	50.3	50.3	50.3	50.3	50.3
Atmospheric Attenuation (dBA)	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50
1-Hour Construction Noise Level at the Receptor (dBA)	25	27	27	24	26	24	27	27
Daytime Unmitigated Leq (Construction Noise + Existing) (dBA)	40	40	40	40	40	40	40	40
Daytime Increase Over Existing (dBA)	0	0	0	0	0	0	0	0
Significant?	No	No	No	No	No	No	No	No

Table 4. 1-Hour Construction Noise Level at the Receptor (dBA) - San Luis Creek Use Area

Phase Type	Mobilization	Site Improvements	Construct Vertical Shaft	Set up TBM	Tunneling and Spreading of Soils	Cofferdam and TBM Out	Connect to Existing Intake	Fabricate Inlet
Distance from the Center of Construction Activity to a Receptor (ft)	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500
1-Hour Construction Noise Level at 50 ft (dBA)	89	91	91	87	90	87	90	91
Distance Divergence (dBA)	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6
Atmospheric Attenuation (dBA)	7.82	7.82	7.82	7.82	7.82	7.82	7.82	7.82
1-Hour Construction Noise Level at the Receptor (dBA)	36	37	38	34	36	34	37	37
Daytime Unmitigated Leq (Construction Noise + Existing) (dBA)	41	42	42	41	42	41	42	42
Daytime Increase Over Existing (dBA)	1	2	2	1	2	1	2	2
Significant?	No	No	No	No	No	No	No	No

Table 5. 1-Hour Construction Noise Level at the Receptor (dBA) - Subdivision off Dinosaur Point Road

Phase Type	Mobilization	Site Improvements	Construct Vertical Shaft	Set up TBM	Tunneling and Spreading of Soils	Cofferdam and TBM Out	Connect to Existing Intake	Fabricate Inlet
Distance from the Center of Construction Activity to a Receptor (ft)	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500
1-Hour Construction Noise Level at 50 ft (dBA)	89	91	91	87	90	87	90	91
Distance Divergence (dBA)	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0
Atmospheric Attenuation (dBA)	10.29	10.29	10.29	10.29	10.29	10.29	10.29	10.29
1-Hour Construction Noise Level at the Receptor (dBA)	31	33	33	29	32	29	32	32
Daytime Unmitigated Leq (Construction Noise + Existing) (dBA)	40	41	41	40	41	40	41	41
Daytime Increase Over Existing (dBA)	0	1	1	0	1	0	1	1
Significant?	No	No	No	No	No	No	No	No

Set Inlet and Flood Tunnel	Construct Aeration Facility	Fab and Set Air Tubing	Final Work and Testing	Demobilization
16,400	16,400	16,400	16,400	16,400
87	92	88	87	89
50.3	50.3	50.3	50.3	50.3
13.50	13.50	13.50	13.50	13.50
24	28	24	23	25
40	40	40	40	40
0	0	0	0	0
No	No	No	No	No

Set Inlet and Flood Tunnel	Construct Aeration Facility	Fab and Set Air Tubing	Final Work and Testing	Demobilization
9,500	9,500	9,500	9,500	9,500
87	92	88	87	89
45.6	45.6	45.6	45.6	45.6
7.82	7.82	7.82	7.82	7.82
34	39	34	33	36
41	42	41	41	41
1	2	1	1	1
No	No	No	No	No

Set Inlet and Flood Tunnel	Construct Aeration Facility	Fab and Set Air Tubing	Final Work and Testing	Demobilization
12,500	12,500	12,500	12,500	12,500
87	92	88	87	89
48.0	48.0	48.0	48.0	48.0
10.29	10.29	10.29	10.29	10.29
29	34	29	28	31
40	41	40	40	41
0	1	0	0	1
No	No	No	No	No

Construction Noise - Equipment
Lower San Felipe Intake Alternative - Tunneling Option

County		Significance Level
Merced		10 dBA
		(daytime increase over existing noise levels)

Existing Noise Levels

Land Use Type	Rural Residential
Background Noise (dBA)	40

Sensitive Receptor Locations:

Residence on Harper Lane	16,400	feet
San Luis Creek Use Area	9,500	feet
Residence off Dinosaur Point Road	12,500	feet

Construction Noise - Equipment
Lower San Felipe Intake Alternative - Pipeline Option

Table 6. 1-Hour Construction Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'	Equipment Leq(h) @ 50'
Mobilization	Bulldozer	Dozer	40%	82	78
	Concrete Pumpers	Concrete Pump Truck	20%	81	74
	Concrete Trucks	Concrete Mixer Truck	40%	79	75
	Cranes	Crane	16%	81	73
	Dump Truck	Dump Truck	40%	76	72
	Excavator	Excavator	40%	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70
	Grader	Grader	40%	85	81
	Loaders	Front End Loader	40%	79	75
	Portable Diesel Generators	Generator	50%	81	78
	Scraper	Scraper	40%	84	80
	Water Truck	Dump Truck	40%	76	72
Site Improvements	Bulldozer	Dozer	40%	82	78
	Concrete Pumpers	Concrete Pump Truck	20%	81	74
	Concrete Trucks	Concrete Mixer Truck	40%	79	75
	Cranes	Crane	16%	81	73
	Dump Truck	Dump Truck	40%	76	72
	Excavator	Excavator	40%	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70
	Grader	Grader	40%	85	81
	Loaders	Front End Loader	40%	79	75
	Portable Diesel Generators	Generator	50%	81	78
	Scraper	Scraper	40%	84	80
	Water Truck	Dump Truck	40%	76	72

Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
2	3	85	81
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
3	5	79	75
2	3	88	84
2	3	82	78
4	6	87	84
-	-	-	-
2	3	79	75
	Mobilization Total	**92**	**89**
2	3	85	81
1	0	81	74
2	3	82	78
-	-	-	-
6	8	84	80
1	0	81	77
3	5	79	75
2	3	88	84
2	3	82	78
4	6	87	84
1	0	84	80
2	3	79	75
	Site Improvements Total	**94**	**90**

Construction Noise - Equipment
Lower San Felipe Intake Alternative - Pipeline Option

Fabricate Inlet	Bulldozer	Dozer	40%	82	78
	Concrete Pumpers	Concrete Pump Truck	20%	81	74
	Concrete Trucks	Concrete Mixer Truck	40%	79	75
	Cranes	Crane	16%	81	73
	Dump Truck	Dump Truck	40%	76	72
	Excavator	Excavator	40%	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70
	Grader	Grader	40%	85	81
	Loaders	Front End Loader	40%	79	75
	Portable Diesel Generators	Generator	50%	81	78
	Scraper	Scraper	40%	84	80
	Water Truck	Dump Truck	40%	76	72
Build Cofferdam and Set Lower Inlet	Bulldozer	Dozer	40%	82	78
	Concrete Pumpers	Concrete Pump Truck	20%	81	74
	Concrete Trucks	Concrete Mixer Truck	40%	79	75
	Cranes	Crane	16%	81	73
	Dump Truck	Dump Truck	40%	76	72
	Excavator	Excavator	40%	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70
	Grader	Grader	40%	85	81
	Loaders	Front End Loader	40%	79	75
	Portable Diesel Generators	Generator	50%	81	78
	Scraper	Scraper	40%	84	80
	Water Truck	Dump Truck	40%	76	72

-	-	-	-
-	-	-	-
-	-	-	-
3	5	86	78
-	-	-	-
-	-	-	-
3	5	79	75
-	-	-	-
-	-	-	-
4	6	87	84
-	-	-	-
-	-	-	-
	Fabricate Inlet Total	**90**	**85**
-	-	-	-
-	-	-	-
-	-	-	-
3	5	86	78
-	-	-	-
-	-	-	-
3	5	79	75
-	-	-	-
-	-	-	-
4	6	87	84
-	-	-	-
-	-	-	-
Build Cofferdam and Set Lower Inlet Total		**90**	**85**

Construction Noise - Equipment
Lower San Felipe Intake Alternative - Pipeline Option

Table 6. 1-Hour Construction Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'	Equipment Leq(h) @ 50'
Lay Pipe	Bulldozer	Dozer	40%	82	78
	Concrete Pumpers	Concrete Pump Truck	20%	81	74
	Concrete Trucks	Concrete Mixer Truck	40%	79	75
	Cranes	Crane	16%	81	73
	Dump Truck	Dump Truck	40%	76	72
	Excavator	Excavator	40%	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70
	Grader	Grader	40%	85	81
	Loaders	Front End Loader	40%	79	75
	Portable Diesel Generators	Generator	50%	81	78
	Scraper	Scraper	40%	84	80
	Water Truck	Dump Truck	40%	76	72
Connect to Existing Intake	Bulldozer	Dozer	40%	82	78
	Concrete Pumpers	Concrete Pump Truck	20%	81	74
	Concrete Trucks	Concrete Mixer Truck	40%	79	75
	Cranes	Crane	16%	81	73
	Dump Truck	Dump Truck	40%	76	72
	Excavator	Excavator	40%	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70
	Grader	Grader	40%	85	81
	Loaders	Front End Loader	40%	79	75
	Portable Diesel Generators	Generator	50%	81	78
	Scraper	Scraper	40%	84	80
	Water Truck	Dump Truck	40%	76	72
Construct Aeration Facility	Bulldozer	Dozer	40%	82	78
	Concrete Pumpers	Concrete Pump Truck	20%	81	74
	Concrete Trucks	Concrete Mixer Truck	40%	79	75
	Cranes	Crane	16%	81	73
	Dump Truck	Dump Truck	40%	76	72
	Excavator	Excavator	40%	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70
	Grader	Grader	40%	85	81
	Loaders	Front End Loader	40%	79	75
	Portable Diesel Generators	Generator	50%	81	78
	Scraper	Scraper	40%	84	80
	Water Truck	Dump Truck	40%	76	72

Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
-	-	-	-
-	-	-	-
-	-	-	-
3	5	86	78
6	8	84	80
-	-	-	-
3	5	79	75
-	-	-	-
-	-	-	-
4	6	87	84
-	-	-	-
-	-	-	-
Lay Pipe Total		**91**	**86**
-	-	-	-
-	-	-	-
-	-	-	-
3	5	86	78
-	-	-	-
-	-	-	-
3	5	79	75
-	-	-	-
-	-	-	-
4	6	87	84
-	-	-	-
-	-	-	-
Connect to Existing Intake Total		**90**	**85**
-	-	-	-
1	0	81	74
2	3	82	78
3	5	86	78
6	8	84	80
1	0	81	77
3	5	79	75
2	3	88	84
2	3	82	78
4	6	87	84
1	0	84	80
2	3	79	75
Construct Aeration Facility Total		**94**	**90**

Construction Noise - Equipment
Lower San Felipe Intake Alternative - Pipeline Option

Fab and Set Air Tubing	Bulldozer	Dozer	40%	82	78
	Concrete Pumpers	Concrete Pump Truck	20%	81	74
	Concrete Trucks	Concrete Mixer Truck	40%	79	75
	Cranes	Crane	16%	81	73
	Dump Truck	Dump Truck	40%	76	72
	Excavator	Excavator	40%	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70
	Grader	Grader	40%	85	81
	Loaders	Front End Loader	40%	79	75
	Portable Diesel Generators	Generator	50%	81	78
	Scraper	Scraper	40%	84	80
	Water Truck	Dump Truck	40%	76	72

-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
3	5	79	75
-	-	-	-
-	-	-	-
4	6	87	84
-	-	-	-
-	-	-	-
Fab and Set Air Tubing Total		**88**	**85**

Construction Noise - Equipment
Lower San Felipe Intake Alternative - Pipeline Option

Table 6. 1-Hour Construction Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'	Equipment Leq(h) @ 50'
Final Work and Testing	Bulldozer	Dozer	40%	82	78
	Concrete Pumpers	Concrete Pump Truck	20%	81	74
	Concrete Trucks	Concrete Mixer Truck	40%	79	75
	Cranes	Crane	16%	81	73
	Dump Truck	Dump Truck	40%	76	72
	Excavator	Excavator	40%	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70
	Grader	Grader	40%	85	81
	Loaders	Front End Loader	40%	79	75
	Portable Diesel Generators	Generator	50%	81	78
	Scraper	Scraper	40%	84	80
	Water Truck	Dump Truck	40%	76	72
Demobilization	Bulldozer	Dozer	40%	82	78
	Concrete Pumpers	Concrete Pump Truck	20%	81	74
	Concrete Trucks	Concrete Mixer Truck	40%	79	75
	Cranes	Crane	16%	81	73
	Dump Truck	Dump Truck	40%	76	72
	Excavator	Excavator	40%	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70
	Grader	Grader	40%	85	81
	Loaders	Front End Loader	40%	79	75
	Portable Diesel Generators	Generator	50%	81	78
	Scraper	Scraper	40%	84	80
	Water Truck	Dump Truck	40%	76	72

Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
3	5	79	75
-	-	-	-
-	-	-	-
4	6	87	84
-	-	-	-
-	-	-	-
Final Work and Testing Total		**88**	**85**
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
6	8	84	80
-	-	-	-
3	5	79	75
2	3	88	84
-	-	-	-
4	6	87	84
-	-	-	-
2	3	79	75
Demobilization Total		**92**	**88**

Construction Noise - Equipment
Lower San Felipe Intake Alternative - Pipeline Option

Table 7. 1-Hour Construction Noise Level at the Receptor (dBA) - Residence on Harper Lane

Phase Type	Mobilization	Site Improvements	Fabricate Inlet	Build Cofferdam and Set Lower Inlet
Distance from the Center of Construction Activity to a Receptor (ft)	16,400	16,400	16,400	16,400
1-Hour Construction Noise Level at 50 ft (dBA)	89	90	85	85
Distance Divergence (dBA)	50.3	50.3	50.3	50.3
Atmospheric Attenuation (dBA)	13.50	13.50	13.50	13.50
1-Hour Construction Noise Level at the Receptor (dBA)	25	27	22	22
Daytime Unmitigated Leq (Construction Noise + Existing) (dBA)	40	40	40	40
Daytime Increase Over Existing (dBA)	0	0	0	0
Significant?	No	No	No	No

Table 8. 1-Hour Construction Noise Level at the Receptor (dBA) - San Luis Creek Use Area

Phase Type	Mobilization	Site Improvements	Fabricate Inlet	Build Cofferdam and Set Lower Inlet
Distance from the Center of Construction Activity to a Receptor (ft)	9,500	9,500	9,500	9,500
1-Hour Construction Noise Level at 50 ft (dBA)	89	90	85	85
Distance Divergence (dBA)	45.6	45.6	45.6	45.6
Atmospheric Attenuation (dBA)	7.82	7.82	7.82	7.82
1-Hour Construction Noise Level at the Receptor (dBA)	35	37	32	32
Daytime Unmitigated Leq (Construction Noise + Existing) (dBA)	41	42	41	41
Daytime Increase Over Existing (dBA)	1	2	1	1
Significant?	No	No	No	No

Table 9. 1-Hour Construction Noise Level at the Receptor (dBA) - Residence off Dinosaur Point Road

Phase Type	Mobilization	Site Improvements	Fabricate Inlet	Build Cofferdam and Set Lower Inlet
Distance from the Center of Construction Activity to a Receptor (ft)	12,500	12,500	12,500	12,500
1-Hour Construction Noise Level at 50 ft (dBA)	89	90	85	85
Distance Divergence (dBA)	48.0	48.0	48.0	48.0
Atmospheric Attenuation (dBA)	10.29	10.29	10.29	10.29
1-Hour Construction Noise Level at the Receptor (dBA)	31	32	27	27
Daytime Unmitigated Leq (Construction Noise + Existing) (dBA)	40	41	40	40
Daytime Increase Over Existing (dBA)	0	1	0	0
Significant?	No	No	No	No

Lay Pipe	Connect to Existing Intake	Construct Aeration Facility	Fab and Set Air Tubing	Final Work and Testing	Demobilization
16,400	16,400	16,400	16,400	16,400	16,400
86	85	90	85	85	88
50.3	50.3	50.3	50.3	50.3	50.3
13.50	13.50	13.50	13.50	13.50	13.50
23	22	26	21	21	24
40	40	40	40	40	40
0	0	0	0	0	0
No	No	No	No	No	No

Lay Pipe	Connect to Existing Intake	Construct Aeration Facility	Fab and Set Air Tubing	Final Work and Testing	Demobilization
9,500	9,500	9,500	9,500	9,500	9,500
86	85	90	85	85	88
45.6	45.6	45.6	45.6	45.6	45.6
7.82	7.82	7.82	7.82	7.82	7.82
33	32	37	31	31	35
41	41	42	41	41	41
1	1	2	1	1	1
No	No	No	No	No	No

Lay Pipe	Connect to Existing Intake	Construct Aeration Facility	Fab and Set Air Tubing	Final Work and Testing	Demobilization
12,500	12,500	12,500	12,500	12,500	12,500
86	85	90	85	85	88
48.0	48.0	48.0	48.0	48.0	48.0
10.29	10.29	10.29	10.29	10.29	10.29
28	27	32	26	26	30
40	40	41	40	40	40
0	0	1	0	0	0
No	No	No	No	No	No

Construction Noise - Equipment
Lower San Felipe Intake Alternative - Pipeline Option

County	Significance Level
Merced	10 dBA
	(daytime increase over existing noise levels)

Existing Noise Levels

Land Use Type	Rural Residential
Background Noise (dBA)	40

Sensitive Receptor Locations:

Residence on Harper Lane	16,400	feet
San Luis Creek Use Area	9,500	feet
Residence off Dinosaur Point Road	12,500	feet

Construction Noise - Traffic
Lower San Felipe Intake Alternative

Table 10. Construction Vehicles - Equivalent Noise Levels (Tunneling Option)

Type	Roadway	Existing 2016 AADT	Maximum Daily Truck Hauling Trips	Maximum Daily Worker Trips	Speed (mph)	Equivalency Factor for Heavy-Duty Vehicles	Equivalent Vehicles	Total With Project	Increase Ratio
Interstate	I-5 at junction with SR-152	32,000	138	150	55	10.4	1,585	33,585	1.05
State Route	SR-152 at junction with I-5	27,000	138	150	55	10.4	1,585	28,585	1.06
State Route	SR-152 at junction with SR-33	28,600	138	150	55	10.4	1,585	30,185	1.06
State Route	SR-33 at junction with I-5	12,900	138	150	55	10.4	1,585	14,485	1.12
Local	Fifield Rd/ Dinosaur Point Rd	137	138	200	35	19.1	2,836	2,973	**21.70**
Local	Basalt Rd	191	138	200	35	19.1	2,836	3,027	**15.85**
Note:								**Maximum**	**21.70**
Impacts would be significant if equivalent traffic volume increases by nine times (10 dBA increase).								**Significant?**	**Yes**

Table 11. Construction Vehicles - Equivalent Noise Levels (Pipeline Option)

Type	Roadway	Existing 2016 AADT	Maximum Daily Truck Hauling Trips	Maximum Daily Worker Trips	Speed (mph)	Equivalency Factor for Heavy-Duty Vehicles	Equivalent Vehicles	Total With Project	Increase Ratio
Interstate	I-5 at junction with SR-152	32,000	36	46	55	10.4	420	32,420	1.01
State Route	SR-152 at junction with I-5	27,000	36	46	55	10.4	420	27,420	1.02
State Route	SR-152 at junction with SR-33	28,600	36	46	55	10.4	420	29,020	1.01
State Route	SR-33 at junction with I-5	12,900	36	46	55	10.4	420	13,320	1.03
Local	Fifield Rd/ Dinosaur Point Rd	137	36	60	35	19.1	748	885	6.46
Local	Basalt Rd	191	36	60	35	19.1	748	939	4.91
Note:								**Maximum**	**6.46**
Impacts would be significant if equivalent traffic volume increases by nine times (10 dBA increase).								**Significant?**	**No**

Doubling of the noise source produces only a 3 dB increase, which is a barely perceptible change; therefore, there would be no audible change in traffic noise.
FHWA. 2011. Highway Traffic Noise: Analysis and Abatement Guidance.

Construction Noise - Equipment
Treatment Alternative - Santa Teresa WTP

Table 12. 1-Hour Construction Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'	Equipment Leq(h) @ 50'
Mobilization and Site Improvements	Bulldozer	Dozer	40%	82	78
	Concrete Pumpers	Concrete Pump Truck	20%	81	74
	Concrete Saw Cutters	Concrete Saw	20%	90	83
	Concrete Trucks	Concrete Mixer Truck	40%	79	75
	Cranes	Crane	16%	81	73
	Dump Truck	Dump Truck	40%	76	72
	Excavator	Excavator	40%	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70
	Loaders	Front End Loader	40%	79	75
	Vibrating Plate	Compactor (ground)	20%	83	76
	Water Truck	Dump Truck	40%	76	72
	Wheel Trencher	Slurry Trenching Machine	50%	80	77
Retrofit Existing Facilities	Bulldozer	Dozer	40%	82	78
	Concrete Pumpers	Concrete Pump Truck	20%	81	74
	Concrete Saw Cutters	Concrete Saw	20%	90	83
	Concrete Trucks	Concrete Mixer Truck	40%	79	75
	Cranes	Crane	16%	81	73
	Dump Truck	Dump Truck	40%	76	72
	Excavator	Excavator	40%	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70
	Loaders	Front End Loader	40%	79	75
	Vibrating Plate	Compactor (ground)	20%	83	76
	Water Truck	Dump Truck	40%	76	72
	Wheel Trencher	Slurry Trenching Machine	50%	80	77
Starting and Testing	Bulldozer	Dozer	40%	82	78
	Concrete Pumpers	Concrete Pump Truck	20%	81	74
	Concrete Saw Cutters	Concrete Saw	20%	90	83
	Concrete Trucks	Concrete Mixer Truck	40%	79	75
	Cranes	Crane	16%	81	73
	Dump Truck	Dump Truck	40%	76	72
	Excavator	Excavator	40%	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70
	Loaders	Front End Loader	40%	79	75
	Vibrating Plate	Compactor (ground)	20%	83	76
	Water Truck	Dump Truck	40%	76	72
	Wheel Trencher	Slurry Trenching Machine	50%	80	77
Demobilization	Bulldozer	Dozer	40%	82	78
	Concrete Pumpers	Concrete Pump Truck	20%	81	74
	Concrete Saw Cutters	Concrete Saw	20%	90	83
	Concrete Trucks	Concrete Mixer Truck	40%	79	75
	Cranes	Crane	16%	81	73
	Dump Truck	Dump Truck	40%	76	72
	Excavator	Excavator	40%	81	77
	Flatbed Trucks (on site)	Flat Bed Truck	40%	74	70
	Loaders	Front End Loader	40%	79	75
	Vibrating Plate	Compactor (ground)	20%	83	76
	Water Truck	Dump Truck	40%	76	72
	Wheel Trencher	Slurry Trenching Machine	50%	80	77

Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
1	0	82	78
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
2	3	79	75
-	-	-	-
4	6	80	76
1	0	79	75
-	-	-	-
2	3	79	75
-	-	-	-
Mobilization and Site Improvements Total		**87**	**83**
-	-	-	-
2	3	84	77
2	3	93	86
2	3	82	78
2	3	84	76
2	3	79	75
1	0	81	77
4	6	80	76
1	0	79	75
2	3	86	79
2	3	79	75
2	3	83	80
Retrofit Existing Facilities Total		**96**	**90**
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
Starting and Testing Total		**n/a**	**n/a**
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
2	3	79	75
-	-	-	-
4	6	80	76
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
Demobilization Total		**83**	**79**

Construction Noise - Equipment
Treatment Alternative - Santa Teresa WTP

Table 13. 1-Hour Construction Noise Level at the Receptor (dBA)

Phase Type	Mobilization and Site Improvements	Retrofit Existing Facilities	Starting and Testing	Demobilization
Distance from the Center of Construction Activity to a Receptor (ft)	520	520	520	520
1-Hour Construction Noise Level at 50 ft (dBA)	83	90	n/a	79
Distance Divergence (dBA)	20.3	20.3	20.3	20.3
Atmospheric Attenuation (dBA)	0.43	0.43	0.43	0.43
1-Hour Construction Noise Level at the Receptor (dBA)	62	69	n/a	58
Daytime Unmitigated Leq (Construction Noise + Existing) (dBA)	63	69	n/a	60
Daytime Increase Over Existing (dBA)	8	14	n/a	5
Significant?	No	Yes	n/a	No

County
Santa Clara

Significance Level
10 dBA
(daytime increase over existing noise levels)

Existing Noise Levels
Land Use Type Normal Suburban Residential
Background Noise (dBA) 55

Sensitive Receptor:
Residence located at 19500 Graystone Ln, San Jose, CA
The Santa Teresa WTP is surrounded by residences on all sides

Construction Noise - Traffic
Treatment Alternative

Table 14. Construction Vehicles - Equivalent Noise Levels

Type	Roadway	Existing 2016 AADT	Maximum Daily Truck Hauling Trips	Maximum Daily Worker Trips	Average Speed	Equivalency Factor for Heavy-Duty Vehicles	Equivalent Vehicles	Total With Project	Increase Ratio
Interstate	I-880 at junction with US-101	182,000	160	183	35	19.1	3,246	185,246	1.02
Interstate	I-680 at junction with Berryessa Road	177,000	160	183	65	7.9	1,450	178,450	1.01
State Route	SR-237 at junction with I-880	141,000	160	183	35	19.1	3,246	144,246	1.02
State Route	SR-87 at junction with I-280	169,000	160	183	35	19.1	3,246	172,246	1.02
State Route	SR-85 at junction with US-101	55,000	160	183	35	19.1	3,246	58,246	1.06
State Route	US-101 at junction with SR-85	150,000	160	183	40	15.1	2,605	152,605	1.02
Note:								**Maximum**	**1.06**
Impacts would be significant if equivalent traffic volume increases by nine times (10 dBA increase).								**Significant?**	**No**

Doubling of the noise source produces only a 3 dB increase, which is a barely perceptible change; therefore, there would be no audible change in traffic noise.
FHWA. 2011. Highway Traffic Noise: Analysis and Abatement Guidance.

Construction Noise - Equipment
Enlarged Reservoir Alternative

Table 15. 1-Hour Daytime Construction Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'
Peak Day	Excavator	Excavator	40%	81
	Bulldozer	Dozer	40%	82
	Crane/ Lift	Crane	16%	81
	Compactor	Compactor (ground)	20%	83
	Grader	Grader	40%	85
	Scraper	Scraper	40%	84
	Loader	Dozer	40%	82
	Dump Truck	Dump Truck	40%	76
	Water Truck	Tractor	40%	84
	Blasting	Blasting	1%	94

Table 16. 1-Hour Nighttime Construction Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'
Peak Day	Excavator	Excavator	40%	81
	Bulldozer	Dozer	40%	82
	Crane/ Lift	Crane	16%	81
	Compactor	Compactor (ground)	20%	83
	Grader	Grader	40%	85
	Scraper	Scraper	40%	84
	Loader	Dozer	40%	82
	Dump Truck	Dump Truck	40%	76
	Water Truck	Tractor	40%	84

Equipment Leq(h) @ 50'	Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
77	3	5	86	82
78	4	6	88	84
73	5	7	88	80
76	5	7	90	83
81	2	3	88	84
80	2	3	87	83
78	5	7	89	85
72	13	11	87	83
80	5	7	91	87
74	4	6	100	80
		Peak Day Total	**98**	**94**

Equipment Leq(h) @ 50'	Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
77	3	5	86	82
78	4	6	88	84
73	5	7	88	80
76	5	7	90	83
81	2	3	88	84
80	2	3	87	83
78	5	7	89	85
72	13	11	87	83
80	5	7	91	87
		Peak Day Total	**98**	**93**

Table 17. 1-Hour Daytime Construction Noise Level at the Receptor (dBA)

Location	Residence on Harper Lane	San Luis Creek Use Area	Subdivision off SR 152
Distance from the Center of Construction Activity to a Receptor (ft)	16,400	5,600	8,250
1-Hour Construction Noise Level at 50 ft (dBA)	94	94	94
Distance Divergence (dBA)	50.3	41.0	44.3
Atmospheric Attenuation (dBA)	13.50	4.61	6.79
1-Hour Construction Noise Level at the Receptor (dBA)	30	48	42
Daytime Unmitigated Leq (Construction Noise + Existing) (dBA)	40	49	44
Daytime Increase Over Existing (dBA)	0	9	4
Significant?	No	No	No

Table 18. 1-Hour Nighttime Construction Noise Level at the Receptor (dBA)

Location	Residence on Harper Lane	San Luis Creek Use Area	Subdivision off SR 152
Distance from the Center of Construction Activity to a Receptor (ft)	16,400	5,600	8,250
1-Hour Construction Noise Level at 50 ft (dBA)	93	93	93
Distance Divergence (dBA)	50.3	41.0	44.3
Atmospheric Attenuation (dBA)	13.50	4.61	6.79
1-Hour Construction Noise Level at the Receptor (dBA)	30	48	42
Nighttime Unmitigated Leq (Construction Noise + Existing) (dBA)	33	48	43
Nighttime Increase Over Existing (dBA)	3	18	13
Significant?	No	Yes	Yes

County		Significance Level	
Merced	Daytime	10	dBA
	Nighttime	5	dBA

Existing Noise Levels

Land Use Type	Rural Residential
Daytime Background Noise (dBA)	40
Nightime Background Noise (dBA)	30

Sensitive Receptor Locations:

San Luis Creek Use Area	5,600	feet
Residence on Harper Lane	16,400	feet
Subdivision off SR 152	8,250	feet

Construction Noise - Traffic
Enlarged Reservoir Alternative

Table 19. Construction Vehicles - Equivalent Noise Levels

Type	Roadway	Existing 2016 AADT	Maximum Daily Truck Hauling Trips	Maximum Daily Worker Trips	Speed (mph)	Equivalency Factor for Heavy-Duty Vehicles	Equivalent Vehicles	Total With Project	Increase Ratio
Interstate	I-5 at junction with SR-152	32,000	160	108	55	10.4	1,772	33,772	1.06
US	SR-152 at junction with I-5	27,000	160	108	55	10.4	1,772	28,772	1.07
State Route	SR-152 at junction with SR-33	28,600	320	217	55	10.4	3,545	32,145	1.12
State Route	SR-33 at junction with I-5	12,900	160	108	55	10.4	1,772	14,672	1.14
Local	Fifield Rd/ Dinosaur Point Rd	137	480	434	35	19.1	9,602	9,739	**71.09**
Local	Basalt Rd	191	480	434	35	19.1	9,602	9,793	**51.27**
Note:								**Maximum**	**71.09**
Impacts would be significant if equivalent traffic volume increases by nine times (10 dBA increase).								**Significant?**	**Yes**

Doubling of the noise source produces only a 3 dB increase, which is a barely perceptible change; therefore, there would be no audible change in traffic noise.
FHWA. 2011. Highway Traffic Noise: Analysis and Abatement Guidance.

Construction Noise - Equipment
Pacheco Reservoir Expansion Alternative

Table 20. 1-Hour Construction Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'
Peak Day	Bulldozer	Dozer	40%	82
	Loader	Front End Loader	40%	79
	Grader	Grader	40%	85
	Backhoe	Backhoe	40%	78
	Excavator	Excavator	40%	81
	On Highway Truck	Flat Bed Truck	40%	74
	Off Highway Truck	Dump Truck	40%	76
	Scraper	Scraper	40%	84
	Smooth Drum Compactor	Compactor (ground)	20%	83
	Large Compactor	Roller	20%	80
	Grapple	Grapple (on backhoe)	40%	87
	Conveyor	Conveyor	100%	90
	Grout Mixer	Drum Mixer	50%	80
	Trailer Mounted Concrete Pump	Concrete Pump Truck	20%	81
	Concrete Vibrator	Vibrating Hopper	50%	87
	Pumps	Pumps	50%	81
	Grout/Shotcrete Plants	Concrete Batch Plant	15%	83
	Generator	Generator	50%	81
	Diesel Compressor	Compressor (air)	40%	78
	Diesel Welder	Welder/Torch	40%	74
	Sand Blasting Pot	Sand Blasting (Single Nozzl	20%	96
	Pressure Washer	Pneumatic Tools	50%	85
	Crane	Crane	16%	81
	Man Lift	Man Lift	20%	75
	Auger Drill Rig	Auger Drill Rig	20%	84
	Jackhammer	Jackhammer	20%	89
	Hydraulic Hoe Ram	Mounted Impact Hammer (h	20%	90
	Drill Rig Truck	Drill Rig Truck	20%	79
	Ventilation Fan	Ventilation Fan	100%	79
	Pickup Trucks	Pickup Truck	40%	75
	Blasting	Blasting	1%	94

Equipment Leq(h) @ 50'	Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
78	6	8	90	86
75	9	10	89	85
81	2	3	88	84
74	6	8	86	82
77	1	0	81	77
70	6	8	82	78
72	17	12	88	84
80	1	0	84	80
76	1	0	83	76
73	6	8	88	81
83	1	0	87	83
90	1	0	90	90
77	1	0	80	77
74	2	3	84	77
84	1	0	87	84
78	3	5	86	83
75	2	3	86	78
78	4	6	87	84
74	4	6	84	80
70	5	7	81	77
89	2	3	99	92
82	2		85	82
73	7	8	89	81
68	2	3	78	71
77	4	6	90	83
82	1	0	89	82
83	1	0	90	83
72	5	7	86	79
79	1	0	79	79
71	23	14	89	85
74	1	0	94	74
		Peak Day Total	**104**	**98**

Table 21. 1-Hour Construction Noise Level at the Receptor (dBA)

Location	Residence on El Toro Road	Residence on unnamed access road	Residence off SR 152
Distance from the Center of Construction Activity to a Receptor (ft)	1,250	11,750	7,000
1-Hour Construction Noise Level at 50 ft (dBA)	98	98	98
Distance Divergence (dBA)	28.0	47.4	42.9
Atmospheric Attenuation (dBA)	1.03	9.67	5.76
1-Hour Construction Noise Level at the Receptor (dBA)	69	41	50
Unmitigated Leq (Construction Noise + Existing) (dBA)	69	44	50
Increase Over Existing (dBA)	29	4	10
Significant?	Yes	No	Yes

County		Significance Level	
Santa Clara	Daytime	10	dBA
	Nighttime	5	dBA

Existing Noise Levels

Land Use Type	Rural Residential
Daytime Background Noise (dBA)	40
Nighttime Background Noise (dBA)	30

Sensitive Receptor Locations:

Residence on El Toro Road	1,250	feet
Residence on unnamed access road	11,750	feet
Residence off SR 152	7,000	feet

Operational Noise
Pacheco Reservoir Expansion Alternative

Table 22. 1-Hour Operational Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'	Equipment Leq(h) @ 50'	Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
Peak Day	Pump station	Pumps	50%	81	78	11	10	91	88
							Peak Day Total	**91**	**88**

Table 23. 1-Hour Operational Noise Level at the Receptor (dBA)

Location	Residence on El Toro Road	Residence on unnamed access road	Residence off SR 152
Distance from the Center of Proposed Pump station to a Receptor (ft)	2,130	14,600	9,120
1-Hour Operational Noise Level at 50 ft (dBA)	88	88	88
Distance Divergence (dBA)	32.6	49.3	45.2
Atmospheric Attenuation (dBA)	1.75	12.02	7.51
1-Hour Operational Noise Level at the Receptor (dBA)	54	27	36
Unmitigated Leq (Construction Noise + Existing) (dBA)	54	40	41
Increase Over Existing (dBA)	14	0	1
Significant?	Yes	No	No

County
Merced

Significance Level
10 dBA *(daytime increase over existing noise levels)*
5 dBA *(nighttime increase over existing noise levels)*

Existing Noise Levels
Land Use Type Rural Residential
Daytime Background Noise (dBA) 40
Nighttime Background Noise (dBA) 30
Sensitive Receptor Locations:

Residence on El Toro Road 2,130 feet
Residence on unnamed access road 14,600 feet
Residence off SR 152 9,120 feet

Construction Noise - Traffic
Pacheco Reservoir Expansion Alternative

Table 24. Construction Vehicles - Equivalent Noise Levels

Type	Roadway	Existing 2016 AADT	Maximum Daily Truck Hauling Trips	Maximum Daily Worker Trips	Speed (mph)	Equivalency Factor for Heavy-Duty Vehicles	Equivalent Vehicles	Total With Project	Increase Ratio
Interstate	I-5 at junction with SR-152	32,000	430	950	55	10.4	5,422	37,422	1.17
State Route	SR-152 at junction with I-5	27,000	430	950	55	10.4	5,422	32,422	1.20
State Route	SR-152 at junction with SR-33	28,600	430	950	55	10.4	5,422	34,022	1.19
State Route	SR-33 at junction with I-5	12,900	430	950	55	10.4	5,422	18,322	1.42
Note:								**Maximum**	**1.42**
Impacts would be significant if equivalent traffic volume increases by nine times (10 dBA increase).								**Significant?**	**No**

Doubling of the noise source produces only a 3 dB increase, which is a barely perceptible change; therefore, there would be no audible change in traffic noise.
FHWA. 2011. Highway Traffic Noise: Analysis and Abatement Guidance.

Table 25. Atmospheric Attenuation

Assumptions	Merced	Santa Clara
Ambient pressure (kPa)	101.3	101.3
Temperature (F)	68	68
Relative humidity (%)	90	90
Frequency of noise source (Hz)	500	500
Air Attenuation Coefficient (α, dB/km)	2.7	2.7
(dB/ft)	0.0008	0.0008

Conversion:
0.3048 m/ft
1000 m/km

$A_{air} = \alpha d$

Weather in Merced County
Average temperature 62.9 °F
Average relative humidity 79.48 %

Weather in Santa Clara County
Average temperature 59.7 °F
Average relative humidity 81.51 %

Reference:
Harris, Cyril M. 1998. Handbook of Acoustical Measurements and Noise Control. 3rd ed. - Chapter 3 Calculation of Attenuation
http://www.usa.com/santa-clara-county-ca-weather.htm; http://www.usa.com/merced-county-ca-weather.htm

Table 26. Equipment noise emissions and acoustical usage factors database

Equipment Description	Impact Device?	Acoustical Use Factor	Spec 721.560 Lmax @ 50ft (dBA, slow)	Actual Measured Lmax @ 50 ft (dBA, slow)
All Other Equipment > 5 hp	No	50%	85	N/A
Auger Drill Rig	No	20%	85	84
Backhoe	No	40%	80	78
Bar Bender	No	20%	80	N/A
Blasting	Yes	1%	94	N/A
Boring Jack Power Unit	No	50%	80	83
Chain Saw	No	20%	85	84
Clam Shovel (dropping)	Yes	20%	93	87
Compactor (ground)	No	20%	80	83
Compressor (air)	No	40%	80	78
Concrete Batch Plant	No	15%	83	N/A
Concrete Mixer Truck	No	40%	85	79
Concrete Pump Truck	No	20%	82	81
Concrete Saw	No	20%	90	90
Conveyor	No	100%	90	90
Crane	No	16%	85	81
Dozer	No	40%	85	82
Drill Rig Truck	No	20%	84	79
Drum Mixer	No	50%	80	80
Dump Truck	No	40%	84	76
Excavator	No	40%	85	81
Flat Bed Truck	No	40%	84	74
Front End Loader	No	40%	80	79
Generator	No	50%	82	81
Generator (<25KVA, VMS signs)	No	50%	70	73
Gradall	No	40%	85	83
Grader	No	40%	85	N/A
Grapple (on backhoe)	No	40%	85	87
Horizontal Boring Hydr. Jack	No	25%	80	82
Hydra Break Ram	Yes	10%	90	N/A
Impact Pile Driver	Yes	20%	95	101
Jackhammer	Yes	20%	85	89
Man Lift	No	20%	85	75
Mounted Impact Hammer (hoe ram)	Yes	20%	90	90
Pavement Scarifier	No	20%	85	90
Paver	No	50%	85	77
Pickup Truck	No	40%	55	75
Pneumatic Tools	No	50%	85	85
Pumps	No	50%	77	81
Refrigerator Unit	No	100%	82	73
Rivit Buster/Chipping Gun	Yes	20%	85	79
Rock Drill	No	20%	85	81
Roller	No	20%	85	80
Sand Blasting (Single Nozzle)	No	20%	85	96
Scraper	No	40%	85	84
Shears (on backhoe)	No	40%	85	96
Slurry Plant	No	100%	78	78
Slurry Trenching Machine	No	50%	82	80
Soil Mix Drill Rig	No	50%	80	N/A
Tractor	No	40%	84	N/A
Vacuum Excavator (vac-truck)	No	40%	85	85
Vacuum Street Sweeper	No	10%	80	82
Ventilation Fan	No	100%	85	79
Vibrating Hopper	No	50%	85	87
Vibratory Concrete Mixer	No	20%	80	80
Vibratory Pile Driver	No	20%	95	101
Warning Horn	No	5%	85	83
Welder/Torch	No	40%	73	74

Usage factor is the percentage of time during a construction noise operation that a piece of construction equipment is operating at full power. In case of construction blasting, the equipment gives a very short duration blast and can be quantified by using a 1% usage factor in the RCNM to allow for some prediction.

FHWA. RCNM User's Guide - Table 1. CA/T equipment noise emissions and acoustical usage factors database.

Table 27. Average Ambient Noise Levels for Various Land Uses

Land Use Description	Average Ldn (dBA)	Daytime Leq (dBA)	Nighttime Leq (dBA)
Wilderness	35	35	25
Rural Residential	40	40	30
Quiet Suburban Residential	50	50	40
Normal Suburban Residential	55	55	45
Urban Residential	60	60	50
Noisy Urban Residential	65	65	55
Very Noisy Urban Residential	70	70	60

Source: U.S. EPA, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974.

Table 28. Noise Reductions from Mitigation Measures

Mitigation Type	Reduction (dBA)
Noise barrier or other obstruction just barely breaks the line-of-sight between the noise source and the receptor	3
Noise source completely enclosed or completely shielded with solid barrier located close to the source	8
Enclosure and/or barrier with some gaps	5
Noise source completely enclosed and completely shielded with a solid barrier located close to the source	10
Noise source enclosed or shielded with heavy vinyl noise curtain material	5

Source: FHWA. RCNM User's Guide Appendix A Best Practices for Calculating Estimated Shielding for Use in the RCNM

San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix E3: Construction Vibration Calculations

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Construction Vibration - Equipment
Lower San Felipe Intake Alternative - Tunneling Option

Table 29. Summary of Results

	PPV (in/sec)		
Phase	**Residence on Harper Lane**	**San Luis Creek Use Area**	**Residence off Dinosaur Point Road**
Mobilization	0.000060	0.000137	0.000091
Site Improvements	0.000060	0.000137	0.000091
Construct Vertical Shaft	0.000123	0.000279	0.000185
Set up TBM	0.000014	0.000031	0.000020
Tunneling and Spreading of Soils	0.000050	0.000113	0.000075
Cofferdam and TBM Out	0.000014	0.000031	0.000020
Connect to Existing Intake	0.000118	0.000267	0.000177
Fabricate Inlet	0.000118	0.000267	0.000177
Set Inlet and Flood Tunnel	0.000014	0.000031	0.000020
Construct Aeration Facility	0.000127	0.000287	0.000190
Fab and Set Air Tubing	0.000041	0.000092	0.000061
Final Work and Testing	0.000014	0.000031	0.000020
Demobilization	0.000050	0.000113	0.000075
Maximum	**0.000127**	**0.000287**	**0.000190**
Significant?	No	No	No

Construction Vibration - Equipment
Lower San Felipe Intake Alternative - Tunneling Option

Table 30. Construction Vibration

Phase	Equipment Description	Equivalent Equipment Types	Distance (ft): / Number of Equipment	At Source 25 / PPV (in/sec)	Residence on Harper Lane 16,400 / PPV (in/sec)	Creek Use Area 9,500 / PPV (in/sec)	Dinosaur Point Road 12,500 / PPV (in/sec)
Mobilization	Bulldozer	Large Bulldozer	2	0.178	0.000011	0.000024	0.000016
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	-	n/a	n/a	n/a	n/a
	Drill Rig	Caisson Drilling	-	-	-	-	-
	Dump Truck	Loaded Trucks	6	0.456	0.000027	0.000062	0.000041
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	-	n/a	n/a	n/a	n/a
	Loaders	n/a	2	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	7	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
			Mobilization Total	**N/A**	**0.000060**	**0.000137**	**0.000091**
Site Improvements	Bulldozer	Large Bulldozer	2	0.178	0.000011	0.000024	0.000016
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	-	n/a	n/a	n/a	n/a
	Drill Rig	Caisson Drilling	-	-	-	-	-
	Dump Truck	Loaded Trucks	6	0.456	0.000027	0.000062	0.000041
	Excavator	n/a	1	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	2	n/a	n/a	n/a	n/a
	Loaders	n/a	2	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	7	n/a	n/a	n/a	n/a
	Scraper	n/a	1	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
			Site Improvements Total	**N/A**	**0.000060**	**0.000137**	**0.000091**

Construction Vibration - Equipment
Lower San Felipe Intake Alternative - Tunneling Option

Table 30. Construction Vibration

Phase	Equipment Description	Equivalent Equipment Types	Distance (ft): / Number of Equipment	At Source 25 / PPV (in/sec)	Residence on Harper Lane 16,400 / PPV (in/sec)	Creek Use Area 9,500 / PPV (in/sec)	Dinosaur Point Road 12,500 / PPV (in/sec)
Construct Vertical Shaft	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
	Concrete Trucks	Loaded Trucks	15	1.140	0.000068	0.000154	0.000102
	Cranes	n/a	4	n/a	n/a	n/a	n/a
	Drill Rig	Caisson Drilling	1	0.089	0.000005	0.000012	0.000008
	Dump Truck	Loaded Trucks	6	0.456	0.000027	0.000062	0.000041
	Excavator	n/a	1	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	-	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	7	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	-	-	-	-	-
		Construct Vertical Shaft Total		**N/A**	**0.000123**	**0.000279**	**0.000185**
Set up TBM	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	4	n/a	n/a	n/a	n/a
	Drill Rig	Caisson Drilling	-	-	-	-	-
	Dump Truck	Loaded Trucks	-	-	-	-	-
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	-	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	7	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	-	-	-	-	-
		Set up TBM Total		**N/A**	**0.000014**	**0.000031**	**0.000020**
Tunneling and Spreading of Soils	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	-	n/a	n/a	n/a	n/a
	Drill Rig	Caisson Drilling	-	-	-	-	-
	Dump Truck	Loaded Trucks	6	0.456	0.000027	0.000062	0.000041
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	2	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	7	n/a	n/a	n/a	n/a
	Scraper	n/a	1	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
		Tunneling and Spreading of Soils Total		**N/A**	**0.000050**	**0.000113**	**0.000075**
Cofferdam and TBM Out	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	4	n/a	n/a	n/a	n/a
	Drill Rig	Caisson Drilling	-	-	-	-	-
	Dump Truck	Loaded Trucks	-	-	-	-	-
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	-	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	7	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	-	-	-	-	-
		Cofferdam and TBM Out Total		**N/A**	**0.000014**	**0.000031**	**0.000020**

Construction Vibration - Equipment
Lower San Felipe Intake Alternative - Tunneling Option

Table 30. Construction Vibration

Phase	Equipment Description	Equivalent Equipment Types	Distance (ft): / Number of Equipment	At Source 25 / PPV (in/sec)	Residence on Harper Lane 16,400 / PPV (in/sec)	Creek Use Area 9,500 / PPV (in/sec)	Dinosaur Point Road 12,500 / PPV (in/sec)
Connect to Existing Intake	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
	Concrete Trucks	Loaded Trucks	15	1.140	0.000068	0.000154	0.000102
	Cranes	n/a	-	n/a	n/a	n/a	n/a
	Drill Rig	Caisson Drilling	-	-	-	-	-
	Dump Truck	Loaded Trucks	6	0.456	0.000027	0.000062	0.000041
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	-	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	7	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	-	-	-	-	-
			Connect to Existing Intake Total	**N/A**	**0.000118**	**0.000267**	**0.000177**
Fabricate Inlet	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
	Concrete Trucks	Loaded Trucks	15	1.140	0.000068	0.000154	0.000102
	Cranes	n/a	4	n/a	n/a	n/a	n/a
	Drill Rig	Caisson Drilling	-	-	-	-	-
	Dump Truck	Loaded Trucks	6	0.456	0.000027	0.000062	0.000041
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	-	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	7	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	-	-	-	-	-
			Fabricate Inlet Total	**N/A**	**0.000118**	**0.000267**	**0.000177**
Set Inlet and Flood Tunnel	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	4	n/a	n/a	n/a	n/a
	Drill Rig	Caisson Drilling	-	-	-	-	-
	Dump Truck	Loaded Trucks	-	-	-	-	-
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	-	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	7	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	-	-	-	-	-
			Set Inlet and Flood Tunnel Total	**N/A**	**0.000014**	**0.000031**	**0.000020**
Construct Aeration Facility	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
	Concrete Trucks	Loaded Trucks	15	1.140	0.000068	0.000154	0.000102
	Cranes	n/a	4	n/a	n/a	n/a	n/a
	Drill Rig	Caisson Drilling	-	-	-	-	-
	Dump Truck	Loaded Trucks	6	0.456	0.000027	0.000062	0.000041
	Excavator	n/a	1	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	2	n/a	n/a	n/a	n/a
	Loaders	n/a	2	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	7	n/a	n/a	n/a	n/a
	Scraper	n/a	1	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
			Construct Aeration Facility Total	**N/A**	**0.000127**	**0.000287**	**0.000190**

Construction Vibration - Equipment
Lower San Felipe Intake Alternative - Tunneling Option

Table 30. Construction Vibration

Phase	Equipment Description	Equivalent Equipment Types	Distance (ft): / Number of Equipment	At Source 25 / PPV (in/sec)	Residence on Harper Lane 16,400 / PPV (in/sec)	Creek Use Area 9,500 / PPV (in/sec)	Subdivision off SR 152 12,500 / PPV (in/sec)
Fab and Set Air Tubing	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	-	n/a	n/a	n/a	n/a
	Drill Rig	Caisson Drilling	-	-	-	-	-
	Dump Truck	Loaded Trucks	6	0.456	0.000027	0.000062	0.000041
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	-	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	7	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	-	-	-	-	-
			Fab and Set Air Tubing Total	**N/A**	**0.000041**	**0.000092**	**0.000061**
Final Work and Testing	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	-	n/a	n/a	n/a	n/a
	Drill Rig	Caisson Drilling	-	-	-	-	-
	Dump Truck	Loaded Trucks	-	-	-	-	-
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	-	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	7	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	-	-	-	-	-
			Final Work and Testing Total	**N/A**	**0.000014**	**0.000031**	**0.000020**
Demobilization	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	-	n/a	n/a	n/a	n/a
	Drill Rig	Caisson Drilling	-	-	-	-	-
	Dump Truck	Loaded Trucks	6	0.456	0.000027	0.000062	0.000041
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	2	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	7	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
			Demobilization Total	**N/A**	**0.000050**	**0.000113**	**0.000075**

Significance Threshold

0.3 in/sec

Construction Vibration - Equipment
Lower San Felipe Intake Alternative - Pipeline Option

Table 31. Summary of Results

Phase	PPV (in/sec)		
	Residence on Harper Lane	San Luis Creek Use Area	Residence off Dinosaur Point Road
Mobilization	0.000033	0.000075	0.000050
Site Improvements	0.000074	0.000168	0.000111
Fabricate Inlet	0.000014	0.000031	0.000020
Build Cofferdam and Set Lower Inlet	0.000014	0.000031	0.000020
Lay Pipe	0.000041	0.000092	0.000061
Connect to Existing Intake	0.000014	0.000031	0.000020
Construct Aeration Facility	0.000063	0.000144	0.000095
Fab and Set Air Tubing	0.000014	0.000031	0.000020
Final Work and Testing	0.000014	0.000031	0.000020
Demobilization	0.000050	0.000113	0.000075
Maximum	**0.000074**	**0.000168**	**0.000111**
Significant?	No	No	No

Table 32. Construction Vibration

			Distance (ft):	At Source	on Harper Lane	Creek Use Area	Dinosaur Point Road
				25	16,400	9,500	12,500
Phase	Equipment Description	Equivalent Equipment Types	Number of Equipment	PPV (in/sec)	PPV (in/sec)	PPV (in/sec)	PPV (in/sec)
Mobilization	Bulldozer	Large Bulldozer	2	0.178	0.000011	0.000024	0.000016
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	-	n/a	n/a	n/a	n/a
	Dump Truck	Loaded Trucks	-	-	-	-	-
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	2	n/a	n/a	n/a	n/a
	Loaders	n/a	2	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	4	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
			Mobilization Total	**N/A**	**0.000033**	**0.000075**	**0.000050**
Site Improvements	Bulldozer	Large Bulldozer	2	0.178	0.000011	0.000024	0.000016
	Concrete Pumpers	Loaded Trucks	1	0.076	0.000005	0.000010	0.000007
	Concrete Trucks	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
	Cranes	n/a	-	n/a	n/a	n/a	n/a
	Dump Truck	Loaded Trucks	6	0.456	0.000027	0.000062	0.000041
	Excavator	n/a	1	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	2	n/a	n/a	n/a	n/a
	Loaders	n/a	2	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	4	n/a	n/a	n/a	n/a
	Scraper	n/a	1	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
			Site Improvements Total	**N/A**	**0.000074**	**0.000168**	**0.000111**

Construction Vibration - Equipment
Lower San Felipe Intake Alternative - Pipeline Option

Table 32. Construction Vibration

				At Source	on Harper Lane	Creek Use Area	Dinosaur Point Road
			Distance (ft):	25	16,400	9,500	12,500
Phase	Equipment Description	Equivalent Equipment Types	Number of Equipment	PPV (in/sec)	PPV (in/sec)	PPV (in/sec)	PPV (in/sec)
Fabricate Inlet	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	3	n/a	n/a	n/a	n/a
	Dump Truck	Loaded Trucks	-	-	-	-	-
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	-	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	4	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	-	-	-	-	-
			Fabricate Inlet Total	**N/A**	**0.000014**	**0.000031**	**0.000020**
Build Cofferdam and Set Lower Inlet	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	3	n/a	n/a	n/a	n/a
	Dump Truck	Loaded Trucks	-	-	-	-	-
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	-	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	4	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	-	-	-	-	-
			Build Cofferdam and Set Lower Inlet Total	**N/A**	**0.000014**	**0.000031**	**0.000020**
Lay Pipe	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	3	n/a	n/a	n/a	n/a
	Dump Truck	Loaded Trucks	6	0.456	0.000027	0.000062	0.000041
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	-	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	4	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	-	-	-	-	-
			Lay Pipe Total	**N/A**	**0.000041**	**0.000092**	**0.000061**

Construction Vibration - Equipment
Lower San Felipe Intake Alternative - Pipeline Option

Table 32. Construction Vibration

				At Source	on Harper Lane	Creek Use Area	Dinosaur Point Road
			Distance (ft):	25	16,400	9,500	12,500
Phase	Equipment Description	Equivalent Equipment Types	Number of Equipment	PPV (in/sec)	PPV (in/sec)	PPV (in/sec)	PPV (in/sec)
Connect to Existing Intake	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	3	n/a	n/a	n/a	n/a
	Dump Truck	Loaded Trucks	-	-	-	-	-
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	-	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	4	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	-	-	-	-	-
			Connect to Existing Intake Total	**N/A**	**0.000014**	**0.000031**	**0.000020**
Construct Aeration Facility	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	1	0.076	0.000005	0.000010	0.000007
	Concrete Trucks	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
	Cranes	n/a	3	n/a	n/a	n/a	n/a
	Dump Truck	Loaded Trucks	6	0.456	0.000027	0.000062	0.000041
	Excavator	n/a	1	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	2	n/a	n/a	n/a	n/a
	Loaders	n/a	2	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	4	n/a	n/a	n/a	n/a
	Scraper	n/a	1	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
			Construct Aeration Facility Total	**N/A**	**0.000063**	**0.000144**	**0.000095**
Fab and Set Air Tubing	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	-	n/a	n/a	n/a	n/a
	Dump Truck	Loaded Trucks	-	-	-	-	-
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	-	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	4	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	-	-	-	-	-
			Fab and Set Air Tubing Total	**N/A**	**0.000014**	**0.000031**	**0.000020**

Construction Vibration - Equipment
Lower San Felipe Intake Alternative - Pipeline Option

Table 32. Construction Vibration

				At Source	on Harper Lane	Creek Use Area	Dinosaur Point Road
			Distance (ft):	25	16,400	9,500	12,500
Phase	Equipment Description	Equivalent Equipment Types	Number of Equipment	PPV (in/sec)	PPV (in/sec)	PPV (in/sec)	PPV (in/sec)
Final Work and Testing	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	-	n/a	n/a	n/a	n/a
	Dump Truck	Loaded Trucks	-	-	-	-	-
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	-	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	4	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	-	-	-	-	-
			Final Work and Testing Total	**N/A**	**0.000014**	**0.000031**	**0.000020**
Demobilization	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	-	n/a	n/a	n/a	n/a
	Dump Truck	Loaded Trucks	6	0.456	0.000027	0.000062	0.000041
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	3	0.228	0.000014	0.000031	0.000020
	Grader	n/a	2	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Portable Diesel Generators	n/a	4	n/a	n/a	n/a	n/a
	Scraper	n/a	-	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
			Demobilization Total	**N/A**	**0.000050**	**0.000113**	**0.000075**

Significance Threshold

0.3 in/sec

Construction Vibration - Equipment
Treatment Alternative - Santa Teresa WTP

Table 33. Summary of Results

	PPV (in/sec)		
Phase	Dinosaur Point	Basalt Area	Gianelli Pumping Plant
Mobilization and Site Improvements	0.000041	0.000094	0.000062
Retrofit Existing Facilities	0.000090	0.000204	0.000135
Starting and Testing	-	-	-
Demobilization	0.000027	0.000062	0.000041
Maximum	**0.000090**	**0.000204**	**0.000135**
Significant?	No	No	No

Table 34. Construction Vibration

Phase	Equipment Description	Equivalent Equipment Types	Distance (ft): Number of Equipment	At Source 25 PPV (in/sec)	Dinosaur Point 16,400 PPV (in/sec)	Basalt Area 9,500 PPV (in/sec)	Gianelli Pumping Plant 12,500 PPV (in/sec)
Mobilization and Site Improvements	Bulldozer	Large Bulldozer	1	0.089	0.000005	0.000012	0.000008
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Saw Cutters	n/a	-				
	Concrete Trucks	Loaded Trucks	-	-	-	-	-
	Cranes	n/a	-	n/a	n/a	n/a	n/a
	Dump Truck	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	4	0.304	0.000018	0.000041	0.000027
	Loaders	n/a	1	n/a	n/a	n/a	n/a
	Vibrating Plate	Vibratory Roller	-	-	-	-	-
	Water Truck	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
	Wheel Trencher	Large Bulldozer	-	n/a	n/a	n/a	n/a
			Mobilization and Site Improvements Total	**N/A**	**0.000041**	**0.000094**	**0.000062**
Retrofit Existing Facilities	Bulldozer	Large Bulldozer	-	n/a	n/a	n/a	n/a
	Concrete Pumpers	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
	Concrete Saw Cutters	n/a	2	n/a	n/a	n/a	n/a
	Concrete Trucks	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
	Cranes	n/a	2	n/a	n/a	n/a	n/a
	Dump Truck	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
	Excavator	n/a	1	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	4	0.304	0.000018	0.000041	0.000027
	Loaders	n/a	1	n/a	n/a	n/a	n/a
	Vibrating Plate	Vibratory Roller	2	0.420	0.000025	0.000057	0.000038
	Water Truck	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
	Wheel Trencher	Large Bulldozer	2	0.178	0.000011	0.000024	0.000016
			Retrofit Existing Facilities Total	**N/A**	**0.000090**	**0.000204**	**0.000135**

Table 34. Construction Vibration

Phase	Equipment Description	Equivalent Equipment Types	Distance (ft): Number of Equipment	At Source 25 PPV (in/sec)	Dinosaur Point 16,400 PPV (in/sec)	Basalt Area 9,500 PPV (in/sec)	Gianelli Pumping Plant 12,500 PPV (in/sec)
Starting and Testing	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	n/a	n/a	n/a	n/a
	Concrete Saw Cutters	n/a	-	n/a	n/a	n/a	n/a
	Concrete Trucks	Loaded Trucks	-	n/a	n/a	n/a	n/a
	Cranes	n/a	-	n/a	n/a	n/a	n/a
	Dump Truck	Loaded Trucks	-	n/a	n/a	n/a	n/a
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	-	n/a	n/a	n/a	n/a
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Vibrating Plate	Vibratory Roller	-	-	-	-	-
	Water Truck	Loaded Trucks	-	n/a	n/a	n/a	n/a
	Wheel Trencher	Large Bulldozer	-	-	-	-	-
			Starting and Testing Total	**N/A**	**-**	**-**	**-**
Demobilization	Bulldozer	Large Bulldozer	-	-	-	-	-
	Concrete Pumpers	Loaded Trucks	-	-	-	-	-
	Concrete Saw Cutters	n/a	-	n/a	n/a	n/a	n/a
	Concrete Trucks	Loaded Trucks	-	n/a	n/a	n/a	n/a
	Cranes	n/a	-	n/a	n/a	n/a	n/a
	Dump Truck	Loaded Trucks	2	0.152	0.000009	0.000021	0.000014
	Excavator	n/a	-	n/a	n/a	n/a	n/a
	Flatbed Trucks (on site)	Loaded Trucks	4	0.304	0.000018	0.000041	0.000027
	Loaders	n/a	-	n/a	n/a	n/a	n/a
	Vibrating Plate	Vibratory Roller	-	-	-	-	-
	Water Truck	Loaded Trucks	-	n/a	n/a	n/a	n/a
	Wheel Trencher	Large Bulldozer	-	-	-	-	-
			Demobilization Total	**N/A**	**0.000027**	**0.000062**	**0.000041**

Significance Threshold

0.3 in/sec

Construction Vibration - Equipment
Enlarged Reservoir Alternative

Table 35. Construction Vibration

Phase	Equipment Description	Equivalent Equipment Types	Distance (ft): / Number of Equipment	At Source 25 / PPV (in/sec)	Residence on Harper Lane 16,400 / PPV (in/sec)	Creek Use Area 5,600 / PPV (in/sec)	Subdivision off SR 152 8,250 / PPV (in/sec)
Peak Day	Excavator	n/a	2	n/a	n/a	n/a	n/a
	Dozer	Large Bulldozer	3	0.267	0.000016	0.000080	0.000045
	Crane/Lift	n/a	5	n/a	n/a	n/a	n/a
	Compactor	Small bulldozer	5	0.015	0.000001	0.000004	0.000003
	Grader	Large Bulldozer	2	0.178	0.000011	0.000053	0.000030
	Scraper	Large Bulldozer	2	0.178	0.000011	0.000053	0.000030
	Loader	Loaded Trucks	5	0.380	0.000023	0.000113	0.000063
	Dump Truck	Loaded Trucks	13	0.988	0.000059	0.000295	0.000165
	Water Truck	Loaded Trucks	5	0.380	0.000023	0.000113	0.000063
	Blasting	n/a	4	0.050	0.000003	0.000015	0.000008
			Peak Day Total	**N/A**	**0.000142**	**0.000712**	**0.000398**

Note: Reference distance for blasting is 2,500 feet

Significance Threshold

0.3 in/sec

Construction Vibration - Equipment
Pacheco Reservoir Expansion Alternative

Table 36. Construction Vibration

Phase	Equipment Description	Equivalent Equipment Types	Distance (ft): / Number of Equipment	At Source 25 / PPV (in/sec)	Residence on El Toro Road 1,250 / PPV (in/sec)	unnamed access road 11,750 / PPV (in/sec)	Residence off SR 152 7,000 / PPV (in/sec)
Peak Day	Bulldozer	Large Bulldozer	6	0.534	0.001510	0.000052	0.000114
	Loader	Large Bulldozer	9	0.801	0.002266	0.000079	0.000171
	Grader	Large Bulldozer	2	0.178	0.000503	0.000017	0.000038
	Backhoe	Small bulldozer	6	0.018	0.000051	0.000002	0.000004
	Excavator	Large Bulldozer	1	0.089	0.000252	0.000009	0.000019
	On Highway Truck	Loaded Trucks	6	0.456	0.001290	0.000045	0.000097
	Off Highway Truck	Loaded Trucks	17	1.292	0.003654	0.000127	0.000276
	Scraper	Large Bulldozer	1	0.089	0.000252	0.000009	0.000019
	Smooth Drum Compactor	Vibratory Roller	1	0.210	0.000594	0.000021	0.000045
	Large Compactor	Vibratory Roller	6	0.050	0.141421	0.004907	0.010672
	Grapple	Large Bulldozer	1	0.089	0.000252	0.000009	0.000019
	Conveyor	n/a	1	n/a	n/a	n/a	n/a
	Grout Mixer	n/a	1	n/a	n/a	n/a	n/a
	Trailer Mounted Concrete Pump	n/a	2	n/a	n/a	n/a	n/a
	Concrete Vibrator	n/a	1	n/a	n/a	n/a	n/a
	Pumps	n/a	3	n/a	n/a	n/a	n/a
	Grout/Shotcrete Plants	n/a	2	n/a	n/a	n/a	n/a
	Generator	n/a	4	n/a	n/a	n/a	n/a
	Diesel Compressor	n/a	4	n/a	n/a	n/a	n/a
	Diesel Welder	n/a	5	n/a	n/a	n/a	n/a
	Sand Blasting Pot	n/a	2	n/a	n/a	n/a	n/a
	Pressure Washer	n/a	2	n/a	n/a	n/a	n/a
	Crane	Large Bulldozer	7	0.623	0.001762	0.000061	0.000133
	Man Lift	Small bulldozer	2	0.006	0.000017	0.000001	0.000001
	Auger Drill Rig	Caisson Drilling	4	0.356	0.001007	0.000035	0.000076
	Jackhammer	Jackhammer	1	0.035	0.000099	0.000003	0.000007
	Hydraulic Hoe Ram	Hoe Ram	1	0.089	0.000252	0.000009	0.000019
	Drill Rig Truck	Caisson Drilling	5	0.445	0.001259	0.000044	0.000095
	Ventilation Fan	n/a	1	n/a	n/a	n/a	n/a
	Pickup Trucks	n/a	23	n/a	n/a	n/a	n/a
	Blasting	n/a	1	0.050	0.141421	0.004907	0.010672
			Peak Day Total	**N/A**	**0.156440**	**0.005428**	**0.011805**

Note: Reference distance for blasting is 2,500 feet

Significance Threshold

0.3 in/sec

San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix F: Traffic and Transportation Appendix

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Appendix F
Traffic and Transportation Appendix

The Traffic and Transportation Appendix supplements Section 4.11 Traffic and Transportation in the San Luis Low Point Improvement Project (SLLPIP) Environmental Impact Statement/Environmental Impact Report (EIS/EIR). The sections below provide detailed information about traffic flow assessment methods, trip generation, and roadway operations under the action alternatives.

Traffic analysis in the State of California is guided by standards set at the State level by the California Department of Transportation (Caltrans), and by local jurisdictions. State highways fall under the jurisdiction of Caltrans. Other roadways fall under the local jurisdiction, either city or county, in which they are located.

Each jurisdiction has adopted standards regarding the desired performance level of traffic conditions on the circulation system within its jurisdiction. A performance measure called "Level of Service" (LOS) is used to characterize traffic operating conditions of a circulation element. Progressively worsening traffic operating conditions are given the letter grades "A" through "F". Table F-1 summarizes the traffic operating conditions associated with each LOS designation. Table F-2 provides LOS criteria for freeways in Santa Clara County, while Table F-3 exhibits LOS criteria for Merced County roadways.

Table F-1. Level of Service Characteristics

LOS	Traffic Condition
A	Free flow conditions; Low volumes; high operating speeds; uninterrupted flow; no restriction on maneuverability; drivers maintain desired speeds; little or no delays.
B	Stable flow conditions; operating speeds beginning to be restricted.
C	Stable flow but speed and maneuverability restricted by higher traffic volumes; satisfactory operating speed for urban conditions; delays at signals.
D	Approaching unstable flow; low speeds; major delays at signals; little freedom to maneuver.
E	Lower operating speeds; volume at or near capacity; unstable flow; major delays and stoppages.
F	Forced flow conditions; low speeds; volumes below capacity, may be zero; stoppages for long periods because of downstream congestion.

Source: Transportation Research Board 2000

Table F-2. Level of Service Criteria for Freeways – Santa Clara County

LOS	Density (passenger cars/mile/lane)	Speed (miles/hour)
A	≤ 11.0	≥ 67.0
B	11.0 – 18.1	66.5 – 67.0
C	18.0 – 26.0	66.0 – 66.5
D	26.0 – 46.0	46.0 – 66.0
E	46.0 – 58.0	35.0 – 46.0
F	> 58.0	< 35.0

Source: Santa Clara Valley Transportation Authority 2003

Table F-3. Level of Service Criteria for Roadways – Merced County

#	Area	Facility	Interchanges	Intersections	Flow	Lanes	Median	Level of Service (Average Annual Daily Traffic)				
								A	B	C	D	E
1	Urban	Freeway	< 2 miles apart	-	-	4	N/A	22,000	36,000	52,000	67,000	76,500
2	Urban	Expressway	-	-	-	4	Divided	-	-	21,400	31,100	32,900
3	Urban	Highway	-	-	Uninterrupted	2	Undivided	2,000	7,000	13,800	19,600	27,000
4	Urban	Highway	-	< 2/mile	-	2	Undivided	-	4,200	13,800	16,400	16,900
5	Urban	Highway	-	< 4.5/mile	-	2	Undivided	-	1,900	11,200	15,400	16,300
6	Urban	Collector	-	-	-	2	Undivided	-	-	4,800	10,000	12,600
7	Urban	Highway	-	< 4.5/mile	-	4	Undivided	-	3,500	23,200	29,100	30,600
8	Urban	Arterial	-	-	-	4	Undivided	-	-	15,600	27,800	29,400
9	Urban	Highway	-	< 2/mile	-	4	Undivided	3,500	20,900	24,600	25,700	-
10	Urban	Collector	-	-	-	4	Undivided	-	-	9,800	19,200	22,800
11	Urban	Highway	-	< 2/mile	-	2	Undivided	-	4,000	13,100	15,500	16,300
12	Urban	Arterial	-	-	-	2	Undivided	-	-	7,000	13,600	14,600
13	Transition	Freeway	-	-	-	4	-	23,500	38,700	52,500	62,200	69,100
14	Transition	Collector	-	-	-	2	Undivided	-	-	4,400	9,400	12,000
15	Rural	Freeway	-	-	-	6	-	33,100	54,300	73,900	87,400	97,200
16	Rural	Freeway	-	-	-	4	-	21,300	35,300	47,900	56,600	63,000
17	Rural	Non-Freeway	-	-	Uninterrupted	4	Divided	17,500	28,600	40,800	52,400	58,300
18	Rural	Non-Freeway	-	-	Isolated Stops	4	-	-	2,900	17,400	23,000	25,200
19	Rural	Non-Freeway	-	-	Uninterrupted	2	Undivided	2,600	5,300	8,600	13,800	22,300
20	Rural	Non-Freeway	-	-	Isolated Stops	2	Undivided	-	1,900	8,000	10,700	12,100
21	Suburban	Non-Freeway	-	-	Interrupted	4	Divided	-	5,300	25,200	29,400	31,200
22	Suburban	Highway	-	-	Uninterrupted	2	Undivided	2,500	7,200	12,700	17,300	23,500
23	Suburban	Arterial	-	-	Interrupted	2	Undivided	-	2,200	11,000	13,900	14,900
24	Suburban	Collector	-	-	-	2	Undivided	-	-	1,900	7,600	10,100

Source: *Merced County 2013.*

While most motorists consider LOS A, B, and C as satisfactory travel conditions, LOS D is considered marginally acceptable. Congestion and delay are considered unacceptable to most motorists and are given the LOS E or F ratings. Table F-4 presents local and regional LOS standards established by each jurisdiction within the study area.

Table F-4. LOS Standards of Significance

Regulatory Agency	LOS Thresholds
Caltrans[1]	LOS C for rural interregional routes and LOS D for urban interregional routes
Merced County[2]	LOS D for freeways and urban roadways, LOS C for other rural roadways
Santa Clara County[3]	LOS E for Congestion Management Program (CMP) facilities and LOS D for other facilities
City of Los Banos[4]	LOS C for roadway segments
City of Gustine[5]	LOS D for major roadways
City of Gilroy[6]	LOS C for roadways and LOS D for some commercial and industrial areas

Notes:
[1] Source: Merced County Association of Governments 2014
[2] Source: Merced County 2013
[3] Source: Santa Clara Valley Transportation Authority (VTA) 2016
[4] Source: City of Los Banos 2009
[5] Source: City of Gustine 2002
[6] Source: City of Gilroy 2002

Figure F-1 exhibits the road network surrounding the proposed construction sites in the San Luis Reservoir Area.

Figure F-2 identifies the roads that would provide access to and from the construction site at the Santa Tereasa Water Treatment Plant (WTP) within the Santa Clara Valley Water District (SCVWD) Service Area.

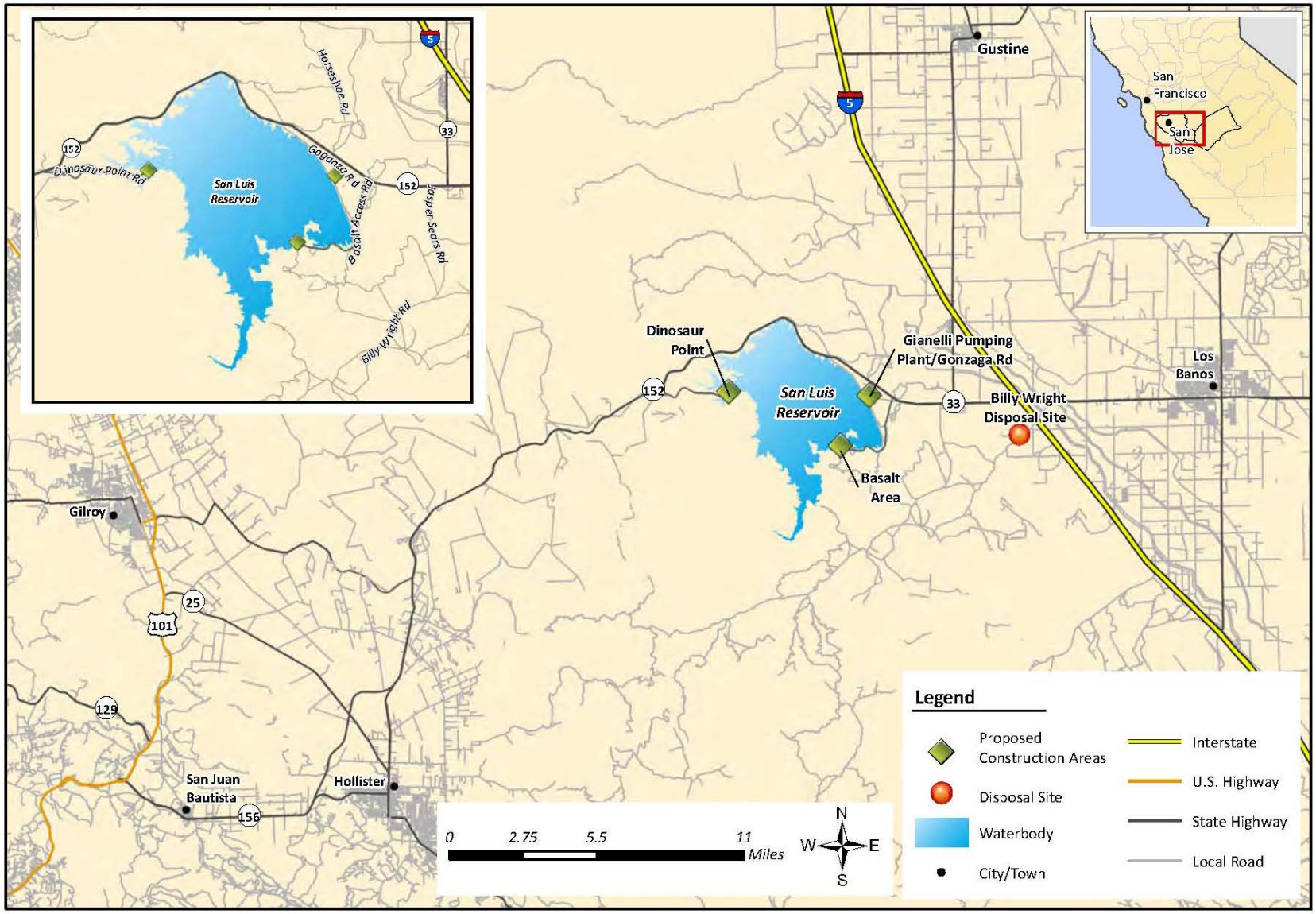


Figure F-1. San Luis Reservoir Area of Analysis



Figure F-2. Santa Clara Valley Water District Service Area- Santa Teresa WTP

F.1 Traffic Flow Assessment Methods

The project alternatives would result in increases in traffic during construction and small or no changes during operations. This impact assessment analyzes the increase in traffic that would occur during construction based on changes to the LOS. LOS thresholds provided in Table F-4 for the relevant jurisdictions are used to identify traffic impacts. In addition to daily operations, the impact assessment includes AM and PM peak hours. It is assumed that the AM peak hour occurs between 7 and 9 a.m., and the PM peak hour occurs between 4 and 6:00 p.m.

For roadways within Merced County, the LOS value was determined using their annual average daily traffic (AADT) value, physical characteristics (e.g., number of lanes), and their location (e.g., urban, suburban, rural). The LOS criteria for different types of roadways in Merced County is provided in Table F-3.

For roadways in Santa Clara County, guidelines provided in the Transportation Impact Analysis Guidelines, Santa Clara Valley Transportation Authority (VTA) Congestion Management Program were used to evaluate potential traffic impacts. According to those guidelines:

- A freeway segment should be evaluated only if a project is expected to add traffic equal to or greater than one percent of the freeway segment's capacity. This calculation shall be for each direction of travel.
- Freeway segments should be evaluated using the LOS criteria provided in Table F-2.
- A project would be considered to cause a significant impact to a CMP facility if it is projected to cause the facility to worsen from LOS E or better to LOS F. This calculation shall be for each direction of travel.
- A project would be considered to cause a significant impact to a freeway segment operating at LOS F if it would add traffic volume exceeding one percent of the freeway capacity. This calculation shall be for each direction of travel.

For each project alternative, construction data (including the number of construction trucks, construction truck routes and schedule, number of workers, and worker traffic routes and schedule) were used to identify anticipated short-term construction-related and long-term operations-related trip generation. These additional short-term and long-term trips were assigned to roadways located in the vicinity of the service areas (the San Luis Reservoir Region for San Felipe Intake and San Luis Reservoir Enlargement Alternative, and the SCVWD Service Area for the Treatment Alternative) to determine traffic operations under various project alternatives. Using the traffic operations' assessment methods mentioned above and the LOS standards of significance

summarized in Table F-4, potential transportation impacts to neighboring roadways were determined for each project alternative.

F.2 Trip Generation

A maximum of 238 and 74 construction-related traffic trips (trucks and workers) per day would access the project site during the construction of the Lower San Felipe Intake Alternative's Tunnel and Pipeline options, respectively. This would result in a total of 476 and 148 construction-related trips to the project site as part of the Lower San Felipe Intake Alternative's Tunnel and Pipeline options. In addition to the transportation of construction equipment and debris, construction workers would be driving to/from the site daily. For construction workers, it was assumed that 75 percent would originate from the City of Los Banos in the east and 25 percent would originate from Gilroy in the west. This assumption was based on proximity to labor populations in Gilroy and Los Banos. Materials are assumed to originate from Los Banos and other locations along I-5. For this analysis, construction trips were applied to roadways in the San Luis Reservoir Region that are anticipated to support construction worker trips, material deliveries and disposal. Trip generation and distribution for the Lower San Felipe Intake Alternative are summarized in Table F-5.

Table F-5. Trip Generation – Lower San Felipe Intake Alternative

Type of Trip	Time Period	Trip Distribution		Total Trips
		West to US 101	East to I-5	
Tunnel Option				
Construction Truck Trip	Daily	0	76	76
	AM/PM Peak	0	38	38
Construction Worker Trip	Daily	100	300	400
	AM/PM Peak	50	150	200
Total Construction-Related Trip	Daily	100	376	476
	AM/PM Peak	50	188	238
Long-Term O&M Trip[1]	Daily	0	4	4
	AM/PM Peak	0	2	2
Pipeline Option				
Construction Truck Trip	Daily	0	28	28
	AM/PM Peak	0	14	14
Construction Worker Trip	Daily	32	88	120
	AM/PM Peak	16	44	60
Total Construction-Related Trip	Daily	32	116	148
	AM/PM Peak	16	58	74
Long-Term O&M Trip[1]	Daily	0	4	4
	AM/PM Peak	0	2	2

Source: Reclamation 2017

Note: [1] Long-term operations and maintenance (O&M) trips will only occur with liquid oxygen (LOX) delivery at the aeration facility. If a compressed air system is used instead of LOX, then these truck trips will not occur.

Construction of the Treatment Alternative would result in a maximum of 110 daily trips (10 construction truck trips and 100 construction worker trips) to the Santa Teresa WTP. These trips include construction personnel driving to/from sites every day during the construction phase of the Treatment Alternative. Materials were assumed to originate from sites located northeast (60 percent) and southeast (40 percent) of the service area. As for the construction workers, 50 percent were assumed to originate from areas located southeast of the service area and 50 percent from areas located northeast of the service area. For this analysis, every construction trip was applied to the regional access routes. The trip generation and distribution that would be associated with the Treatment Alternative are summarized in Table F-6.

Table F-6. Trip Generation – Treatment Alternative

Construction Site	Type of Trip	Time Period	Trip Distribution		Total Trips
			Southeast of Service Area	Northeast of Service Area	
Santa Teresa WTP	Construction Truck Trip	Daily	4	6	10
		AM/PM Peak	2	3	5
	Construction Worker Trip	Daily	50	50	100
		AM/PM Peak	25	25	50
	Total Construction-Related Trip	Daily	54	56	110
		AM/PM Peak	27	28	55
	Long-Term O&M Trip[1]	Daily	2	2	4
		AM/PM Peak	1	1	2

Source: Reclamation 2017
Note: [1] Long-term O&M trips equal to full-time equivalent (FTE) employees.

A maximum of 240 construction-related trucks and 130 day-time and 87 night-time construction-related workers daily (resulting in 480 truck and 434 worker trips per day) would be involved with the San Luis Reservoir Expansion Alternative. It is assumed that all of the construction truck trips would be distributed throughout the 24-hour construction, so that 10 percent of the daily trips would occur during the AM/PM peak hour. The construction personnel trips are assumed to occur inbound before 6 AM and 6 PM, and outbound after 6 AM and 6 PM, which translates to 130 day-time workers entering the construction site before 6 AM and leaving after 6 PM, while 87 night-time workers enter the construction site before 6 PM and leave after 6 AM. Therefore, only the night-time worker trips would occur during the AM/PM peak hours. Similar to the San Felipe Intake Alternative, 25 percent of workers were assumed to access the construction site from the west via US 101 and State Route (SR) 152, while 75 percent would access from the east via I-5, SR 152 and SR 33. Materials and truck trips were assumed to originate from Los Banos and other locations along I-5. The San Luis Reservoir Expansion Alternative is

not expected to add any long-term trips to the project site after the construction is completed. Trip generation and distribution of construction-related trips that would be associated with the San Luis Reservoir Expansion Alternative is summarized in Table F-7.

Table F-7. Trip Generation – San Luis Reservoir Expansion Alternative

Type of Trip	Time Period	Trip Distribution		Total Trips
		West to US 101	East to I-5	
Construction Truck Trip	Daily	0	480	480
	AM/PM Peak	0	48	48
Construction Worker Trip	Daily	108	326	434
	AM/PM Peak	22	65	87
Total Construction-Related Trip	Daily	108	806	914
	AM/PM Peak	22	113	135
Long-Term O&M Trip	Daily	0	0	0
	AM/PM Peak	0	0	0

Source: Reclamation 2018

The highest generated construction-related trips are expected to occur during Spring/Summer/Fall 2027; therefore, traffic conditions in 2027 is analyzed. Since the San Luis Reservoir Region is rural in area, background traffic growth is expected to be minimal. It is thus assumed that background traffic in the San Luis Reservoir Region would increase between 2016 and 2027 conditions at 0.5 percent annually.

A maximum of 215 construction-related trucks and 350 day-time and 125 night-time construction-related workers daily (translating to 430 truck trips and 950 worker trips per day) would be involved with the Pacheco Reservoir Expansion Alternative (Reclamation 2018). It is assumed that construction truck trips would be distributed throughout the 24-hour construction, so that 10 percent of the daily trips would occur during the AM/PM peak hour. The construction personnel trips are assumed to occur inbound before 6 AM and 6 PM, and outbound after 6 AM and 6 PM, which translates to 350 day-time workers entering the construction site before 6 AM and leaving after 6 PM, while 125 night-time workers enter the construction site before 6 PM and leave after 6 AM. Therefore, only the night-time worker trips would occur during the AM/PM peak hours. Similar to the San Felipe Intake Alternative and San Luis Reservoir Expansion Alternative, 25 percent of workers are assumed to access the construction site from the west via US 101 and SR 152, while 75 percent would access from the east via I-5, SR 152 and SR 33. Materials and truck trips are assumed to originate from Los Banos and other locations along I-5.

The Pacheco Reservoir Expansion Alternative is not expected to add any long-term trips to the project site after the construction is completed. Trip generation

and distribution of construction-related trips that would be associated with the Pacheco Reservoir Expansion Alternative is summarized in Table F-8.

Table F-8. Trip Generation – Pacheco Reservoir Expansion Alternative

Type of Trip	Time Period	Trip Distribution		Total Trips
		West to US 101	East to I-5	
Construction Truck Trip	Daily	0	430	430
	AM/PM Peak	0	44	44
Construction Worker Trip	Daily	238	712	950
	AM/PM Peak	31	94	125
Total Construction-Related Trip	Daily	238	1,142	1,380
	AM/PM Peak	31	138	169
Long-Term O&M Trip	Daily	0	0	0
	AM/PM Peak	0	0	0

Source: Reclamation 2018

F.3 Roadway Operations

Roadway operations during construction of the Lower San Felipe Intake Alternative's Tunnel Option are summarized in Tables F-9, F-10, and F-11.

For daily operations, the added construction-related trips would not change the LOS at any of the study roadway segments in Merced County. Even though traffic would increase along Basalt Road and Fifield Road/Dinosaur Point Road by a large percentage, AADT values would be less than 1900 vehicles, which according to the 2030 Merced County General Plan is the threshold value for a rural, two-lane non-freeway road with isolated stops operating at LOS B. As such, according to the guidelines provided in the 2030 Merced County General Plan, those two roads would continue to operate at LOS B.

Highway Capacity Software (version 7) was utilized to analyze traffic conditions during the AM and PM peak hours. The added construction-related trips would not change the LOS at any of the study roadway segments in Merced County, except on the Basalt Road northbound and southbound segments (AM and PM peak hours) and on SR 152 eastbound at SR 33 (PM peak hour). Even though the LOS on Basalt Road increases from A to B after the construction-related trips are added for these two segments, it does not exceed the threshold of significance (LOS C) for rural roadways shown in Table F-4. Even though the LOS on SR 152 increases from B to C after the construction-related trips are added, it does not exceed the threshold of significance (LOS C) for rural roadways shown in Table F-4.

In Santa Clara County, none of the study roadway segments need to be evaluated, since the added construction trips would be less than one percent of

the respective roadway capacities (the VTA threshold for freeway segment evaluation).

Table F-9. Merced County Roadway Daily Operations – Lower San Felipe Intake Alternative (Tunnel Option)

Roadway	Existing (2016) AADT1	Existing LOS	Maximum Daily Truck Trips	Maximum Daily Worker Trips	Total AADT During Construction	LOS during Construction	LOS Change
I-5 at SR 152	32,000	B	30	100	32,130	B	No Change
SR 152 at I-5	27,000	B	16	100	27,116	B	No Change
SR 152 at SR 33	28,600	B	46	200	28,846	B	No Change
SR 33 at I-5	12,900	F	30	100	13,030	F	No Change
Fifield Rd/ Dinosaur Point Rd	137	B	76	400	613	B	No Change
Basalt Rd	191	B	76	400	667	B	No Change

Source: Caltrans 2016

Table F-10. Merced County Roadway AM/PM Peak Hour Operations – Lower San Felipe Intake Alternative (Tunnel Option)

Roadway	Existing (2016) Volume[1]	Existing LOS	Maximum Truck Trips	Maximum Worker Trips	Total AADT During Construction	LOS during Construction	LOS Change
AM Peak Hour							
I-5 NB at SR 152	2,050	C	6	25	2,081	C	No Change
I-5 SB at SR 152	1,700	C	6	25	1,731	C	No change
SR 152 EB at I-5	1,050	A	6	25	1,081	A	No change
SR 152 WB at I-5	1,400	B	6	25	1,431	B	No change
SR 152 EB at SR 33	200	A	12	50	262	A	No change
SR 152 WB at SR 33	1,500	B	12	50	1,562	B	No change
SR 33 NB at I-5	550	D	7	25	582	D	No change
SR 33 SB at I-5	350	D	7	25	382	D	No change
Fifield Rd/ Dinosaur Point Rd NB at SR 152	10	A	19	100	129	A	No change
Fifield Rd/ Dinosaur Point Rd SB at SR 152	10	A	19	100	129	A	No change
Basalt Rd NB	10	A	19	100	129	B	Higher but does not exceed LOS C
Basalt Rd SB	10	A	19	100	129	B	

Roadway	Existing (2016) Volume[1]	Existing LOS	Maximum Truck Trips	Maximum Worker Trips	Total AADT During Construction	LOS during Construction	LOS Change
PM Peak Hour							
I-5 NB at SR 152	2,150	C	6	25	2,181	C	No change
I-5 SB at SR 152	1,100	B	6	25	1,131	B	No change
SR 152 EB at I-5	1,700	B	6	25	1,731	B	No change
SR 152 WB at I-5	800	A	6	25	831	A	No change
SR 152 EB at SR 33	1,800	B	12	50	1,862	C	Higher but does not exceed LOS C
SR 152 WB at SR 33	650	A	12	50	712	A	No change
SR 33 NB at I-5	650	E	7	25	682	E	No change
SR 33 SB at I-5	300	D	7	25	332	D	No change
Fifield Rd/ Dinosaur Point Rd NB at SR 152	10	A	19	100	129	A	No change
Fifield Rd/ Dinosaur Point Rd SB at SR 152	10	A	19	100	129	A	No change
Basalt Rd NB	10	A	19	100	129	B	Higher but does not exceed LOS C
Basalt Rd SB	10	A	19	100	129	B	

Note:
[1.] Source: Caltrans 2016 (AADT directly from the source; AM and PM peak hour volumes derived from the source)

Table F-11. Santa Clara County Roadway Operations – Lower San Felipe Intake Alternative (Tunnel Option)

Roadway	Direction	Number of Lanes	Roadway Capacity[1] (vph)	Maximum Peak Hour Construction Trips			Added Trips Less Than 1% of Roadway Capacity?[2]	Need Evaluation?
				Truck	Worker	Total		
US 101 at SR 152	Northbound	3	6,900	0	25	25	Yes	No
	Southbound	3	6,900	0	25	25	Yes	No
SR 152 at SR 156	Eastbound	2	4,400	0	25	25	Yes	No
	Westbound	2	4,400	0	25	25	Yes	No

Key:
[1] Based on the guidelines provided in the Transportation Impact Analysis Guidelines, VTA CMP, October 2014.
[2] VTA recommended threshold for evaluation of highway segments.

Roadway operations during construction of the Lower San Felipe Intake Alternative's Pipeline Option are summarized in Tables F-12, F-13, and F-14.

For daily operations, the added construction-related trips would not change the LOS at any of the study roadway segments in Merced County. As discussed for the Tunnel Option, even though traffic would increase by a large percentage

along Basalt Road and Fifield Road/Dinosaur Point Road, AADT value would be less than 1900 vehicles, which according to the 2030 Merced County General Plan is the threshold value for a rural, two-lane non-freeway road with isolated stops operating at LOS B. As such, according to the guidelines provided in the 2030 Merced County General Plan, those two roads would continue to operate at LOS B.

As for the Tunnel Option, Highway Capacity Software (version 7) was utilized to analyze traffic conditions in the AM and PM peak hour operations. The added construction-related trips would not change the LOS at any of the study roadway segments in Merced County, except the SR 152 EB at SR 33 segment in the PM peak hour. Even though the LOS increases from B to C after the construction-related trips are added on this segment, it does not exceed the threshold of significance (LOS C) for rural roadways shown in Table F-4.

In Santa Clara County, both of the study roadway segments need not be evaluated, since the added construction trips would be less than one percent of the respective roadway capacities (the VTA threshold for freeway segment evaluation).

Table F-12. Merced County Roadway Daily Operations – Lower San Felipe Intake Alternative (Pipeline Option)

Roadway	Existing (2016) AADT[1]	Existing LOS	Maximum Daily Truck Trips	Maximum Daily Worker Trips	Total AADT During Construction	LOS during Construction	LOS Change
I-5 at junction with SR 152	32,000	B	10	28	32,038	B	No Change
SR 152 at junction with I-5	27,000	B	8	32	27,040	B	No Change
SR 152 at junction with SR 33	28,600	B	18	60	28,678	B	No Change
SR 33 at junction with I-5	12,900	F	10	28	12,938	F	No Change
Fifield Rd/ Dinosaur Point Rd	137	B	28	120	285	B	No Change
Basalt Rd	191	B	28	120	339	B	No Change

Note:
[1] *Source: Caltrans 2016*

Table F-13. Merced County Roadway AM/PM Peak Hour Operations – Lower San Felipe Intake Alternative (Pipeline Option)

Roadway	Existing (2016) Volume[1]	Existing LOS	Maximum Truck Trips	Maximum Worker Trips	Total AADT During Construction	LOS during Construction	LOS Change
AM Peak Hour							
I-5 NB at SR 152	2,050	C	3	7	2,060	C	No Change
I-5 SB at SR 152	1,700	C	3	7	1,710	C	No change
SR 152 EB at I-5	1,050	A	2	8	1,060	A	No change
SR 152 WB at I-5	1,400	B	2	8	1,410	B	No change
SR 152 EB at SR 33	200	A	5	15	220	A	No change
SR 152 WB at SR 33	1,500	B	5	15	1,520	B	No change
SR 33 NB at I-5	550	D	2	7	559	D	No change
SR 33 SB at I-5	350	D	2	7	359	D	No change
Fifield Rd/ Dinosaur Point Rd NB at SR 152	10	A	7	30	47	A	No change
Fifield Rd/ Dinosaur Point Rd SB at SR 152	10	A	7	30	47	A	No change
Basalt Rd NB	10	A	7	30	47	A	No change
Basalt Rd SB	10	A	7	30	47	A	No change
PM Peak Hour							
I-5 NB at SR 152	2,150	C	3	7	2,160	C	No change
I-5 SB at SR 152	1,100	B	3	7	1,110	B	No change
SR 152 EB at I-5	1,700	B	2	8	1,710	B	No change
SR 152 WB at I-5	800	A	2	8	810	A	No change
SR 152 EB at SR 33	1,800	B	5	15	1,820	C	Higher but does not exceed LOS C
SR 152 WB at SR 33	650	A	5	15	670	A	No change
SR 33 NB at I-5	650	E	2	7	659	E	No change
SR 33 SB at I-5	300	D	2	7	309	D	No change
Fifield Rd/ Dinosaur Point Rd NB at SR 152	10	A	7	30	47	A	No change
Fifield Rd/ Dinosaur Point Rd SB at SR 152	10	A	7	30	47	A	No change
Basalt Rd NB	10	A	7	30	47	A	No change
Basalt Rd SB	10	A	7	30	47	A	No change

Note:
[1] Source: Caltrans 2016 (AADT directly from the source; AM and PM peak hour volumes derived from the source)

Table F-14. Santa Clara County Roadway Operations – Lower San Felipe Intake Alternative (Pipeline Option)

Roadway	Direction	Number of Lanes	Roadway Capacity[1] (vph)	Maximum Peak Hour Construction Trips			Added Trips Less Than 1% of Roadway Capacity[2]?	Need Evaluation?
				Truck	Worker	Total		
US 101 at SR 152	Northbound	3	6,900	0	8	8	Yes	No
	Southbound	3	6,900	0	8	8	Yes	No
SR 152 at SR 156	Eastbound	2	4,400	0	8	8	Yes	No
	Westbound	2	4,400	0	8	8	Yes	No

Key:
[1] Based on the guidelines provided in the Transportation Impact Analysis Guidelines, VTA CMP, October 2014.
[2] VTA recommended threshold for evaluation of highway segments.

Operations of the regional roadways during construction of the Treatment Alternative are summarized in Table F-15.

The Treatment Alternative would generate construction-related traffic that would be less than the VTA recommended threshold for roadway evaluation (one percent of roadway capacity). Therefore, none of the neighboring regional roadway segments need to be evaluated, and the Treatment Alternative is expected to result in less-than-significant impacts to regional roadways located in the SCVWD service area.

Construction-related traffic under the Treatment Alternative would not conflict with applicable policies that establish roadway performance standards and would not result in a substantial increase in traffic in relation to the existing traffic load and roadway capacity.

Table F-15. Regional Roadway Operations – Treatment Alternative

Roadway Segment	Direction	Number of Lanes	Capacity[1] (vehicles per hour)	Peak Period	Existing (2016) LOS[2]	Maximum Peak Hour Trips			Added Trips Less Than 1% of Roadway Capacity?[3]	Need Evaluation?
						Truck	Worker	Total		
I-880 at US 101	Northbound	3	6,900	PM	F	3	25	28	Yes	No
	Southbound	3	6,900	AM	F	3	25	28	Yes	No
I-680 at Berryessa Road	Northbound	4	9,200	PM	C	3	25	28	Yes	No
	Southbound	4	9,200	AM	D	3	25	28	Yes	No
SR 237 at I-880	Eastbound	3	6,900	PM	C	3	25	28	Yes	No
	Westbound	3	6,900	AM	F	3	25	28	Yes	No
SR 87 at I-280	Northbound	3	6,900	AM	F	2	25	27	Yes	No
	Southbound	3	6,900	PM	F	2	25	27	Yes	No
SR 85 at US 101	Southbound	3	6,900	AM	B	2	25	27	Yes	No
	Northbound	3	6,900	PM	B	2	25	27	Yes	No
US 101 at SR 85	Southbound	4	9,200	AM	B	2	25	27	Yes	No
	Northbound	4	9,200	PM	C	2	25	27	Yes	No

Notes:

[1] Based on the guidelines provided in the Transportation Impact Analysis Guidelines, VTA, CMP, October 2014.

[2] Source: Santa Clara County 2016. Reported for mixed-use lanes.

[3] VTA recommended threshold for evaluation of highway segments.

Roadway operations during construction for the San Luis Reservoir Expansion Alternative are summarized in Tables F-16, F-17, and F-18. For daily operations, the added construction-related trips would not change the LOS at any of the study roadway segments in Merced County.

Highway Capacity Software (version 7) was utilized to analyze traffic conditions during the AM and PM peak hours. The added construction-related trips would not change the LOS at any of the study roadway segments in Merced County, except on the Basalt Road northbound segment in the AM peak hour and southbound segment in the PM peak hour, and on SR 152 eastbound at SR 33 (PM peak). Even though the LOS increases after the construction-related trips are added on these three segments, it does not exceed the threshold of significance (LOS C) for rural roadways shown in Table F-4.

In Santa Clara County, none of the study roadway segments need to be evaluated because the added construction trips would be less than one percent of the respective roadway capacities (the VTA threshold for freeway segment evaluation).

Table F-16. Merced County Roadway Daily Operations – San Luis Reservoir Expansion Alternative

Roadway	Existing (2016) AADT[1]	Existing LOS	Maximum Daily Truck Trips	Maximum Daily Worker Trips	Total AADT During Construction	LOS during Construction	LOS Change
I-5 at SR 152	32,000	B	160	108	32,268	B	No Change
SR 152 at I-5	27,000	B	160	108	27,268	B	No Change
SR 152 at SR 33	28,600	B	320	218	29,138	B	No Change
SR 33 at I-5	12,900	F	160	108	13,168	F	No Change
Fifield Rd/ Dinosaur Point Rd	137	B	480	434	1,051	B	No Change
Basalt Rd	191	B	480	434	1,105	B	No Change

Note:
[1] Source: Caltrans 2016

Table F-17. Merced County Roadway AM/PM Peak Hour Operations – San Luis Reservoir Expansion Alternative

Roadway	Existing (2016) Volume[1]	Existing LOS	Maximum Truck Trips	Maximum Worker Trips	Total AADT During Construction	LOS during Construction	LOS Change
AM Peak Hour							
I-5 NB at SR 152	2,050	C	8	0	2,058	C	No change
I-5 SB at SR 152	1,700	C	8	21	1,729	C	No change
SR 152 EB at I-5	1,050	A	8	22	1,080	A	No change
SR 152 WB at I-5	1,400	B	8	0	1,408	B	No change
SR 152 EB at SR 33	200	A	16	43	259	A	No change
SR 152 WB at SR 33	1,500	B	16	0	1,516	B	No change
SR 33 NB at I-5	550	D	8	22	580	D	No change
SR 33 SB at I-5	350	D	8	0	358	D	No change
Fifield Rd/ Dinosaur Point Rd NB at SR 152	10	A	24	87	121	A	No change
Fifield Rd/ Dinosaur Point Rd SB at SR 152	10	A	24	0	34	A	No change
Basalt Rd NB	10	A	24	87	121	B	Higher but does not exceed LOS C
Basalt Rd SB	10	A	24	0	34	A	No change
PM Peak Hour							
I-5 NB at SR 152	2,150	C	8	21	2,179	C	No change
I-5 SB at SR 152	1,100	B	8	0	1,108	B	No change
SR 152 EB at I-5	1,700	B	8	0	1,708	B	No change
SR 152 WB at I-5	800	A	8	22	830	A	No change
SR 152 EB at SR 33	1,800	B	16	0	1,816	C	Higher but does not exceed LOS C
SR 152 WB at SR 33	650	A	16	43	709	A	No change
SR 33 NB at I-5	650	E	8	0	658	E	No change
SR 33 SB at I-5	300	D	8	22	330	D	No change
Fifield Rd/ Dinosaur Point Rd NB at SR 152	10	A	24	0	34	A	No change
Fifield Rd/ Dinosaur Point Rd SB at SR 152	10	A	24	87	121	A	No change
Basalt Rd NB	10	A	24	0	34	A	No change
Basalt Rd SB	10	A	24	87	121	B	Higher but does not exceed LOS C

Note:
[1] Source: Caltrans 2016 (AADT directly from the source; AM and PM peak hour volumes derived from the source)

Table F-18. Santa Clara County Roadway Daily Operations – San Luis Reservoir Expansion Alternative

Roadway	Direction	Number of Lanes	Roadway Capacity[1] (vph)	Maximum Daily Construction Trips			Added Trips Less Than 1% of Roadway Capacity?[2]	Need Evaluation?
				Truck	Worker	Total		
US 101 at SR 152	Northbound	3	6,900	0	22	22	Yes	No
	Southbound	3	6,900	0	22	22	Yes	No
SR 152 at SR 156	Eastbound	2	4,400	0	22	22	Yes	No
	Westbound	2	4,400	0	22	22	Yes	No

Key:
[1] Based on the guidelines provided in the Transportation Impact Analysis Guidelines, VTA CMP, October 2014.
[2] VTA recommended threshold for evaluation of highway segments.

Roadway operations during construction for the Pacheco Reservoir Expansion Alternative are summarized in Tables F-19, F-20, and F-21. Vehicle use resulting from this alternative would primarily occur on SR 152 and the existing access road off SR 152 south of Pacheco Lake. A 6-mile haul road and 1.7-mile permanent access road would be constructed as part of this alternative. In addition, the existing access road would be improved, and a temporary 0.8-mile access road would be constructed.

For daily operations, the added construction-related trips would not change the LOS at any of the study roadway segments in Merced County.

Highway Capacity Software (version 7) was utilized to analyze traffic conditions during the AM and PM peak hours. The added construction-related trips would not change the LOS at any of the study roadway segments in Merced County, except on SR 152 eastbound at I-5 in the AM and PM peak hours and SR 33 northbound at I-5 segments in the AM peak hour. Even though the LOS increases after the construction-related trips are added on these two segments, for the SR 152 eastbound at I-5 segment, it does not exceed the threshold of significance (LOS C) for rural roadways shown in Table F-4. For the SR 33 NB at I-5 segment, the projected future No Action traffic conditions are at LOS D so the additional trips are not expected to change traffic conditions from acceptable to unacceptable.

In Santa Clara County, none of the study roadway segments need to be evaluated, because the added construction trips would be less than one percent of the respective roadway capacities (the VTA threshold for freeway segment evaluation).

Table F-19. Merced County Roadway Operations – Pacheco Reservoir Expansion Alternative

Roadway	Future (2027) AADT[1]	No Action LOS (2027)	Maximum Daily Truck Trips	Maximum Daily Worker Trips	Total AADT During Construction	LOS during Construction	LOS Change
I-5 at SR 152	33,800	B	144	238	34,182	B	No Change
SR 152 at I-5	28,500	B	144	238	28,882	B	No Change
SR 152 at SR 33	30,200	B	288	476	30,964	B	No Change
SR 33 at I-5	13,600	F	142	238	13,980	F	No Change

Note:
[1] Source: 0.5% annual growth rate applied to existing volumes from Caltrans 2016

Table F-20. Merced County Roadway AM/PM Peak Hour Operations – Pacheco Reservoir Expansion Alternative

Roadway	Future (2027) Volume[1]	Future LOS (2027)	Maximum Truck Trips	Maximum Worker Trips	Total AADT During Construction	LOS during Construction	LOS Change
AM Peak Hour							
I-5 NB at SR 152	2,150	C	8	0	2,158	C	No change
I-5 SB at SR 152	1,800	C	8	31	1,839	C	No change
SR 152 EB at I-5	1,100	A	8	32	1,140	B	Higher but does not exceed LOS C
SR 152 WB at I-5	1,500	B	8	0	1,508	B	No change
SR 152 EB at SR 33	200	A	16	63	279	A	No change
SR 152 WB at SR 33	1,600	B	16	0	1,616	B	No change
SR 33 NB at I-5	600	D	6	31	637	E	Higher but No Action already exceeds LOS C
SR 33 SB at I-5	350	D	6	0	356	D	No change
PM Peak Hour							
I-5 NB at SR 152	2,250	C	8	31	2,289	C	No change
I-5 SB at SR 152	1,150	B	8	0	1,158	B	No change
SR 152 EB at I-5	1,800	B	8	0	1,808	C	Higher but does not exceed LOS C
SR 152 WB at I-5	850	A	8	32	890	A	No change
SR 152 EB at SR 33	1,900	C	16	0	1,916	C	No change
SR 152 WB at SR 33	700	A	16	63	779	A	No change
SR 33 NB at I-5	700	E	6	0	706	E	No change
SR 33 SB at I-5	300	D	6	31	337	D	No change

Note:
[1] Source: 0.5% annual growth rate applied to existing volumes from Caltrans 2016 (AADT directly from the source; AM and PM peak hours volumes derived from the source)

Table F-21. Santa Clara County Roadway Operations – Pacheco Reservoir Expansion Alternative

Roadway	Direction	Number of Lanes	Roadway Capacity[1] (vph)	Maximum Peak Construction Trips			Added Trips Less Than 1% of Roadway Capacity?[2]	Need Evaluation?
				Truck	Worker	Total		
US 101 at SR 152	Northbound	3	6,900	0	31	31	Yes	No
	Southbound	3	6,900	0	31	31	Yes	No
SR 152 at SR 156	Eastbound	2	4,400	0	31	31	Yes	No
	Westbound	2	4,400	0	31	31	Yes	No

Key:
[1] Based on the guidelines provided in the Transportation Impact Analysis Guidelines, VTA CMP, October 2014.
[2] VTA recommended threshold for evaluation of highway segments.

F.4 References

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San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix F: Attachment A, 2016 Traffic Volumes on California State Highways

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Dist	Route	County	Postmile	Description	Back Peak Hour	Back Peak Month	Back AADT	Ahead Peak Hour	Ahead Peak Month	Ahead AADT
06	005	KER	33.489	JCT. RTE. 223	5300	44000	37000	5500	46000	38000
06	005	KER	38.793	JCT. RTE. 119	5500	45500	38000	5500	47500	38000
06	005	KER	41.193	JCT. RTE. 43	5600	47500	38000	5600	46000	36500
06	005	KER	47.546	STOCKDALE ROAD	5600	46000	36500	5400	50000	41000
06	005	KER	52.145	JCT. RTE. 58	5400	50000	41000	5400	47500	39500
06	005	KER	56.642	7TH STANDARD ROAD	5200	46500	38000	5100	45000	38000
06	005	KER	58.006	ROWLEE ROAD	5200	45500	38500	5700	49000	41500
06	005	KER	62.605	LERDO AVENUE	5700	49000	41500	5500	48000	40500
06	005	KER	73.017	JCT. RTE. 46	5500	48000	40500	4650	41000	34500
06	005	KER	82.347	TWISSELMAN ROAD	4650	41000	34500	4600	40500	34000
06	005	KER	87.025	KERN/KINGS COUNTY LINE	4600	40500	34000			
06	005	KIN	0	KERN/KINGS COUNTY LINE				4600	40500	34000
06	005	KIN	12.362	UTICA AVENUE	4600	40500	34000	5100	45000	37500
06	005	KIN	16.595	JCT. RTE. 41	5100	45000	37500	5300	47500	39000
06	005	KIN	26.724	KINGS/FRESNO COUNTY LINE	5300	47500	39000			
06	005	FRE	0	KINGS/FRESNO COUNTY LINE				5300	47500	39000
06	005	FRE	.228	JCT. RTE. 269	5300	47500	39000	5000	46000	37500
06	005	FRE	5.501	JAYNE AVENUE	5000	46000	37500	4950	45500	37000
06	005	FRE	14.873	JCT. RTE. 198	4950	45500	37000	5100	47500	39000
06	005	FRE	17.964	JCT. RTE. 33 SOUTH, JCT. RTE. 145 NORTH	5100	47500	39000	5300	48500	40000
06	005	FRE	29.955	JCT. RTE. 33 NORTH	5300	48500	40000	5200	44000	38500
06	005	FRE	38.359	KAMM AVENUE	5200	44000	38500	5400	45500	39500
06	005	FRE	45.798	MANNING AVENUE	5400	45500	39500	5400	46500	40500
06	005	FRE	48.99	PANOCHE ROAD	5400	46500	40500	5300	46000	41000
06	005	FRE	52.746	RUSSELL AVENUE	5300	46000	41000	5100	45000	40000
06	005	FRE	60.077	SHIELDS AVENUE	5100	45000	40000	5200	48500	40500
06	005	FRE	65.782	NEES AVENUE	5200	48500	40500	5200	49000	41000
06	005	FRE	66.159	FRESNO/MERCED COUNTY LINE	5200	49000	41000			
10	005	MER	0	FRESNO/MERCED COUNTY LINE				5600	45500	38000
10	005	MER	6.28	JCT. RTE. 165 NORTH	3900	35500	30000	4750	40500	34000
10	005	MER	17.578	JCT. RTE. 152	5300	35000	32000	4050	40000	31600
10	005	MER	21.839	JCT. RTE. 33	3950	39500	30900	3100	33000	29100
10	005	MER	23.6	NORTH OF ROUTE 33 @ SANTA NELLA TRUCK SCALES	4000	37000	32500	4000	42500	37400
10	005	MER	32.391	JCT. RTE. 140 EAST	3650	41000	39500	4050	42500	41500
10	005	MER	32.477	MERCED/STANISLAUS COUNTY LINE	4050	42500	41500			
10	005	STA	0	MERCED/STANISLAUS COUNTY LINE				3700	42500	41500
10	005	STA	5.505	STUHR ROAD	3700	41000	40000	3700	41000	40000

Dist	Route	County		Postmile	Description	Back Peak Hour	Back Peak Month	Back AADT	Ahead Peak Hour	Ahead Peak Month	Ahead AADT
06	033	FRE		72.837	DOUGLAS AVENUE	300	3400	2850	300	3400	2850
06	033	FRE	R	79.905	BRANNON AVENUE	270	3200	2550	370	3050	2350
10	033	MER	L	1.232	FRESNO/MERCED COUNTY LINE	300	4050	3300			
10	033	MER	R	0	FRESNO/MERCED COUNTY LINE				300	4050	3300
10	033	MER	R	1.17	DOS PALOS, BLOSSOM STREET	710	9200	7400	810	7600	6100
10	033	MER		1.888	CARMELLIA AVENUE	620	6600	6000	520	6600	5850
10	033	MER	R	5.635	EAST JCT. RTE. 152	980	11900	9400	680	7800	6800
10	033	MER	R	13.238	WEST JCT. RTE 152	680	7800	6800	880	10200	8800
10	033	MER	R	15.6	VERA CRUZ DRIVE	1050	10800	9800	830	10600	9700
10	033	MER	R	16.258	CENTINELLA, HENRY MILLER ROAD	950	11100	9700	1200	12700	10100
10	033	MER	R	16.643	JCT. RTE. 5	1200	14200	12900	1350	15300	14200
10	033	MER		17.27	MC CABE ROAD	470	5800	5700	450	5600	5500
10	033	MER		27.111	NORTH JCT. RTE. 140 EAST	710	9400	7600	800	9900	8850
10	033	MER		30.302	MERCED/STANISLAUS COUNTY LINE	590	6400	6350			
10	033	STA		0	MERCED/STANISLAUS COUNTY LINE				590	6400	6350
10	033	STA		.68	NEWMAN, MERCED STREET	780	9600	9000	720	9200	8400
10	033	STA		.95	NEWMAN, DRISKELL ROAD/KERN STREET	710	9200	9100	750	7300	7250
10	033	STA		2.06	STUHR ROAD	780	8900	8400	430	4500	4400
10	033	STA		4.82	J.T. CROW RD RT	470	5800	5500	510	5800	5500
10	033	STA		6.838	CROWS LANDING, CROWS LANDING/FINK ROADS	560	6200	6000	330	4900	4600
10	033	STA		7.04	CROWS LANDING, 4TH STREET	390	4250	3750	430	4550	3950
10	033	STA		12.571	PATTERSON, SPERRY ROAD	610	6700	4900	570	6600	5500
10	033	STA		13.1	SALADO AVENUE/EL CIRCULO	810	8800	6900	850	9600	6700
10	033	STA		13.18	LAS PALMAS AVENUE	90	6200	6100	510	6500	6400
10	033	STA		13.26	DEL PUERTO AVENUE/EL CIRCULO	540	6000	4500	650	7200	5400
10	033	STA		14.52	WARD AVENUE	540	5800	5250	560	5600	5500
10	033	STA		16.43	BALDWIN RD-LT	450	4850	4800	420	4500	3900
10	033	STA		19.55	WESTLEY, GRAYSON/HOWARD ROADS	400	4200	3800	310	3200	3100
10	033	STA		19.92	WESTLEY, E STREET	270	3200	3000	220	2750	2500
10	033	STA		27.086	STANISLAUS/SAN JOAQUIN COUNTY LINE	610	6400	6350			
10	033	SJ		0	STANISLAUS/SAN JOAQUIN COUNTY LINE				610	6400	6350
10	033	SJ		.818	VERNALIS, JCT. RTE. 132	240	3600	2900	290	3650	3600
10	033	SJ		3.51	NEW JERUSALEM, DURHAM FERRY ROAD	290	3650	3600	290	3450	2400
10	033	SJ		4.826	JCT. RTE. 5	800	4400	3900			
07	034	VEN		4.295	OXNARD, JCT. RTE. 1				1500	14800	14000
07	034	VEN		6.27	OXNARD, RICE AVENUE	1250	10700	10200	1500	12200	11700
07	034	VEN		8.43	PLEASANT VALLEY ROAD, WEST JUNCTION	1500	12200	11700	1450	11300	9600

Dist	Route	County		Postmile	Description	Back Peak Hour	Back Peak Month	Back AADT	Ahead Peak Hour	Ahead Peak Month	Ahead AADT
03	084	YOL		15.687	END OF ROUTE	140	1450	1300			
04	085	SCL		0	SAN JOSE, JCT. RTE. 101				4600	56000	55000
04	085	SCL		.181	SAN JOSE, BERNAL ROAD	4600	56000	55000	6200	76000	74000
04	085	SCL		.79	SAN JOSE, GREAT OAKS BOULEVARD	6500	80000	78000	7500	92000	90000
04	085	SCL		1.973	SAN JOSE, COTTLE ROAD	7500	92000	90000	9900	121000	118000
04	085	SCL		3.93	SAN JOSE, BLOSSOM HILL ROAD	9900	121000	118000	12300	158000	154000
04	085	SCL		5.22	JCT. RTE. 87	12300	158000	154000	11400	147000	143000
04	085	SCL		6.136	ALMADEN EXPRESSWAY	11400	147000	143000	10200	130000	127000
04	085	SCL		8.109	SAN JOSE, CAMDEN AVENUE	10200	130000	127000	11000	141000	138000
04	085	SCL		9.277	SAN JOSE, UNION AVENUE	11000	141000	138000	11400	146000	142000
04	085	SCL	R	10.231	SAN JOSE, BASCOM AVENUE	11400	146000	142000	10200	131000	128000
04	085	SCL	R	10.498	JCT. RTE. 17	10200	131000	128000	8700	116000	112000
04	085	SCL	R	10.997	LOS GATOS, WINCHESTER BLVD.	8700	116000	112000	9700	128000	124000
04	085	SCL	R	13.684	SARATOGA, SARATOGA AVENUE	9700	128000	124000	8700	115000	111000
04	085	SCL	R	15.867	CUPERTINO, SARATOGA-SUNNYVALE ROAD	8700	115000	111000	9000	119000	115000
04	085	SCL	R	17.699	CUPERTINO, STEVENS CREEK BOULEVARD	9000	119000	115000	9100	121000	117000
04	085	SCL	R	18.448	SUNNYVALE, JCT. RTE. 280	9100	121000	117000	9200	124000	120000
04	085	SCL	R	18.861	CUPERTINO, HOMESTEAD ROAD	9200	124000	120000	9700	131000	127000
04	085	SCL	R	19.856	SUNNYVALE, FREMONT AVENUE	9700	131000	127000	9400	126000	122000
04	085	SCL	R	21.749	MOUNTAIN VIEW, JCT. RTE. 82	9400	126000	122000	8400	114000	110000
04	085	SCL	R	22.163	JCT. RTE. 237	8400	114000	110000	6600	89000	86000
04	085	SCL	R	22.629	MOUNTAIN VIEW, EVELYN AVENUE	6600	89000	86000	6400	87000	84000
04	085	SCL	R	23.435	MOUNTAIN VIEW, MOFFETT BOULEVARD	6400	87000	84000	5800	79000	76000
04	085	SCL	R	23.867	MOUNTAIN VIEW, JCT. RTE. 101	5800	79000	76000	5800	79000	76000
04	085	SCL	R	24.059	END OF ROUTE	5800	79000	76000			
11	086	IMP	R	0	BEGIN ROUTE, JCT. RTE. 111				510	5800	5500
11	086	IMP		2.077	DOGWOOD ROAD	620	6400	5900	530	5200	4850
11	086	IMP		3.05	WEST HEBER TURN	530	5200	4850	400	4050	3800
11	086	IMP		4.53	MC CABE ROAD	400	4050	3800	600	7900	7800
11	086	IMP		6.006	JCT. RTE. 8	2250	24100	23000	2850	32000	30500
11	086	IMP	L	6.534	EL CENTRO, ROSS AVENUE	2850	32000	30500	2750	29500	28500
11	086	IMP		7.24	EL CENTRO, STATE STREET	2750	29500	28500	2500	28500	27500
11	086	IMP	L	7.308	MAIN STREET	2500	28500	27500	1700	20500	18900
11	086	IMP	L	8.028	EL CENTRO, EIGHTH STREET	1700	20500	18900	1550	18100	17100
11	086	IMP	L	8.525	ADAMS/IMPERIAL AVENUES	1550	18100	17100	2600	31500	28500
11	086	IMP		7.43	EL CENTRO, EUCLID/HOGAR AVENUE	2600	31500	28500	2400	28000	26000
11	086	IMP		7.49	EL CENTRO, WOODWARD AVENUE	2400	28000	26000	2450	29000	26500

Dist	Route	County		Postmile	Description	Back Peak Hour	Back Peak Month	Back AADT	Ahead Peak Hour	Ahead Peak Month	Ahead AADT
08	086	RIV	R	16.744	AIRPORT BLVD	1850	23900	21000	2500	32000	28000
08	086	RIV	R	22.157	DILLON ROAD	2500	32000	28000	2750	35500	31000
08	086	RIV	R	23	JCT. RTE. 10	2750	35500	31000			
04	087	SCL		0	SAN JOSE, JCT. RTE 85, BEGIN ROUTE				9300	122000	119000
04	087	SCL		1.34	CAPITOL EXPRESSWAY	9300	122000	119000	10200	136000	133000
04	087	SCL		2.826	CURTNER AVENUE	10200	136000	133000	9900	131000	128000
04	087	SCL		3.563	ALMADEN EXPRESSWAY	9900	131000	128000	11200	155000	149000
04	087	SCL		4.35	SAN JOSE, LELONG STREET	11200	155000	149000	12700	176000	169000
04	087	SCL		5.156	SAN JOSE, JCT. RTE. 280	12700	176000	169000	9200	128000	123000
04	087	SCL		6.1	SAN JOSE, JULIAN STREET	9200	128000	123000	9300	128000	123000
04	087	SCL		6.69	W. TAYLOR	9300	128000	123000	6900	95000	91000
04	087	SCL	T	8.755	AIRPORT PARKWAY	6900	95000	91000	6500	90000	86000
04	087	SCL		9.22	JCT. RTE. 101	6500	90000	86000			
10	088	SJ		0	JCT. RTE. 99; STOCKTON WEST				2800	26500	24100
10	088	SJ		.4	WILCOX ROAD	1400	19300	17000	1600	21100	18000
10	088	SJ		1.77	WHITE LANE	1300	17000	14500	1200	16100	13800
10	088	SJ		2.22	FAIRCHILD LANE	1200	16100	13800	1050	13900	11900
10	088	SJ		4.94	WATERLOO, FERGUSON/ COMSTOCK ROAD	830	10900	9300	640	8500	7200
10	088	SJ		6.518	EIGHT MILE ROAD	650	8600	7350	950	9600	8600
10	088	SJ		9.61	HARNEY LANE	820	9200	8100	970	11100	9800
10	088	SJ	L	12.24	LOCKEFORD, JCT RTE 12 WEST	980	11800	10700	1600	15500	15300
10	088	SJ		13.6	JACKTONE ROAD	1500	18000	14600	1850	20400	15600
10	088	SJ		14.08	ELLIOTT/TULLY ROAD	1850	20100	15600	1700	17400	13500
10	088	SJ		16.27	DISCH ROAD	1550	15600	12100	1050	13600	10900
10	088	SJ		18.08	MACKVILLE ROAD	1100	15100	12600	1050	16000	11700
10	088	SJ		19.174	CLEMENTS, JCT. RTE. 12 EAST	1250	13400	12400	1400	15000	13600
10	088	SJ		22.093	LIBERTY ROAD	1000	10700	9750	1000	9400	8700
10	088	SJ		25.365	SAN JOAQUIN/AMADOR COUNTY	1000	8700	8100			
10	088	AMA		0	SAN JOAQUIN/AMADOR COUNTY				950	8700	8100
10	088	AMA		5.527	JCT. RTE. 124 NORTH	1000	10100	9400	830	7500	6800
10	088	AMA		7.389	WEST JCT. RTE. 104	990	8500	8400	1150	12100	12000
10	088	AMA		12.68	EAST JCT. RTE. 104	860	9300	8650	1150	9000	8300
10	088	AMA		14.25	JCT. RTE. 49	1200	9300	8800	920	8900	8400
10	088	AMA		14.9	JACKSON, COURT STREET	920	8900	8400	950	10000	8900
10	088	AMA		22.69	PINE GROVE, RIDGE ROAD	1450	14300	12000	1900	21700	12000
10	088	AMA		23.36	VOLCANO ROAD	1900	21700	12000	1400	14500	12000
10	088	AMA	R	26.791	JCT. RTE. 26, RED CORRAL RD	1150	9900	9300	970	7800	7200

Dist	Route	County		Postmile		Description	Back Peak Hour	Back Peak Month	Back AADT	Ahead Peak Hour	Ahead Peak Month	Ahead AADT
05	101	SBT		0		MONTEREY/SAN BENITO COUNTY LINE				5700	77000	64000
05	101	SBT		.312	R	BEGIN RIGHT ALIGN				2750	38000	33000
05	101	SBT		2.998	R	JCT. RTE. 156 EAST	2750	38000	33000	2250	32500	26700
05	101	SBT		3.173	R	END RIGHT ALIGN	2250	30000	26700			
05	101	SBT		.312	L	BEGIN LEFT ALIGN				2650	34500	31000
05	101	SBT		3.049	L	NORTH JCT. RTE. 156	2650	35000	31000	2450	34000	26700
05	101	SBT		3.229	L	END LEFT ALIGN	2400	31000	26000			
05	101	SBT	R	4.898		JCT. RTE. 129 WEST	4750	59000	52000	5000	63000	53000
05	101	SBT	R	6.485		LOMERIAS	5000	63000	53000	5000	61000	53000
05	101	SBT		7.55		SAN BENITO/SANTA CLARA COUNTY LINE	5700	68000	60000			
04	101	SCL		.028		SAN BENITO/SANTA CLARA COUNTY LINE				5700	68000	60000
04	101	SCL		3.16		JCT. RTE. 25 EAST	5500	68000	60000	6400	88000	80000
04	101	SCL	R	4.942		MONTEREY ROAD	6400	88000	80000	6200	85000	77000
04	101	SCL	R	6.08		GILROY, JCT. RTE. 152 EAST	6200	85000	77000	8000	111000	102000
04	101	SCL	R	7.532		GILROY, NORTH JCT. RTE. 152 WEST	8100	110000	102000	8700	117000	110000
04	101	SCL	R	10.27		MASTEN AVENUE	8700	117000	110000	9500	129000	122000
04	101	SCL	R	12.46		SAN MARTIN	9300	129000	122000	9400	133000	125000
04	101	SCL	R	15.069		TENNANT AVENUE	9400	133000	125000	9800	138000	130000
04	101	SCL	R	16.006		EAST DUNNE AVENUE	9800	138000	130000	10300	145000	137000
04	101	SCL	R	17.82		MORGAN HILL, COCHRAN ROAD	10300	145000	137000	10800	151000	144000
04	101	SCL	R	26.78		SAN JOSE, JCT. RTE. 85	11300	156000	150000	9000	125000	120000
04	101	SCL	R	28.609		SAN JOSE, JCT. RTE. 82 NORTH	9000	125000	120000	11400	158000	153000
04	101	SCL		30.097		HELLYER AVENUE	11300	158000	153000	12600	176000	170000
04	101	SCL		31.695		SAN JOSE, CAPITOL EXPRESSWAY	12600	176000	170000	16600	236000	228000
04	101	SCL		33.034		SAN JOSE, TULLY ROAD	16600	236000	228000	19400	279000	270000
04	101	SCL		34.87		SAN JOSE, JCT. RTE. 280 WEST, JCT. RTE. 680 NORTH	19400	279000	270000	13900	208000	198000
04	101	SCL	R	35.759		SAN JOSE, JCT. RTE. 130 EAST	13900	208000	198000	12500	187000	178000
04	101	SCL	R	36.144		SAN JOSE, MC KEE ROAD	12700	190000	181000	13300	200000	190000
04	101	SCL		37.726		SAN JOSE, OAKLAND ROAD	13300	200000	190000	13700	204000	193000
04	101	SCL		38.3		SAN JOSE, JCT. RTE. 880	13700	204000	193000	10400	155000	148000
04	101	SCL		38.8		SAN JOSE, NORTH FOURTH STREET	10400	155000	148000	9800	146000	140000
04	101	SCL		39.285		SAN JOSE, NORTH FIRST STREET	9800	146000	140000	10600	157000	152000
04	101	SCL		39.925		JCT. RTE. 87, GUADALUPE PARKWAY	9900	145000	141000	13700	199000	195000
04	101	SCL		40.701		SAN JOSE, DE LA CRUZ BLVD/TRIMBLE RD	12800	187000	183000	13500	197000	193000
04	101	SCL		41.978		SAN TOMAS EXPRESSWAY	13500	197000	193000	13900	202000	198000
04	101	SCL		42.734		GREAT AMERICA PARKWAY/ BOWERS AVE	13900	202000	198000	13100	191000	187000
04	101	SCL		43.85		SUNNYVALE, LAWRENCE EXPRESSWAY	13100	191000	187000	12700	185000	181000

Dist	Route	County		Postmile		Description	Back Peak Hour	Back Peak Month	Back AADT	Ahead Peak Hour	Ahead Peak Month	Ahead AADT
02	151	SHA	R	5.93	L	ON FRONT ST AT HARDENBROOK AVE	460	4700	4000	460	4700	4000
02	151	SHA	R	5.993	L	FRONT ST/SHASTA DAM BLVD, END LEFT ALIGN	460	4700	4000			
02	151	SHA		6.79		CASCADE BOULEVARD	1250	13100	12700	1200	13000	12600
02	151	SHA	R	6.924		JCT. RTE. 5	1200	13000	12600			
05	152	SCR	T	.31		WATSONVILLE, JCT. RTE. 1				2650	28000	26700
05	152	SCR	T	.676		GREEN VALLEY RD	2650	29000	26700	3700	30500	29000
05	152	SCR	T	2.5		WATSONVILLE, FREEDOM BLVD	3700	30500	29000	2150	22200	21300
05	152	SCR	T	2.803		WATSONVILLE, MAIN STREET AT EAST LAKE STREET	2150	22200	21300	2600	23400	22600
05	152	SCR	T	2.929	R	WATSONVILLE, ON EAST LAKE/MAIN ST, RIGHT ALIGN				1000	8900	8100
05	152	SCR	T	3.273	R	EAST BEACH ST AT LINCOLN, END RIGHT ALIGN	890	7900	7100			
05	152	SCR	T	2.929	L	WATSONVILLE,ON EAST LAKE/MAIN STREET, LEFT ALIGN				900	8200	7400
05	152	SCR	T	3.273	L	WATSONVILLE, EAST LAKE/LINCOLN, END LEFT ALIGN	900	8200	7400			
05	152	SCR		.383		ON EAST LAKE ST AT LINCOLN ST	1700	16800	14900	1700	16800	14900
05	152	SCR		.714		BECK AVENUE	1700	16800	14900	1900	17600	16300
05	152	SCR	R	1.995		HOLOHAN/COLLEGE ROAD	2100	17600	16300	1350	17300	13800
05	152	SCR		3.69		CARLTON/CASSERLY ROAD	980	12200	8700	870	10600	6700
05	152	SCR		8.29		SANTA CRUZ/SANTA CLARA COUNTY LINE	690	7000	6200			
04	152	SCL		0		SANTA CRUZ/SANTA CLARA COUNTY LINE				730	6900	6100
04	152	SCL		5.03		WATSONVILLE RD	730	6900	6100	710	6700	5900
04	152	SCL		7.93		GILROY, SANTA TERESA BLVD	1050	10800	9600	2150	22100	19600
04	152	SCL	M	9.43		MONTEREY STREET	2050	21000	18600	2300	23500	20800
04	152	SCL	M	9.78		GILROY ON LEEAVESLEY AVENUE	2300	23500	20800	2500	27000	24000
04	152	SCL	M	10.277		GILROY, JCT. RTE. 101	3900	44000	39000	2450	31000	27000
04	152	SCL		14.89		BLOOMFIELD AVE.	2450	31000	27000	2600	33500	29000
04	152	SCL	R	21.977		JCT. RTE. 156 SOUTH	2350	30000	26000	4050	46500	39500
04	152	SCL	R	23.409		CASA DE FRUTA	4050	47000	39500	4000	46500	39000
04	152	SCL	R	35.161		SANTA CLARA/MERCED COUNTY LINE	3900	45000	38000			
10	152	MER	R	0		SANTA CLARA/MERCED COUNTY LINE				3600	41500	34800
10	152	MER	R	13.24		WEST JCT. RTE. 33	3050	35000	29100	2900	34000	28600
10	152	MER		13.848		JCT. RTE. 5	3100	36500	30700	2150	31500	27000
10	152	MER		19.268		LOS BANOS, ORTIGALITA ROAD	1900	24200	23000	2900	29500	28000
10	152	MER		19.618		LOS BANOS, WEST I STREET	2900	31000	28000	2500	31500	30000
10	152	MER		20.598		LOS BANOS, 7TH STREET	3000	35500	31500	2500	34000	33500
10	152	MER		21.058		LOS BANOS, EAST I STREET	2250	31000	30500	2500	33500	29000
10	152	MER		21.272		LOS BANOS, JCT. RTE. 165	2450	31500	28000	2850	38000	33500
10	152	MER		22.252		LOS BANOS, WARD ROAD	2850	38000	33500	1750	21100	19400
10	152	MER		23.915		LOS BANOS, SANTA FE ROAD	1900	23800	21200	1900	20700	19800

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10	152	MER	R	32.366	DOS PALOS WYE, EAST JCT. RTE. 33	1900	20700	19700	1550	19400	17200
10	152	MER	R	40.77	JCT. RTE. 59	1650	17700	17000	1450	16000	15800
10	152	MER	R	40.949	MERCED/MADERA COUNTY LINE	1550	21000	18700			
06	152	MAD	R	0	MERCED/MADERA COUNTY LINE				1500	18400	16400
06	152	MAD		10.799	JCT. RTE. 233 NORTHWEST	1350	16500	14400	1300	16200	14100
06	152	MAD		15.634	CALIFA, JCT. RTE. 99	1650	18400	16400			
03	153	ED		0	JCT. RTE. 49				260	3200	2000
03	153	ED		.12	COLD SPRINGS ROAD	260	3200	2000	20	140	90
03	153	ED		.55	MARSHALL'S MONUMENT	20	140	90			
05	154	SB	R	0	JCT. RTE. 101				1100	14000	12000
05	154	SB	R	8.11	JCT. RTE. 246 WEST	1300	16000	14000	1300	16000	14200
05	154	SB		14.77	ENTRANCE, LAKE CACHUMA COUNTY PARK	1300	16000	14300	1200	15000	13100
05	154	SB		23.38	STAGECOACH ROAD	1400	17000	14800	1400	17000	14700
05	154	SB	R	31.551	JCT. RTE. 192 EAST	1600	20000	17300	1800	22000	19400
05	154	SB		32.285	JCT. RTE. 101	1800	22000	19000	1700	21000	18500
05	154	SB		32.84	STATE STREET AND NB 101 RAMPS	1700	21000	18300			
06	155	KER	L	0	DELANO ON FREMONT/ 9TH AND OFF/ON RAMPS NB 99				380	2800	2150
06	155	KER	L	.27	DELANO, FREMONT STREET/6TH AVENUE	390	2300	2200	390	2300	2200
06	155	KER	L	.402	DELANO ON ELLINGTON/9TH AND OFF/ON RAMPS SB 99	480	4950	4800	480	4950	4800
06	155	KER		0	DELANO ON ELLINGTON/9TH AND OFF/ON RAMPS SB 99	480	4950	4800	480	4950	4800
06	155	KER		.388	DELANO, ELLINGTON STREET/ 4TH AVENUE	480	4900	4750	1050	11700	10500
06	155	KER	R	0	DELANO, JCT. RTE. 99	1050	11700	10500	1150	12100	11300
06	155	KER	R	.22	DELANO, HIGH STREET	1350	14500	13500	1100	11900	11000
06	155	KER	R	.47	DELANO, LEXINGTON AVENUE	880	10100	9200	960	11200	10900
06	155	KER	R	1.46	DELANO, EAST CITY LIMITS, BROWNING ROAD	470	5600	5300	330	3450	3250
06	155	KER	R	3.469	ZACHARY AVENUE	260	2800	2600	430	2600	2400
06	155	KER	R	6.55	FAMOSO-PORTERVILLE HIGHWAY	280	1750	1600	80	500	450
06	155	KER	R	10.99	JCT. RTE. 65	80	500	450	40	260	180
06	155	KER	R	26.564	JUNCTION OLD ROUTE 155 AT WOODY ROAD	40	220	170	40	240	180
06	155	KER		38.25	GLENVILLE, GRANITE ROAD	150	860	730	150	900	750
06	155	KER		40.48	EAST LIMITS GLENVILLE	70	500	360	70	450	360
06	155	KER	R	53.22	ALTA SIERRA, VIA EVANS ROAD	70	440	360	70	390	350
06	155	KER	R	60.637	WOFFORD BOULEVARD	190	1850	1700	730	7100	6300
06	155	KER	R	61.04	JUNCTION OLD ROUTE 155	730	7100	6300	660	6200	5500
06	155	KER	R	70.991	JCT. RTE. 178	700	6500	5500			
05	156	MON	R	.167	JCT. RTE. 1				3400	36000	32000
05	156	MON	R	1.109	JCT. RTE. 183	3650	36000	32000	3400	38000	33000

Dist	Route	County		Postmile	Description	Back Peak Hour	Back Peak Month	Back AADT	Ahead Peak Hour	Ahead Peak Month	Ahead AADT
02	273	SHA		16.833	JCT. RTE. 299 W AND JCT. RTE. 44 E				1750	17400	15800
02	273	SHA		17.39	QUARTZ HILL/RIO	1700	17400	16200	1800	19300	19000
02	273	SHA		17.81	REDDING, BENTON DRIVE	1800	19300	19000	1950	21700	20800
02	273	SHA		18.622	LAKE BOULEVARD	1950	21700	20800	1250	12800	12700
02	273	SHA		18.92	TWINVIEW BOULEVARD	1250	12800	12700	860	14200	9000
02	273	SHA		19.77	CATERPILLAR ROAD	860	14200	9000	710	7300	7100
02	273	SHA		20.033	JCT. RTE. 5	710	7300	7100			
03	275	YOL		12.009	JCT. RTE. 50				1350	11300	9300
03	275	YOL		12.039	WEST SACRAMENTO, JCT. RTE. 84	1350	11300	9300	1850	18000	16500
03	275	YOL		13.077	SAC/YOL COUNTY LINE, END OF ROUTE	1850	18000	16500			
03	275	SAC		0	SAC/YOL COUNTY LINE, END OF ROUTE				1850	18000	16500
04	280	SCL	R	0	SAN JOSE, JCT. RTES. 101/680				12600	169000	164000
04	280	SCL	R	.366	MCLAUGHLIN AVENUE	13400	179000	174000	19800	264000	256000
04	280	SCL	R	1.294	SAN JOSE, 10TH STREET	19800	264000	256000	17900	238000	231000
04	280	SCL	R	1.992	SAN JOSE, JCT. RTE. 82	17900	238000	231000	18600	247000	240000
04	280	SCL	R	2.522	SAN JOSE, JCT. RTE. 87	18600	247000	240000	15100	201000	195000
04	280	SCL	R	2.875	SAN JOSE, BIRD AVENUE	15100	201000	195000	18600	248000	241000
04	280	SCL	R	3.764	RACE STREET/SOUTHWEST EXPRESSWAY	18600	248000	241000	12900	172000	167000
04	280	SCL	L	4.663	SAN JOSE, LELAND AVENUE	14400	193000	187000	15800	211000	205000
04	280	SCL	L	5.408	SAN JOSE, JCT. RTES. 17/880	15800	211000	205000	15100	202000	195000
04	280	SCL	L	5.954	SAN JOSE, WINCHESTER BOULEVARD	15100	202000	195000	17000	228000	220000
04	280	SCL		5.949	SAN JOSE, SARATOGA AVENUE	17000	228000	220000	14900	199000	192000
04	280	SCL		7.123	SAN JOSE, LAWRENCE EXPRESSWAY	14900	199000	192000	11600	155000	150000
04	280	SCL		7.388	STEVENS CREEK BOULEVARD	11600	155000	150000	13200	176000	170000
04	280	SCL		8.375	CUPERTINO, WOLFE ROAD	13200	176000	170000	12500	168000	162000
04	280	SCL		9.433	SARATOGA, SUNNYVALE/DE ANZA BOULEVARD	12500	168000	162000	11300	151000	146000
04	280	SCL		10.741	SUNNYVALE, JCT. RTE. 85	11300	151000	146000	17800	154000	149000
04	280	SCL		11.447	CUPERTINO, FOOTHILL BOULEVARD	17800	154000	149000	14900	129000	125000
04	280	SCL		14.098	MAGDALENA AVENUE	14900	129000	125000	15100	130000	126000
04	280	SCL		15.046	LOS ALTOS HILLS, EL MONTE AVENUE	15100	130000	126000	14100	122000	118000
04	280	SCL		18.379	PAGE MILL ROAD	14100	122000	118000	13200	114000	110000
04	280	SCL		20.613	ALPINE ROAD	13200	114000	110000	12200	106000	102000
04	280	SCL		20.625	SANTA CLARA/SAN MATEO COUNTY LINE	12200	106000	102000			
04	280	SM	R	0	SANTA CLARA/SAN MATEO COUNTY LINE				12200	106000	102000
04	280	SM	R	1.56	JCT. RTE. 114	12200	106000	102000	12200	106000	102000
04	280	SM	R	1.61	SAND HILL ROAD	12200	106000	102000	13300	115000	111000
04	280	SM	R	3.337	WOODSIDE, JCT. RTE. 84	13300	115000	111000	13000	113000	109000

San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix G: Regional Economics IMPLAN Analysis

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Appendix G
Regional Economics IMPLAN Analysis

This appendix presents regional economic data from Impact Planning and Analysis (IMPLAN) (See Section G.1, Existing Conditions) and IMPLAN results for the San Luis Low Point Improvement Project (SLLPIP) Environmental Impact Statement /Environmental Impact Report (EIS/EIR) Alternatives (See Section G.2, Environmental Consequences/Environmental Impacts).

Regional economic data is presented at a county level, with data from the United States (U.S.) Census Bureau and IMPLAN 2014 data (see Section G.2 for a description of IMPLAN). IMPLAN data files are compiled annually from a variety of sources including, but not limited to, the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor, and the U.S. Census Bureau. Output represents the dollar value of industry production. Labor income is the dollar value of total payroll (including benefits) for each industry plus income received by self-employed individuals.

G.1 Existing Conditions

G.1.1 San Joaquin Valley Region

The Central Valley Project (CVP) and State Water Project (SWP) water service contractors within the San Joaquin Valley have service areas within Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare counties.

Table G-1 presents the regional economy for this entire region, followed tables for each individual county. Industry summaries are aggregated using IMPLAN's default aggregation scheme which categorizes each Industry Sector into eight broad sector categories (MIG 2018).

Table G-1. San Joaquin Valley 2014 Regional Economy Summary (Fresno, Kern, Kings, Merced, San Joaquin, Stanislaus, and Tulare Counties)

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	244,649	$36,579.8	$14,700.4
Mining	20,672	$12,847.9	$2,503.8
Construction	83,509	$14,268.1	$4,278.3
Manufacturing	127,519	$69,213.6	$7,516.5

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
TIPU	92,081	$25,931.4	$6,232.2
Trade	233,472	$28,185.6	$9,810.3
Service	754,630	$87,209.7	$29,790.3
Government	268,377	$28,581.5	$21,528.1
Total	1,824,909	$302,817.6	$96,359.9

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-2. Fresno County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	58,143	$7,985.6	$3,259.9
Mining	739	$225.2	$54.9
Construction	19,758	$3,346.9	$1,005.2
Manufacturing	29,392	$11,752.0	$1,431.6
TIPU	23,228	$9,330.2	$1,783.0
Trade	58,385	$7,182.1	$2,519.1
Service	213,341	$24,350.6	$8,594.7
Government	67,308	$6,821.5	$5,248.7
Total	470,293	$70,994.1	$23,897.1

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-3. Kern County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	66,800	$6,581.7	$3,405.1
Mining	18,513	$12,127.9	$2,419.5
Construction	24,986	$4,372.7	$1,352.4
Manufacturing	17,871	$16,616.9	$1,158.8
TIPU	18,022	$4,919.3	$1,413.9
Trade	47,051	$5,833.0	$2,201.9
Service	160,981	$19,233.2	$6,697.6
Government	61,056	$6,979.8	$5,250.6
Total	415,280	$76,664.5	$23,899.8

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-4. Kings County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	7,771	$2,364.4	$765.0
Mining	158	$29.6	$0.0
Construction	1,261	$220.8	$67.6
Manufacturing	5,396	$4,653.0	$331.0
TIPU	1,577	$372.4	$98.2
Trade	5,634	$574.7	$209.1
Service	18,035	$2,225.7	$673.3
Government	18,437	$2,780.2	$1,482.9
Total	58,269	$13,220.8	$3,627.1

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-5. Madera County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	15,404	$2,592.6	$923.4
Mining	306	$58.9	$1.0
Construction	2,299	$381.8	$105.9
Manufacturing	4,538	$2,182.7	$287.2
TIPU	2,073	$538.0	$125.8
Trade	5,783	$646.1	$230.6
Service	23,001	$2,724.2	$896.5
Government	9,897	$1,047.0	$744.4
Total	63,301	$10,171.3	$3,314.8

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-6. Merced County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	17,273	$4,070.2	$1,405.4
Mining	238	$53.3	$3.7
Construction	3,494	$597.5	$177.1
Manufacturing	12,080	$5,054.1	$624.6
TIPU	4,402	$1,000.2	$222.7
Trade	11,640	$1,238.3	$427.5
Service	34,741	$3,844.5	$1,182.6
Government	17,850	$1,718.1	$1,362.0
Total	101,718	$17,576.2	$5,405.6

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-7. San Joaquin County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	19,400	$3,074.8	$1,267.0
Mining	295	$251.4	$15.2
Construction	13,494	$2,354.2	$734.3
Manufacturing	18,957	$9,106.6	$1,245.0
TIPU	22,518	$5,494.0	$1,433.8
Trade	46,667	$5,998.0	$1,897.5
Service	133,970	$15,617.4	$5,204.0
Government	36,808	$3,757.1	$3,070.9
Total	292,108	$45,653.5	$14,867.7

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-8. Stanislaus County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	18,797	$3,384.5	$1,332.6
Mining	227	$45.3	$2.3
Construction	11,005	$1,808.0	$501.3
Manufacturing	25,223	$12,459.5	$1,640.3
TIPU	10,854	$1,852.5	$607.5
Trade	33,667	$3,997.4	$1,347.0
Service	103,626	$12,008.6	$4,305.0
Government	26,923	$2,780.6	$2,111.3
Total	230,322	$38,336.4	$11,847.3

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-9. Tulare County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	41,061	$6,526.0	$2,342.1
Mining	196	$56.3	$7.1
Construction	7,212	$1,186.3	$334.7
Manufacturing	14,062	$7,388.8	$798.0
TIPU	9,407	$2,424.8	$547.3
Trade	24,644	$2,716.0	$977.6
Service	66,935	$7,205.6	$2,236.7
Government	30,099	$2,697.2	$2,257.1
Total	193,616	$30,201.0	$9,500.6

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

G.1.2 Bay Area Region

The Bay Area region includes Alameda, Contra Costa, San Benito, and Santa Clara counties. CVP contractors in this region receive both irrigation and municipal and industrial (M&I) water supplies. Contractors in Alameda, Contra Costa, and Santa Clara counties receive and deliver CVP M&I deliveries and the San Benito County Water District in San Benito County receives and delivers CVP agricultural water to irrigation customers. SWP contractors in this region are in Santa Clara County and receive M&I water for delivery to urban customers within the county.

Table G-10 presents the regional economy for this entire region, followed by a table for each individual county. Industry summaries are aggregated using IMPLAN's default aggregation scheme which categorizes each Industry Sector into eight broad sector categories (MIG 2018).

Table G-10. Bay Area Region 2014 Regional Economy Summary (Alameda, Contra Costa, San Benito, and Santa Clara Counties)

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	8,885	$952.8	$486.3
Mining	4,494	$2,014.4	$422.7
Construction	138,083	$26,911.0	$9,336.8
Manufacturing	261,628	$220,109.1	$39,828.9
TIPU	181,681	$90,934.7	$30,514.9
Trade	335,661	$57,105.6	$22,937.2
Service	1,655,112	$259,394.8	$114,615.5
Government	245,056	$29,853.2	$24,554.6
Total	2,830,602	$687,275.6	$242,696.9

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-11. Alameda County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	1,189	$109.8	$58.4
Mining	1,148	$510.8	$60.2
Construction	50,975	$10,031.7	$3,524.9
Manufacturing	70,692	$39,675.2	$7,010.5
TIPU	54,395	$16,060.1	$4,771.7
Trade	121,573	$19,096.2	$7,450.5
Service	557,504	$80,865.9	$33,730.0
Government	108,155	$13,354.6	$11,032.3
Total	965,630	$179,704.3	$67,638.5

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-12. Contra Costa County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	1,490	$133.8	$62.2
Mining	1,344	$798.2	$310.8
Construction	32,317	$6,240.9	$2,141.1
Manufacturing	22,192	$52,564.6	$2,616.2
TIPU	30,498	$15,763.7	$3,556.8
Trade	64,118	$7,919.8	$3,066.8
Service	325,575	$47,245.8	$18,297.9
Government	46,720	$5,305.7	$4,290.4
Total	524,255	$135,972.5	$34,342.2

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-13. San Benito County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	2,416	$316.2	$142.3
Mining	33	$7.7	$1.1
Construction	1,476	$234.8	$60.1
Manufacturing	4,203	$1,461.0	$217.5
TIPU	717	$121.3	$41.3
Trade	3,618	$422.2	$166.4
Service	8,548	$975.6	$262.0
Government	2,661	$322.6	$233.6
Total	23,672	$3,861.4	$1,124.3

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-14. Santa Clara County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	3,790	$393.1	$223.5
Mining	1,968	$697.7	$50.6
Construction	53,316	$10,403.6	$3,610.8
Manufacturing	164,541	$126,408.3	$29,984.8
TIPU	96,071	$58,989.6	$22,145.0
Trade	146,352	$29,667.4	$12,253.5
Service	763,485	$130,307.5	$62,325.7
Government	87,520	$10,870.2	$8,998.3
Total	1,317,045	$367,737.4	$139,592.2

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

G.1.3 Southern California Region

The SWP water service contractors within the southern California Region are in Imperial, Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, and Ventura counties. Table G-15 presents household income and per capita income for the counties in the southern California region relative to California.

Table G-15. Southern California Region 2014 Households and Income

Households and Income	Los Angeles County	Orange County	Riverside County	San Bernardino County	San Diego County	San Luis Obispo County	Santa Barbara County	Ventura County	California
Number of Households	3,242,391	1,002,285	690,388	607,604	1,083,811	102,350	142,026	267,829	12,617,280
Average Household Size	3.02	3.04	3.24	3.34	2.85	2.52	2.91	3.07	2.77
Median Household Income ($)	55,870	75,998	56,592	54,100	63,996	59,454	63,409	77,335	61,489
Mean Household Income ($)	82,109	102,520	74,062	69,373	86,416	78,731	89,545	100,397	86,704
Per Capita Income ($)	27,987	34,416	23,660	21,384	31,043	30,392	30,526	33,308	29,906

Source: U.S. Census Bureau 2016.

Table G-16 presents the regional economy for this entire region, followed by a table for each individual county. Industry summaries are aggregated using IMPLAN's default aggregation scheme which categorizes each Industry Sector into eight broad sector categories (MIG 2018).

Table G-16. Southern California 2014 Regional Economy Summary (Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, and Ventura Counties)

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	92,908	$9,530.8	$4,945.0
Mining	32,989	$18,160.7	$3,816.0
Construction	584,098	$103,138.5	$31,535.3
Manufacturing	793,280	$346,622.9	$64,480.4
TIPU	777,108	$274,817.4	$69,024.8
Trade	1,663,383	$230,900.9	$84,372.3
Service	7,472,189	$970,213.1	$370,390.2
Government	1,407,464	$184,560.7	$128,538.0
Total	12,823,418	$2,137,945.0	$757,102.0

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-17. Los Angeles County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	6,261	$483.5	$289.8
Mining	14,495	$10,084.7	$2,282.9
Construction	214,180	$37,349.5	$10,855.6
Manufacturing	381,831	$177,906.6	$30,013.8
TIPU	473,681	$177,129.6	$47,224.6
Trade	771,855	$110,544.4	$40,042.1
Service	3,669,340	$471,973.7	$185,770.0
Government	551,201	$67,279.2	$53,056.4
Total	6,082,843	$1,052,751.2	$369,535.2

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-18. Orange County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	2,877	$324.1	$174.5
Mining	6,171	$2,437.3	$380.5
Construction	111,224	$21,160.1	$7,430.7
Manufacturing	158,649	$66,132.0	$14,268.8
TIPU	69,036	$28,809.5	$6,082.1
Trade	280,090	$43,885.0	$16,818.1
Service	1,274,376	$187,143.2	$70,921.4
Government	150,248	$16,687.8	$13,754.7
Total	2,052,670	$366,579.0	$129,830.8

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-19. Riverside County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	14,400	$1,619.8	$706.9
Mining	1,780	$464.7	$127.9
Construction	71,143	$11,837.6	$3,332.3
Manufacturing	45,132	$15,941.3	$2,882.6
TIPU	48,214	$10,987.9	$2,518.2
Trade	133,246	$15,235.9	$5,285.5
Service	481,528	$50,339.6	$15,746.7
Government	130,911	$16,694.6	$10,961.4
Total	926,353	$123,121.4	$41,561.5

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-20. San Bernardino County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	3,451	$803.7	$230.8
Mining	1,338	$437.8	$67.1
Construction	48,073	$8,147.6	$2,293.5
Manufacturing	53,476	$22,356.7	$3,443.7
TIPU	79,062	$15,799.6	$4,540.4
Trade	136,936	$17,442.6	$5,881.8
Service	451,866	$48,509.7	$16,598.9
Government	133,774	$16,660.7	$11,229.8
Total	907,976	$130,158.4	$44,286.0

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-21. San Diego County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	11,991	$1,003.4	$550.2
Mining	4,149	$1,212.0	$109.1
Construction	93,913	$16,838.9	$5,364.9
Manufacturing	102,968	$41,869.5	$9,616.4
TIPU	73,194	$30,724.1	$6,225.7
Trade	228,996	$29,814.0	$11,137.3
Service	1,129,199	$156,144.8	$61,438.9
Government	336,656	$54,464.1	$30,359.0
Total	1,981,064	$332,070.8	$124,801.5

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-22. San Luis Obispo County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	7,242	$1,000.3	$394.1
Mining	644	$142.5	$18.5
Construction	11,169	$1,946.4	$578.3
Manufacturing	8,197	$3,184.2	$464.2
TIPU	8,270	$3,207.7	$665.0
Trade	21,049	$2,260.0	$811.2
Service	86,676	$9,342.7	$3,067.6
Government	20,334	$1,884.8	$1,634.4
Total	163,580	$22,968.6	$7,633.3

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-23. Santa Barbara County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	20,570	$2,070.1	$1,147.4
Mining	2,081	$1,546.5	$309.8
Construction	12,235	$2,116.6	$630.3
Manufacturing	13,636	$5,102.6	$1,071.2
TIPU	10,255	$3,150.8	$769.2
Trade	28,977	$3,530.0	$1,378.4
Service	144,069	$17,074.2	$6,527.0
Government	37,423	$4,900.4	$3,272.2
Total	269,245	$39,491.2	$15,105.5

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

Table G-24. Ventura County 2014 Regional Economy Summary

Industry	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
Agriculture	26,117	$2,226.0	$1,451.4
Mining	2,330	$1,835.3	$520.2
Construction	22,161	$3,741.7	$1,049.7
Manufacturing	29,392	$14,130.1	$2,719.8
TIPU	15,396	$5,008.1	$999.5
Trade	62,235	$8,188.9	$3,017.9
Service	235,136	$29,685.2	$10,319.7
Government	46,918	$5,989.1	$4,270.2
Total	439,686	$70,804.4	$24,348.4

TIPU = Traffic, Information, and Public Utilities
Source: 2014 IMPLAN data; MIG 2016

G.2 Environmental Consequences/Environmental Impacts

This section describes the IMPLAN results for the SLLPIP Alternatives. Impacts to regional economics from Alternative 2, Alternative 3, Alternative 4 and Alternative 5 are discusses in this section. Impacts under Alternative 1, No Action/No Project are not discussed since No Action/No Project Alternative would be very similar to existing conditions and regional economics are not anticipated to experience substantive changes in the area of analysis.

This section only summarizes the Construction and Annual Expenditure Effects of the SLLPIP Alternatives. Recreation and M&I Water Supply impacts are analyzed qualitatively in this Environmental Impact Statement/ Environmental Impact Report (EIS/EIR) and not summarized in this Appendix. For the analysis of agricultural economic effects, the Statewide Agricultural Production Model (SWAP) estimates changes in value of production of crops as a result of

changes in water supply. Appendix R further described the SWAP agricultural economics model.

IMPLAN is an input-output (I-O) database and modeling software used to estimate economic impacts of changes in final demand or spending associated with the project alternatives. An I-O analysis describes and analyzes the relationship among industries.

Any given industry typically purchases goods and services from -- and sells goods and services to -- another industry within a given geographic area, which in turn, sells to or buys from other industries or supplies final consumers. Figure H-1 shows the general flows of money between industries and consumers that is captured by IMPLAN.

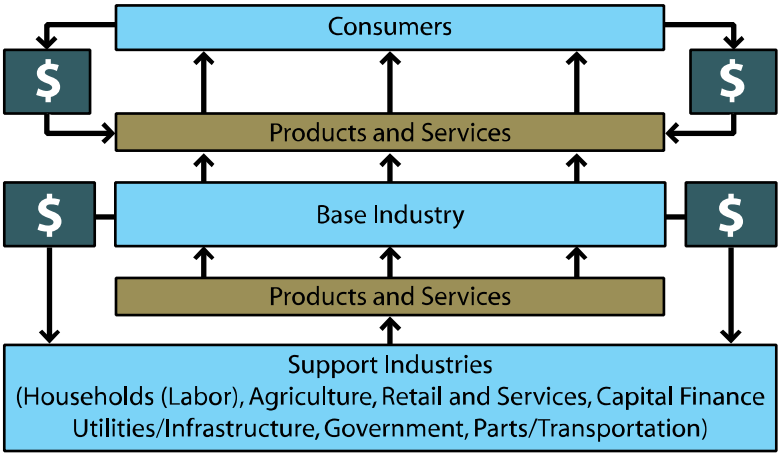


Figure H-1. Economic Linkages in a Hypothetical Industry

IMPLAN uses these inter-industry linkages and provides a tool to estimate the total economic effects within a region from a change in final demand to one economic sector. The industry linkages are estimated by economic multipliers (e.g., a multiplier of 2.0 indicates that each dollar of direct sale generates another dollar of secondary sales in the regional economy; a multiplier of 3.0 indicates that each dollar of direct sale generates an additional $2 of secondary sales in the regional economy, and so on). Total economic effects include:

- **Direct effects** – changes in final demand
- **Indirect effects** – changes in expenditures within the region in industries supplying goods and services
- **Induced effects** – changes in expenditures of household income

This analysis presents estimates of impacts to value of output, labor income, and employment. The 2014 IMPLAN data sets were used for this analysis.

G.2.2 Environmental Consequences/Environmental Impacts of Alternative 2 - Lower San Felipe Intake Alternative

The majority of construction of the Lower San Felipe Intake Alternative would occur in Merced County. There would be some construction in Santa Clara County. Construction activities would create jobs and generate additional economic activity within the region during the period of construction.

The construction period for the Lower San Felipe Intake Alternative Tunnel Option would be 47 months. Estimated construction costs would be $962.1 million. The majority of the cost would be for construction of waterways and waterway structures, which would require specialized underwater construction methods. Tunnel construction would occur 24 hours a day, 7 days a week. Program costs, including design, permitting, administrative and construction management, are also a major element of total project costs. There would be approximately 100 on-site construction workers during peak times. This analysis assumes 400 construction workers over the construction period. On-site construction does not include all direct labor for the project. There would be additional administrative, design, environmental compliance, management, and oversight jobs, as well as, truck drivers and equipment haulers. The level of project expenditures ($962.1 million) would expectedly result in very high direct effects in output, employment and labor income. These direct effects would multiply through the regional economy and generate a high level of indirect and induced effects. Table G-25 summarizes regional economic effects related to construction expenditures for the tunnel option. These would be temporary beneficial economic effects in Merced and Santa Clara counties.

Table G-25. Direct, Indirect, Induced and Total Regional Economic Effects of Construction Expenditures for the Lower San Felipe Intake Alternative, Tunnel Option (2018 $)

Impact Type	Employment (# jobs)	Labor Income (Million $)	Output (Million $)
Direct Effect	2,393	$250.0	$896.6
Indirect Effect	1,163	$91.6	$328.8
Induced Effect	840	$52.6	$213.1
Total Effect	4,396	$394.3	$1,438.5

Note: Totals may not add exactly because of rounding

The construction period for the Lower San Felipe Intake Alternative Pipeline Option would last 33 months, and would focus on installing as much of the pipeline as possible during low water periods. Work would be performed for 8 hours per day, 5 days a week. Estimated construction costs would be $842.1 million. Similar to the tunnel option, the majority of the cost would be for construction of waterways and waterway structures and for program costs. There would be approximately 100 on-site construction workers during peak times. This analysis assumes 400 on-site construction workers over the

construction period. Project expenditures would result in additional direct jobs for design, environmental compliance and permitting, program and construction management, administrative, and other construction-related activities. Table G-26 summarizes regional economic effects related to construction expenditures for the tunnel option. These would be temporary beneficial economic effects in Santa Clara and Merced counties.

Table G-26. Direct, Indirect, Induced and Total Regional Economic Effects of Construction Expenditures for the Lower San Felipe Intake Alternative, Pipeline Option (2018 $)

Impact Type	Employment (# jobs)	Labor Income (Million $)	Output (Million $)
Direct Effect	2,238	$223.3	$781.6
Indirect Effect	1,014	$79.9	$216.6
Induced Effect	746	$46.7	$275.2
Total Effect	3,998	$350.0	$1,273.4

Note: Totals may not add exactly because of rounding

The facilities would also require periodic repair and replacement, which would also generate employment, income, and output during the repairs and replacement period. The project life of facilities included in the Lower San Felipe Intake Alternative is approximately 50 years, depending on the facility; therefore, regional economic effects of repair and replacement would not occur for many years after the initial construction period. Regional economic effects of construction, repair, and replacement expenditures would be temporary and beneficial to Merced and Santa Clara counties.

Operations and maintenance (O&M) costs to implement the Lower San Felipe Intake Alternative would be $2.5 million per year for the pipeline and tunnel options. These effects would be long-term and occur each year during project operation. Direct effects would occur in the water, sewage, and other treatment and delivery systems sector. Table G-27 summarizes regional economic effects of O&M expenditures for the Lower San Felipe Intake Alternative. Regional economic effects of O&M expenditures would be long-term and beneficial to Merced and Santa Clara counties.

Table G-27. Direct, Indirect, Induced and Total Regional Economic Effects of O&M Expenditures for the Lower San Felipe Intake Alternative (2018 $)

Impact Type	Employment (# jobs)	Labor Income (Million $)	Output (Million $)
Direct Effect	15	$1.3	$2.4
Indirect Effect	3	$0.2	$0.3
Induced Effect	4	$0.2	$0.6
Total Effect	22	$1.7	$3.4

Note: Totals may not add exactly because of rounding

G.2.3 Environmental Consequences/Environmental Impacts of Alternative 3 - Treatment Alternative

The construction duration for treatment plant retrofits at the Santa Teresa Water Treatment Plant would be approximately 3 years. Construction would temporarily increase employment, output, and labor income in Santa Clara County. These effects would be temporary and occur over the 3 year construction period. Capital cost expenditures for the Treatment Alternative would be approximately $37.0 million over the construction period. These costs include construction labor, materials, equipment, subcontractor costs, program costs, and contingency costs for environmental mitigation, overhead, insurance and bonds, sales tax and various allowances. There would be an average of approximately 24 on-site construction workers at the site. This analysis assumes a total of 90 on-site construction workers on site over the construction period. There would be additional direct jobs needed for program management, design, environmental compliance, and construction management. Table G-28 summarizes regional economic effects of construction expenditures for the Treatment Alternative.

Table G-28. Direct, Indirect, Induced and Total Regional Economic Effects of Construction Expenditures for the Treatment Alternative (2018 $)

Impact Type	Employment (# jobs)	Labor Income (Million $)	Output (Million $)
Direct Effect	181	$15.6	$29.4
Indirect Effect	37	$3.0	$13.7
Induced Effect	44	$2.8	$19.4
Total Effect	263	$21.5	$62.6

Note: Totals may not add exactly because of rounding

The facilities would also require periodic repair and replacement, which would also generate employment, income, and output during the repairs and replacement period. The project life of facilities included in the Treatment Alternative is typically 20-50 years, depending on the facility; therefore, regional economic effects of repair and replacement would not occur for many years after the initial construction period. Regional economic effects of construction, repair, and replacement expenditures would be temporary and beneficial to Santa Clara County.

O&M costs to implement the Treatment Alternative would be approximately $0.3 million per year. These costs include increased power demands, increased chemical demand and one additional full time O&M operator at the treatment plant. Increased power and chemical costs would not have a significant effect on the regional economy. There would be one additional direct job needed for increased O&M at the treatment plant. This additional job would result in some minor positive effects to the regional economy.

G.2.4 Environmental Consequences/Environmental Impacts of Alternative 4 - San Luis Reservoir Expansion Alternative

Increased water supplies for agricultural uses in the San Joaquin Region would increase value of production. Annual value of production would increase by about $2.6 million in dry years, $1.5 million in below normal and critical years, and $1.2 million in wet years. Effects in below normal, critical and wet years would be less than those in dry years because modeling estimated that less water would be provided to agricultural water users in these hydrologic year types. Increased water supply would increase value of production and consequently increase employment, value added, labor income, and output in the crop sectors and the overall regional economy through indirect and induced impacts. This would be a minor positive effect to the regional agricultural economy.

The construction duration for San Luis Reservoir Expansion Alternative would be approximately 7 years. Construction activities associated with reservoir expansion would temporarily increase employment, output, and labor income in Merced County. Capital cost expenditures for the San Luis Reservoir Expansion Alternative would be approximately $830.0 million over the construction period. These costs include construction labor, materials, equipment, subcontractor costs, program costs, and contingency costs for environmental mitigation, overhead, insurance and bonds, sales tax and various allowances. Construction would be conducted in two shifts, the day shift includes 130 workers at San Luis Reservoir and the night shift includes 87 workers. There would be additional direct jobs needed for program management, design, environmental compliance, and construction management. Table G-29 summarizes regional economic effects of construction expenditures for the San Luis Reservoir Expansion Alternative.

Table G-29. Direct, Indirect, Induced and Total Regional Economic Effects of Construction Expenditures for the San Luis Reservoir Expansion Alternative (2018 $)

Impact Type	Employment (# jobs)	Labor Income (Million $)	Output (Million $)
Direct Effect	4,114	$148.3	$779.2
Indirect Effect	1,260	$47.0	$139.5
Induced Effect	637	$24.5	$83.3
Total Effect	6,011	$219.8	$1,002.0

Note: Totals may not add exactly because of rounding

G.2.5 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

The construction duration for the Pacheco Reservoir Expansion Alternative would be approximately 120 months (5 years). Construction activities associated with reservoir expansion would temporarily increase employment,

output, and labor income in Merced and Santa Clara County. Capital cost expenditures for the Pacheco Reservoir Expansion Alternative would be approximately $1,116.2 million over the construction period. These costs include construction labor, materials, equipment, subcontractor costs, program costs, and contingency costs for environmental mitigation, overhead, insurance and bonds, sales tax and various allowances. Construction would be conducted in two shifts, the day shift includes 350 workers at San Luis Reservoir and the night shift includes 125 workers. There would be additional direct jobs needed for program management, design, environmental compliance, and construction management. Table G-30 summarizes regional economic effects of construction expenditures for the Pacheco Reservoir Expansion Alternative.

Table G-30. Direct, Indirect, Induced and Total Regional Economic Effects of Construction Expenditures for the Pacheco Reservoir Expansion Alternative (2018 $)

Impact Type	Employment (# jobs)	Labor Income (Million $)	Output (Million $)
Direct Effect	6,331	$509.9	$1,020.7
Indirect Effect	1,474	$113.9	$261.2
Induced Effect	1,495	$93.6	$249.0
Total Effect	9,301	$717.4	$1,531.0

Note: Totals may not add exactly because of rounding

G.3 References

Minnesota IMPLAN Group (MIG), Inc. 2016. IMPLAN 2014 data set. Available at: http://implan.com.

Minnesota IMPLAN Group (MIG), Inc. 2018. IMPLAN User's Guide: Default Aggregation Scheme. Available at: https://implanhelp.zendesk.com/hc/en-us/articles/115009542507-Aggregating-Schemes-in-IMPLAN-Online

San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix H: Land Use, Agricultural Resources, and Indian Trust Assets Maps

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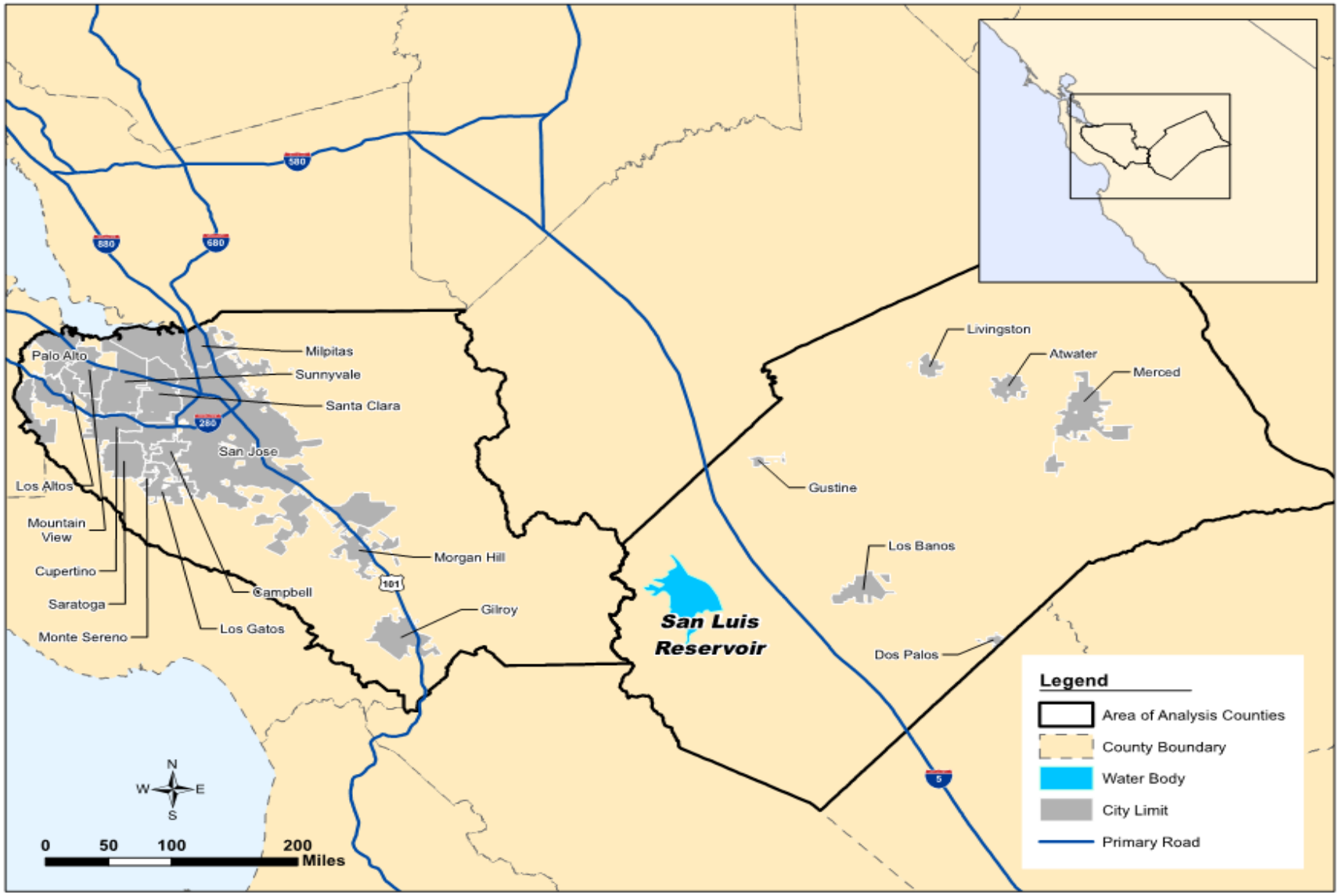


Figure H-1. Land Use and Agricultural Resources Area of Analysis

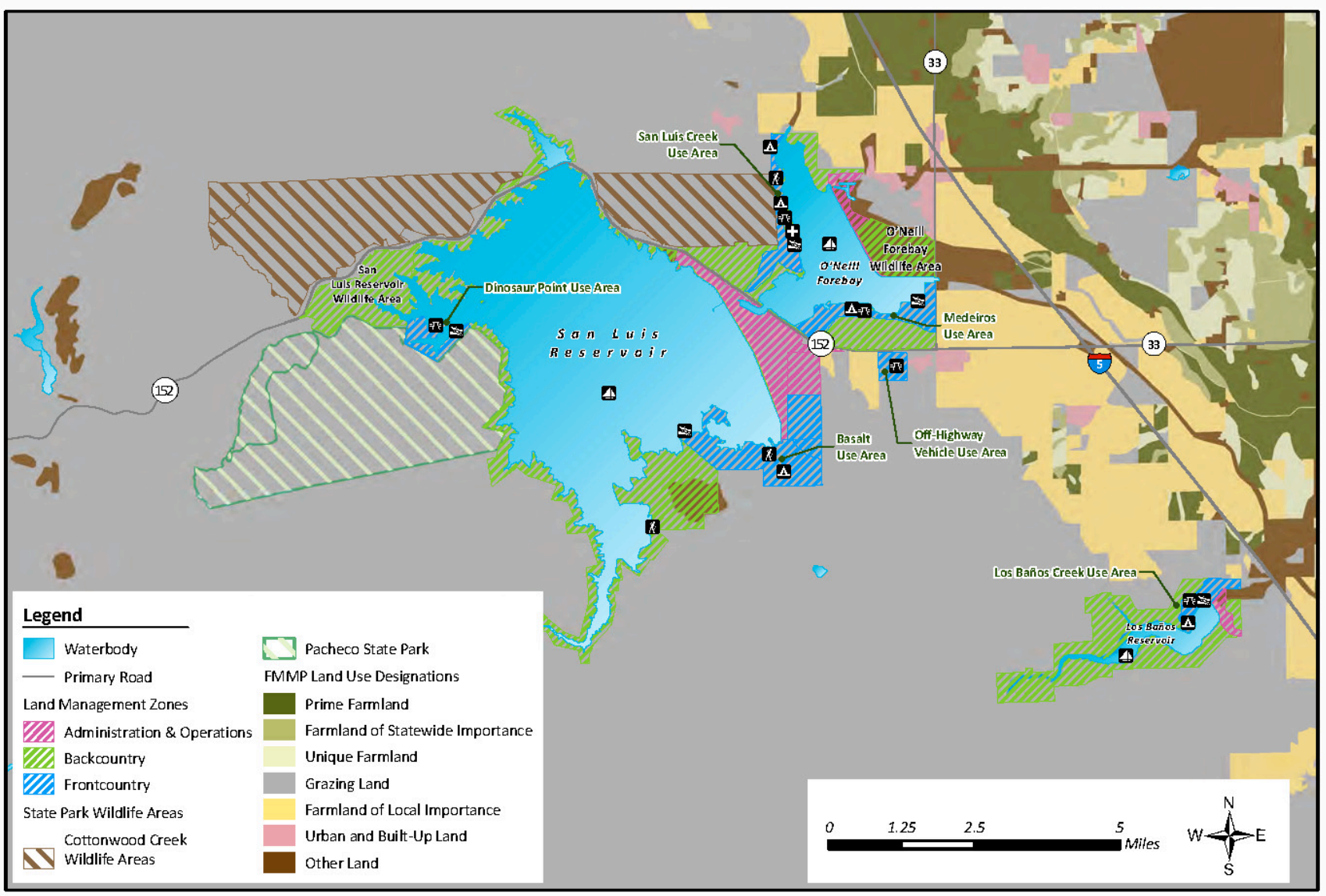


Figure H-2. Land Use at San Luis Reservoir

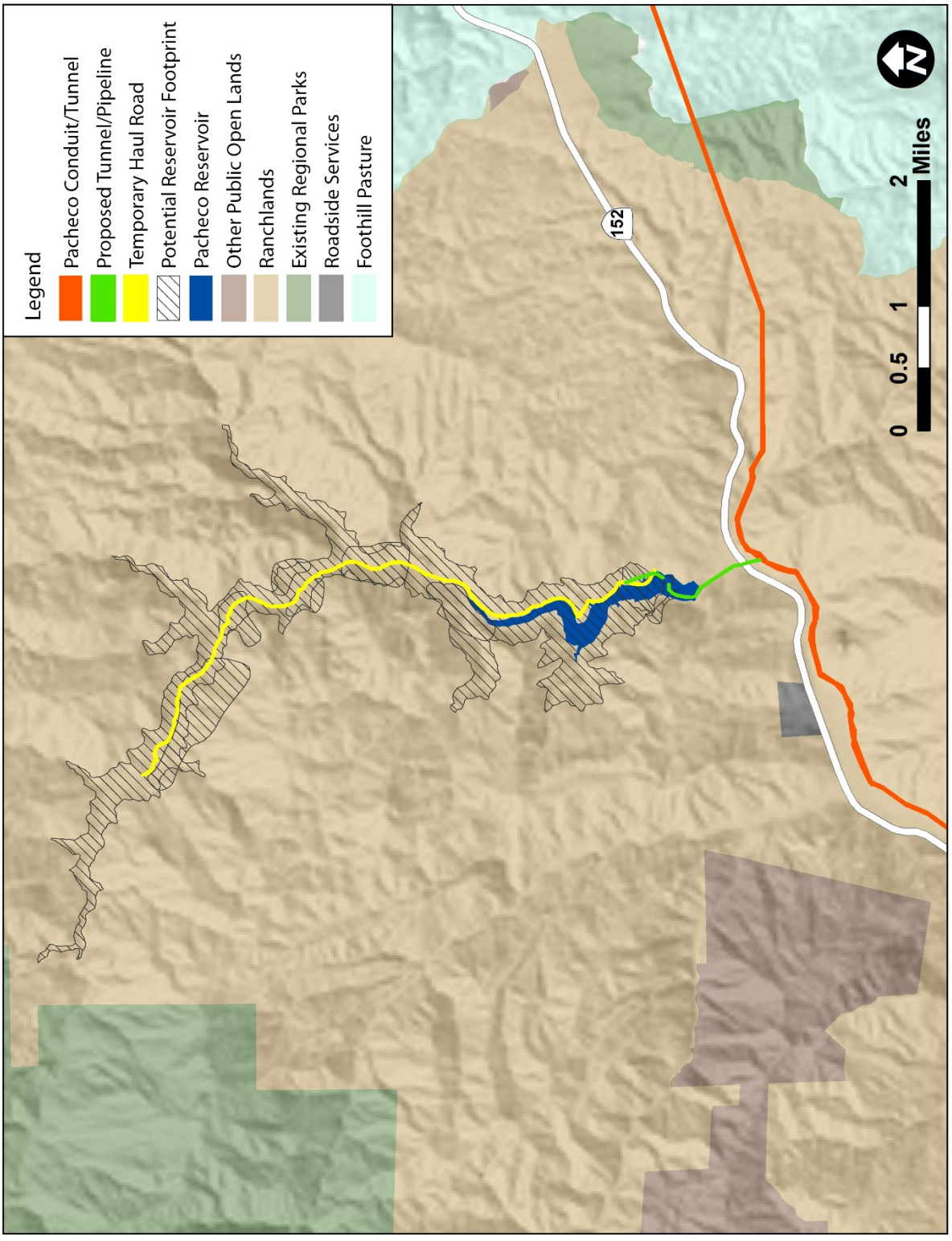
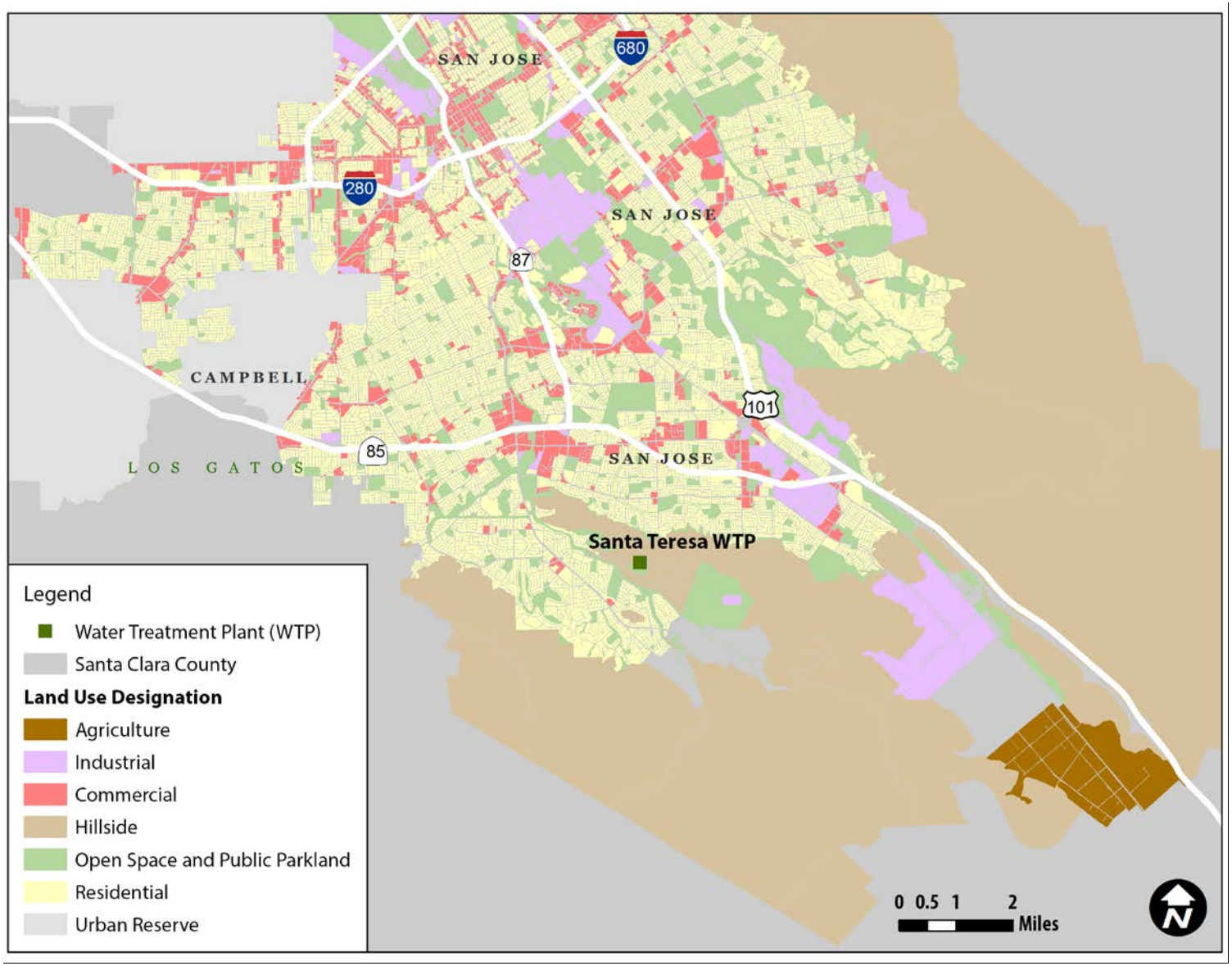


Figure H-3. Land Use at Pacheco Reservoir



Source: California Resources Agency 2004.

Figure H-4. Land Use, City of San Jose



Source: U.S. Census Bureau 2010.

Figure H-5. Indian Trust Assets in the Area of Analysis

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San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix I: Environmental Justice Supporting Information

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Appendix I
Environmental Justice Supporting Information

This appendix supports Chapter 4, Section 4.18, Environmental Justice and contains area of analysis figures, as well as demographic and economic characteristic data from 2016 American Community Survey 5-Year Estimates by the United States (U.S.) Census Bureau for the area of analysis at a regional and local level. Information for the State of California as a whole is presented for comparison purposes.

Table I-1. Environmental Justice Local Area of Analysis Census Tract Numbers

Geographic Area		City(s)	Census Tract Number
Merced County	San Luis Reservoir Region	Gustine, Ingomar & Volta	20
		San Luis Reservoir State Recreation Area & Santa Nella	21
		Los Banos	22.01, 22.02, 23.01 and 23.02
Santa Clara County	SCVWD Service Area – Santa Teresa WTP	San Jose	5119.11
	Pacheco Reservoir	38 miles from San Jose	5135

Source: U.S Census Bureau 2010.
Key:
SCVWD = Santa Clara Valley Water District
WTP = waste treatment plant

Table I-2. Local Demographic Characteristics, 2012-2016

Geographic Area	Total Population	Race[1]							Hispanic Origin[2]		Total Minority[3]
		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	
CT 20	**7,644 (100%)**	**6,455 (84.4%)**	**34 (0.4%)**	**17 (0.2%)**	**35 (0.6%)**	**0 (0.0%)**	**839 (11.0%)**	**264 (3.5%)**	**2,984 (39.0%)**	**4,529 (59.2%)**	**4,660 (61.0%)**
CT 21	**4,229 (100%)**	**3,192 (75.5%)**	**94 (2.2%)**	**0 (0.0%)**	**246 (5.8%)**	**0 (0.0%)**	**534 (12.6%)**	**163 (3.9%)**	**999 (23.6%)**	**2,749 (65%)**	**3,230 (76.4%)**
CT 22.01	**5,541 (100%)**	**4,264 (77.0%)**	**46 (0.8%)**	**18 (0.3%)**	**52 (0.9%)**	**26 (0.5%)**	**979 (18.0%)**	**156 (2.8%)**	**1,033 (18.6%)**	**4,329 (78.1%)**	**4,508 (81.4%)**
CT 22.02	**9,868 (100%)**	**7,110 (72.1%)**	**135 (1.4%)**	**63 (0.6%)**	**346 (3.5%)**	**0 (0.0%)**	**1,781 (18.0%)**	**433 (4.4%)**	**1,824 (18.5%)**	**7,483 (76.0%)**	**8,044 (81.5%)**
CT 23.01	**6,899 (100%)**	**5,001 (72.5%)**	**85 (1.2%)**	**39 (0.6%)**	**293 (4.2%)**	**0 (0.0%)**	**1,051 (15.2%)**	**430 (6.2%)**	**3,097 (45.0%)**	**3,336 (48.4%)**	**3,802 (55.2%)**
CT 23.02	**15,009 (100%)**	**10,744 (72.0%)**	**457 (3.0%)**	**108 (0.7%)**	**439 (2.9%)**	**0 (0.0%)**	**2,544 (17.0%)**	**717 (5.0%)**	**2,855 (19.0%)**	**10,331 (68.8%)**	**12,154 (81.0%)**
CT 5119.11	4,957 (100%)	3,088 (62.3%)	380 (7.7%)	14 (0.3%)	1,084 (21.9%)	0 (0.0%)	68 (1.4%)	323 (6.5%)	2,911 (58.7%)	240 (4.8%)	2,046 (41.3%)
CT 5135	854 (100%)	630 (73.8%)	27 (3.2%)	0 (0.0%)	60 (7.0%)	12 (1.4%)	15 (1.8%)	110 (12.9%)	481 (56.3%)	181 (21.2%)	373 (43.7%)
Merced Co.	**265,001 (100%)**	**155,239 (58.6%)**	**8,902 (3.4%)**	**1,865 (0.7%)**	**19,843 (7.5%)**	**537 (0.2%)**	**66,865 (25.2%)**	**11,750 (4.4%)**	**78,119 (29.5%)**	**152,475 (57.5%)**	**186,882 (70.5%)**
Santa Clara Co.	**1,885,056 (100%)**	**883,775 (46.9%)**	**48,003 (2.5%)**	**8,742 (0.5%)**	**648,047 (34.4%)**	**7,810 (0.4%)**	**198,893 (10.6%)**	**89,786 (4.8%)**	**625,218 (33.2%)**	**496,591 (26.4%)**	**1,259,838 (66.8%)**
California	**38,654,206 (100%)**	**23,680,584 (61.3%)**	**2,261,835 (5.9%)**	**285,512 (0.8%)**	**5,354,608 (13.9%)**	**150,908 (0.4%)**	**5,133,600 (13.3%)**	**1,787,159 (4.6%)**	**14,837,242 (38.4%)**	**14,903,982 (38.6%)**	**23,816,964 (61.6%)**

Source: U.S. Census Bureau 2016a.

Notes:

[1] A minority is defined as a member of the following population groups: American Indian/Alaskan Native, Asian or Pacific Islander, Black (non-Hispanic), or Hispanic (U.S. Census Bureau 2012).

[2] 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 (U.S. Census Bureau 2012).

[3] Total Minority" is the aggregation of all non-white racial groups with the addition of all Hispanics, regardless of race with the total for "Not Hispanic or Latino: While Alone" subtracted from the total population.

Key:

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

CT = Census Tract

%= percent

Table I-2. Local Economic Characteristics, 2012-2016

Geographic Area	Median Household Income[1,2]	Per Capita Income	Percent Population Below Poverty[3]
CT 20	$40,083	$22,536	15.5%
CT 21	$41,744	$17,434	22.2%
CT 22.01	**$26,997**	**$13,477**	**39.6%**
CT 22.02	$50,561	$17,156	17.0%
CT 23.01	$53,871	$24,587	8.1%
CT 23.02	$46,635	$16,303	20.0%
CT 5119.11	$119,402	$60,820	0.5%
CT 5135	$101,111	$49,863	3.1%
Merced Co.	$44,397	$19,130	20.6%
Santa Clara Co.	$101,173	$46,034	6.2%
California	$63,783	$31,458	11.8%

Source: U.S. Census Bureau 2016b.

Notes:

[1] Household income is defined by the U.S. Census Bureau as "the sum of money income received in the calendar year by all household members 15 years old and over" (U.S. Census Bureau 2012).

[2] In 2014 inflation adjusted dollars.

[3] The census classifies families and persons as *below poverty* "if their total family income or unrelated individual income was less than the poverty threshold" as defined for all parts of the country by the Federal government (U.S. Census Bureau 2012). For 2014, the Federal weighted average poverty level threshold for an individual was $12,316 and $27,820 for a family of four (two adults and two children) (U.S. Census Bureau 2016b).

Key:

Boldface denotes areas with incomes meaningfully lower than the regional and State averages. Lack of boldface within the table denotes that no low-income areas exist.

CT = Census Tract

$ = dollar amount

% = percent

-- = no data available

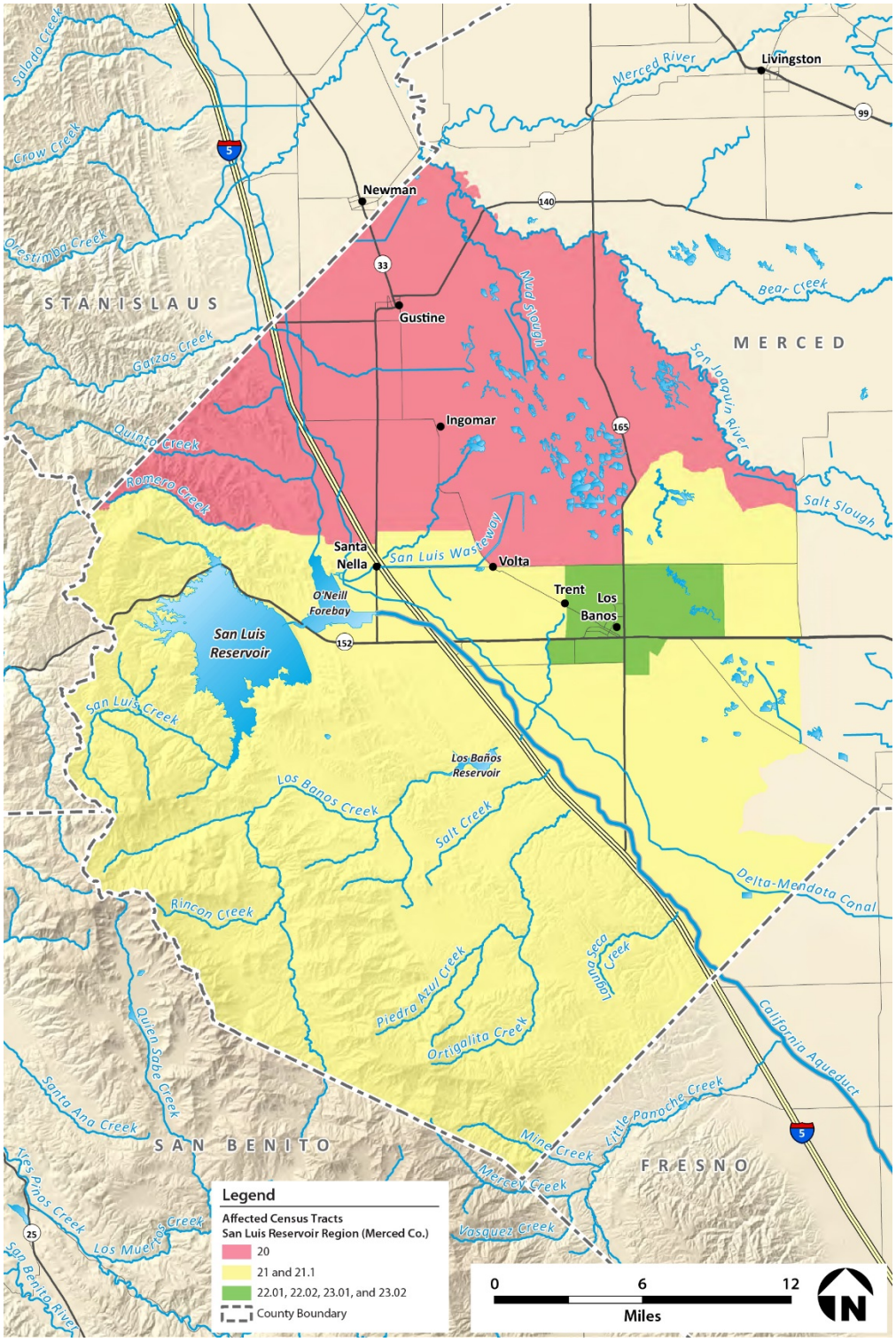


Figure I-1. Environmental Justice Area of Analysis
(San Luis Reservoir Region – Census Tracts)

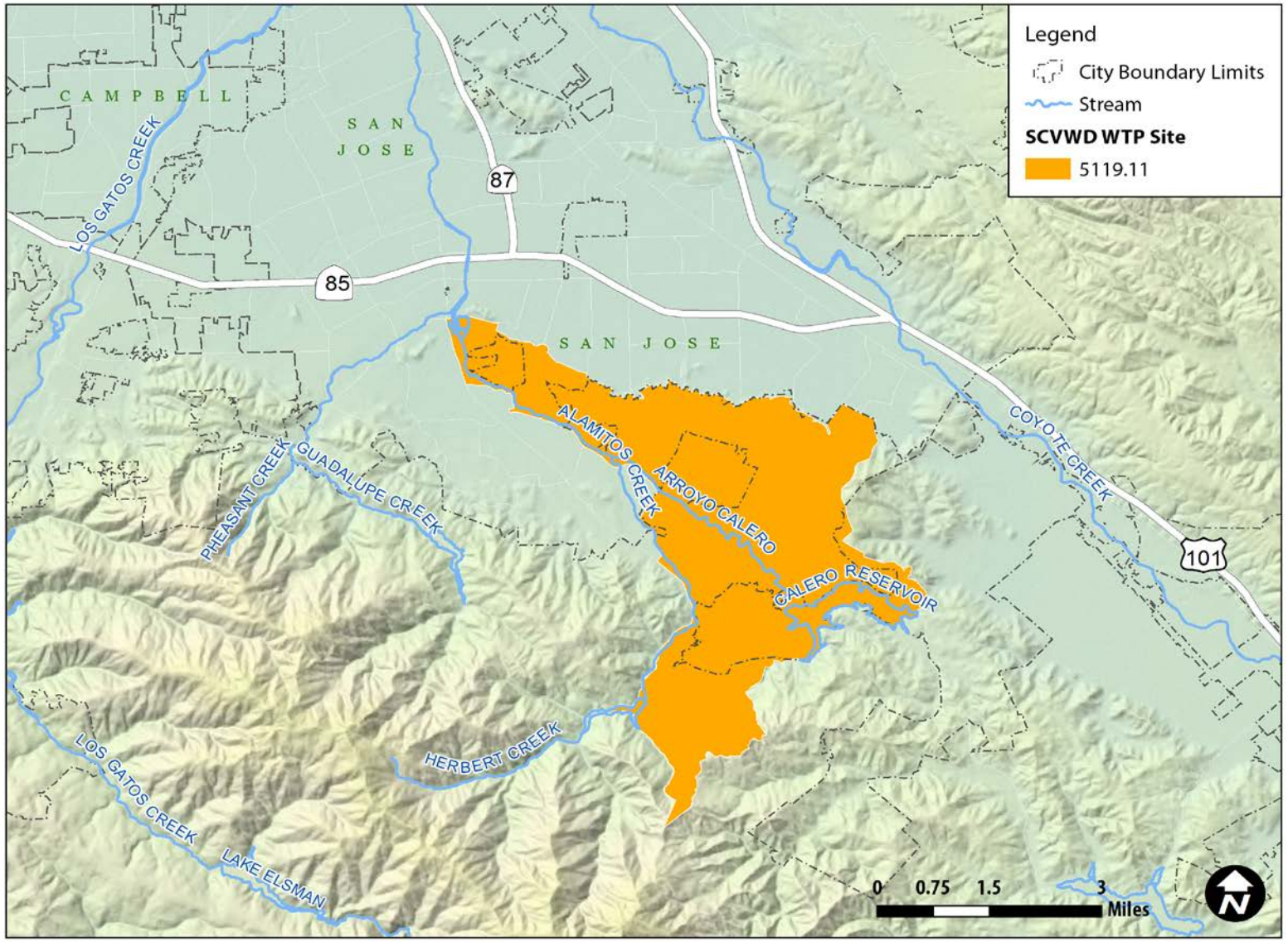


Figure I-2. Environmental Justice Area of Analysis SCVWD WTP - Census Tracts

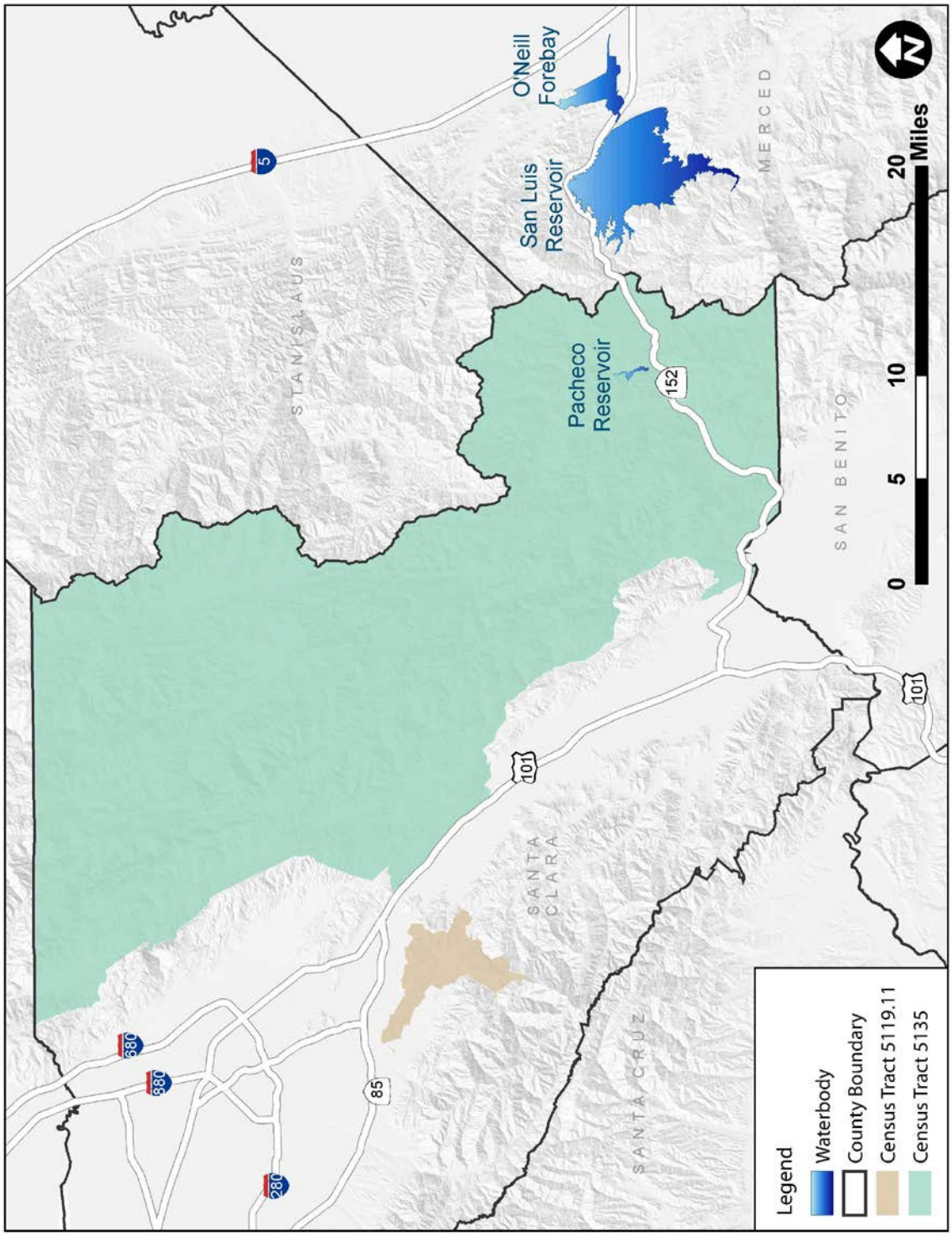


Figure I-3. Environmental Justice Area of Analysis
Pacheco Reservoir- Census Tracts

I.1 References

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San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix J: Groundwater Resources Affected Environment

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Appendix J
Groundwater Resources Affected Environment

This section presents the existing conditions of groundwater resources within the area of analysis for the San Luis Low Point Improvement Project (SLLPIP) alternatives.

J.1 Area of Analysis

The area of analysis for the groundwater resources section includes the South-of-Delta Central Valley Project (CVP) and State Water Project (SWP) Contractors Service areas as shown in Figure J-1. The area of analysis includes the following groundwater basins categorized by the hydrologic regions as defined by the California Department of Water Resources (DWR):

- San Joaquin Valley/Tulare Lake Hydrologic Region: San Joaquin Valley Groundwater Basin
- San Francisco Bay Hydrologic Region: Santa Clara Valley Groundwater Basin; and Gilroy-Hollister Valley Groundwater Basin
- South Lohantan Hydrologic Region: Fremont Valley Groundwater Basin; and Antelope Valley Groundwater Basin
- Colorado River Hydrologic Region: Ames Valley Groundwater Basin; Copper Mountain Valley Groundwater Basin; Warren Valley Groundwater Basin; and Coachella Valley Groundwater Basin
- South Coast Hydrologic Region: Northwest Metropolitan Area Groundwater Basins; San Fernando Valley Groundwater Basin; San Gabriel Valley Groundwater Basin; Coastal Plain of Los Angeles; Coastal Plains of Orange County; and Upper Santa Ana Valley Groundwater Basin

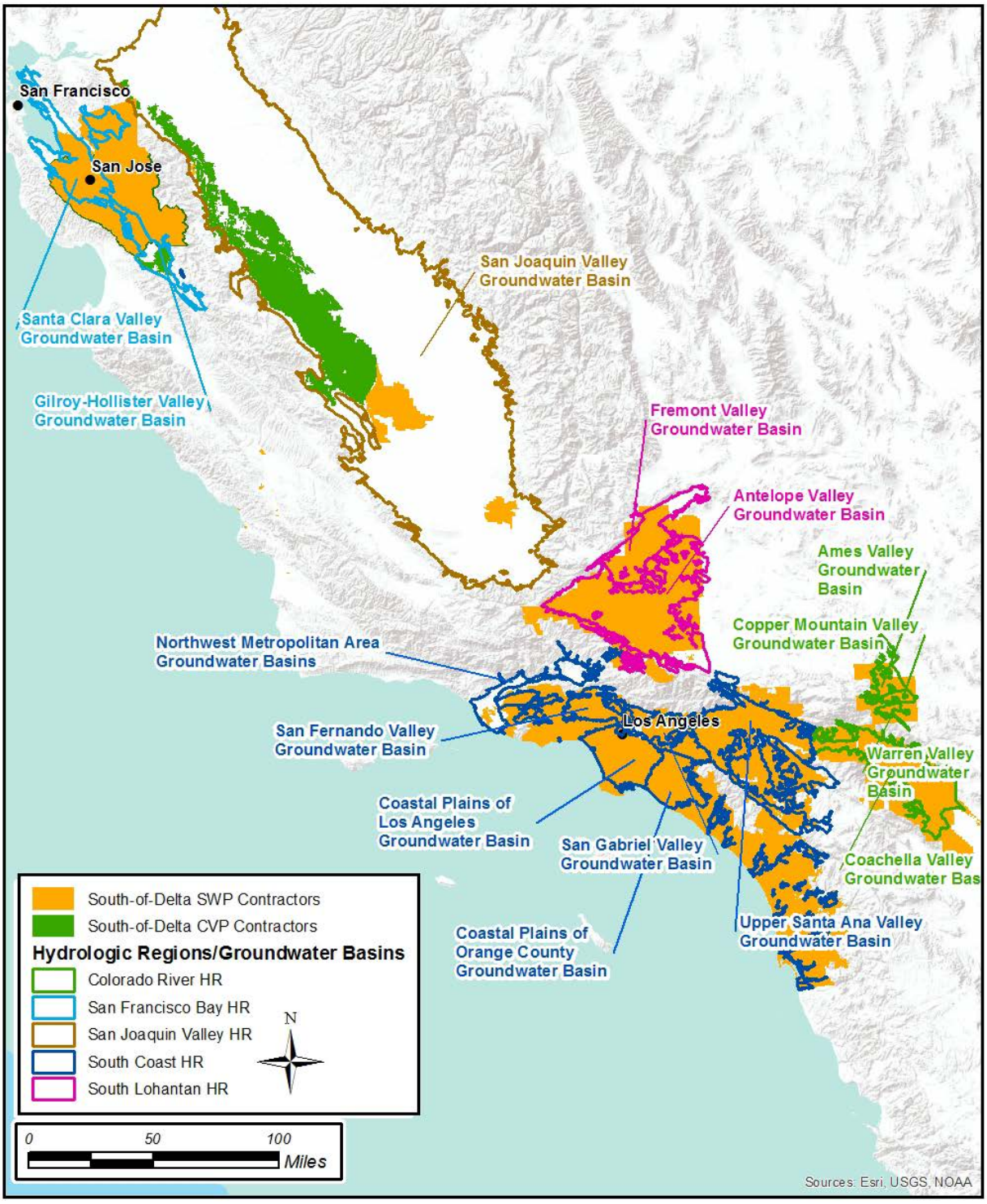


Figure J-1. Groundwater Resources Area of Analysis

There is no mapped groundwater basin underlying the San Luis Reservoir and the Pacheco Reservoir area (DWR 2016a) but the San Joaquin Valley Groundwater Basin (Delta-Mendota sub basin) underlies O'Neill Forebay. It should be noted that though there would be minimal to no direct recharge under the Pacheco Reservoir, the reservoir is currently operated for groundwater recharge through releases to Pacheco Creek. Pacheco Creek flows through the Gilroy-Hollister groundwater subbasin.

J.2 Affected Environment

J.2.1 San Joaquin Valley Hydrologic Region

J.2.1.1 San Joaquin Valley Groundwater Basin

The San Joaquin Valley Groundwater Basin extends over the southern two-thirds of the Central Valley regional aquifer system and has an area of approximately 13,500 square miles. The San Joaquin Valley Groundwater Basin, extends from just north of Stockton in San Joaquin County to Kern County.

Several requests for changes to subbasins boundaries within the San Joaquin Valley groundwater basins have been submitted to DWR in concurrence with the Basin Boundary Emergency Regulation, including changes to Tracy, Delta-Mendota and Westside subbasins. Requests for changes to Delta-Mendota and Westside subbasins have been approved, however, no changes have been incorporated into Bulletin 118 (DWR 2016b). Following section was written based on Bulletin 118 (DWR 2003) boundary.

DWR has prioritized Tracy subbasins as medium priority based on degraded water quality throughout the subbasin (DWR 2014a). Pursuant to Senate Bill (SB) 1168, West Stanislaus Irrigation District, City of Tracy, West Side Irrigation District, Banta-Carbona Irrigation District and County of San Joaquin have proposed to cooperatively manage the subbasin (DWR 2016c). The north western portion of the subbasin does not have designated Groundwater Sustainability Agency (GSA) at the time of writing this report.

DWR has prioritized the Delta-Mendota subbasin as high priority based on overdraft concerns in the subbasin (DWR 2014a). Farmers Water District, Aliso Water District, Patterson Irrigation District, West Stanislaus Irrigation District and San Joaquin River Exchange Contractors Water Authority have proposed to cooperatively manage the subbasin (DWR 2016c).

DWR has prioritized the Westside subbasin as high priority based on overdraft, land subsidence and water quality concerns in the subbasin (DWR 2018). A GSA has not been formed for Westside subbasin at the time of writing this report (DWR 2016c).

Geology, Hydrogeology, and Hydrology The aquifer system in the San Joaquin Valley Groundwater Basin is mostly comprised of unconsolidated alluvial and lacustrine sediments, Halocene to Jurassic in age, derived from parent materials of the Coast Ranges and the Sierra Nevada Mountains. The Valley fill reaches a thickness of about 28,000 feet in the southwestern corner (Page 1986). A significant hydrogeologic feature in the basin is the Corcoran Clay. This clay layer divides the aquifer system into two distinct zones, an upper unconfined to semi-confined aquifer and a lower confined aquifer. Both aquifers are composed of formations derived from the deposition of Coast Range sediments in the western portions of the basin. Overlying these formations are flood-plain deposits. The formations in the western portions of the basin are primarily marine formations that generally contain more silt and clay and also contain higher concentrations of salts. The lower confined aquifer system contains sediments of mixed origin.

The western portion of the San Joaquin Valley has major faults running parallel to the western boundary, along the east side of the Coast Range Mountains. The Greenville and Ortigalita faults lie within 6 to 13 miles of the western boundary (San Luis & Delt- Mendota Water Authority [SLDMWA] 2011).

The main surface water feature in the western portion of the San Joaquin Valley Groundwater Basin is the San Joaquin River and its tributaries, including Salt Slough, Mud Slough, and Los Banos Creek.

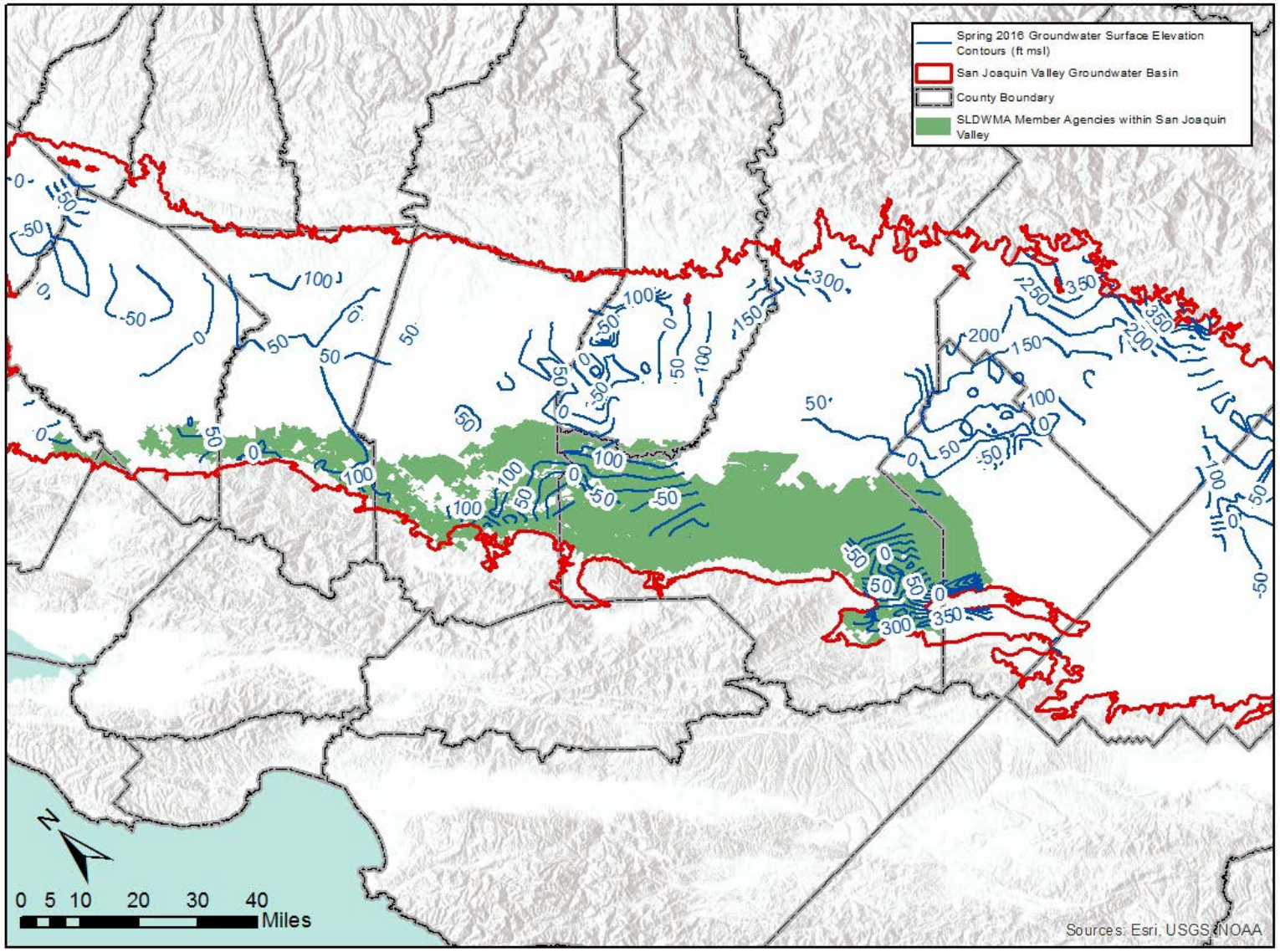
Groundwater Production, Levels, and Storage Prior to the large-scale development of irrigated agriculture, groundwater in the basin generally flowed from areas of higher elevation (i.e., the edges of the basin) toward the San Joaquin River and ultimately to the Delta. Most of the water in the San Joaquin Valley moved laterally, but a small amount leaked upward through the intervening confining unit (Planert and Williams 1995). Upward vertical flow to discharge areas from the deep confined part of the aquifer system was impeded partially by the confining clay beds, particularly the Corcoran Clay. Extensive groundwater pumping and irrigation (with imported surface water) have modified local groundwater flow patterns and in some areas, groundwater depressions are evident. Groundwater flow has become more rapid and complex. Groundwater pumping and percolation of excess irrigation water has resulted in steeper hydraulic gradients as well as shortened flow paths between sources and sinks (Faunt 2009).

Irrigated agriculture in the northern portion of the San Joaquin Valley Groundwater Basin increased from about one million acres in the 1920s to more than 2.2 million acres by the early 1980s (United States Department of the Interior, Bureau of Reclamation [Reclamation] 1997). Subregion 10 (Delta Mendota Basin) in the United States Geological Survey's (USGS's) Central Valley Hydrologic Model (CVHM), show average groundwater pumping to be 60,000 acre-feet (AF) per year from 1962 through 2003 (Faunt 2009).

Figure J-2 shows Spring 2016 groundwater elevation contours for the San Joaquin Valley Groundwater Basin. According to CVHM, the cumulative change in groundwater storage for the entire San Joaquin Valley Groundwater Basin was relatively constant from 1962 through 2003, storage dropped during dry periods and increased during wetter years. However according to C2VSim, storage within the San Joaquin Valley has been showing a steady decline since the 1940s. Annual average groundwater production in the basin was estimated to be 0.9 million AF in the CVHM model (Faunt 2009).

Groundwater-Related Land Subsidence From the 1920s until the mid-1960s, the use of groundwater for irrigation of crops in the San Joaquin Valley increased rapidly, causing land subsidence throughout the west and southern portions of the valley. DWR has prioritized the western portion of the San Joaquin Valley (Tracy, Delta-Mendota and Westside subbasins) as having a high potential for subsidence (DWR 2014b). USGS's extensometer near the city of Dos Palos has recorded approximately 0.1 feet of subsidence in 2015 (USGS 2015). In addition to the extensometers, DWR is also analyzing and recording subsidence trends from 319 continuous global positional system (cPGS) stations across the central valley. cPGS station Patterson_CN2005 located between the City of Patterson and Crows Landing along CA-33 has recorded a little over 0.13 feet of subsidence since 2005 (DWR 2016d).

Groundwater Quality Groundwater quality varies throughout the San Joaquin Valley Groundwater Basin. The Groundwater Ambient Monitoring and Assessment (GAMA) Program's Priority Basin Project evaluates statewide groundwater quality and sampled 58 wells in the western San Joaquin Valley region between March and June 2010 (USGS 2013). Water quality data was analyzed for inorganic constituents (e.g., nutrients, radioactive constituents, TDS, and iron/manganese); special interest constituents (e.g., perchlorate) and organic constituents (e.g., solvents, gasoline additives, and pesticides).



Source: DWR 2016e

Figure J-2. San Joaquin Valley Spring 2016 Groundwater Elevation Contours

Inorganic constituents were detected at concentrations less than health-based benchmarks at most of the 39 grid wells sampled. Exceptions included two detections of arsenic greater than the United States Environmental Protection Agency (USEPA) maximum contamination level of 10 micrograms per liter (µg/L); 20 detections of boron greater than the California Department of Public Health (CDPH) notification level of 1,000 µg/L, 2 detections of molybdenum greater than the USEPA lifetime health advisory level of 40 µg/L, 1 detection of selenium greater than the USEPA maximum contamination level (MCL) of 50 µg/L, 2 detections of strontium greater than the USEPA lifetime health advisory level of 4,000 µg/L, and 3 detections of nitrate greater than the MCL-US of 10 µg/L. Results of inorganic constituents with non-health-based benchmarks like iron, manganese, chloride, sulfate, and total dissolved solids (TDS) were also detected at levels greater than CDPH secondary maximum contamination levels at some of the wells (USGS 2013).

Organic and special-interest constituents from the 39 sampled grid wells were also less than health-based benchmarks. Volatile Organic Compounds were detected in approximately 31 percent of the sampled wells, pesticides and pesticide degradates were detected in approximately 23 percent of the sampled wells, and perchlorate was detected in approximately 38 percent of the sampled wells (USGS 2013).

J.2.1.2 San Francisco Bay Hydrologic Region

The Santa Clara Valley Water District (SCVWD) is the primary water contractor within the South Coast Hydrologic Region. SCVWD is a CVP and SWP contactor. The SCVWD was formed in 1929 for the purpose of providing conjunctive management of surface and groundwater for all beneficial uses, which was later expanded to include stream stewardship and protection from flooding within Santa Clara County. Groundwater is an important water supply source for Santa Clara County and its preservation was the goal that spurred the formation of the SCVWD. SCVWD manages two groundwater subbasins: the Santa Clara subbasin (DWR Basin 2-9.02) and the Llagas subbasin (DWR Basin 3-3.01). SCVWD further subdivides the Santa Clara subbasin into two groundwater management areas: the Santa Clara Plain and the Coyote Valley (SCVWD 2016).

DWR has prioritized the Santa Clara subbasin as high priority based primarily on high population, groundwater use, and documented historical impacts (DWR 2018). The Llagas subbasin was prioritized as high priority based primarily on groundwater use/reliance and irrigated acreage (DWR 2018). Pursuant to the Sustainable Groundwater Management Act (SGMA) requirements, SCVWD declared their intent to exclusively manage Santa Clara and Llagas subbasins as the GSA on June 16, 2016 (DWR 2016c), prior to the June 30, 2017 statutory deadline. In December 2016, SCVWD submitted the 2016 Groundwater Management Plan for the Santa Clara and Llagas Subbasins to DWR as an Alternative to a GSP as allowed by SGMA.

J.2.1.3 Santa Clara Groundwater Subbasin (DWR Basin 2-9.02)

The Santa Clara subbasin is a 297 square mile groundwater basin that borders the southern San Francisco Bay and principally drains parts of Santa Clara and San Mateo Counties. The Santa Clara subbasin occupies a structural trough parallel to the northwest trending Coast Ranges. The Diablo Range bounds it on the east and the Santa Cruz Mountains form the basin boundary on the west. It extends from the northern border of Santa Clara County to the groundwater divide near the town of Morgan Hill. The dominant hydrogeologic feature is a large inland valley (USGS 1995). The valley is drained to the north by tributaries to San Francisco Bay including Coyote Creek, the Guadalupe River, and Los Gatos Creek. Annual average precipitation for the Santa Clara subbasin ranges from less than 15 inches in the valley to more than 28 inches in the upland areas.

Geology, Hydrogeology, and Hydrology Most of the basin is characterized by gently sloping topography of coalescing alluvial fans that combine to form the valley floor and coastal tidal lowlands. The sloping offshore plain and underlying aquifers extend beneath the Bay. The location of the northwest boundary and the extent of the groundwater basin offshore beneath the Bay and its connection with adjacent areas such as the Niles Cone or Fremont groundwater areas remain uncertain. In general, groundwater flow in the Santa Clara subbasin can be characterized as a convergent regional flow system within a basin bounded by mountains and hills on three sides (USGS 2004). Recharge to the groundwater flow system starts along the mountain fronts and flows toward the center of the basin and toward the southern San Francisco Bay (USGS 2004). Much of the predevelopment flow paths have been modified by pumping centers characterized by groups of wells that have resulted in sub-regional cones of depression and related flow paths (SCVWD 2001). Discharge from the groundwater flow system occurs as pumpage, underflow, base flow to streams, and evapotranspiration.

The Santa Clara subbasin is a regional groundwater basin that can be divided into two onshore subregions that represent the confined and unconfined parts of the aquifer systems as shown in Figure J-3. The confined zone in the northern portion of the subbasin is overlain by a clay layer of low permeability (SCVWD 2016). The southern portion of the subbasin is generally unconfined and contains no thick clay layers (SCVWD 2001). The basin contains extensive alluvial-aquifer systems that are bounded by faults and Bedrock Mountains.

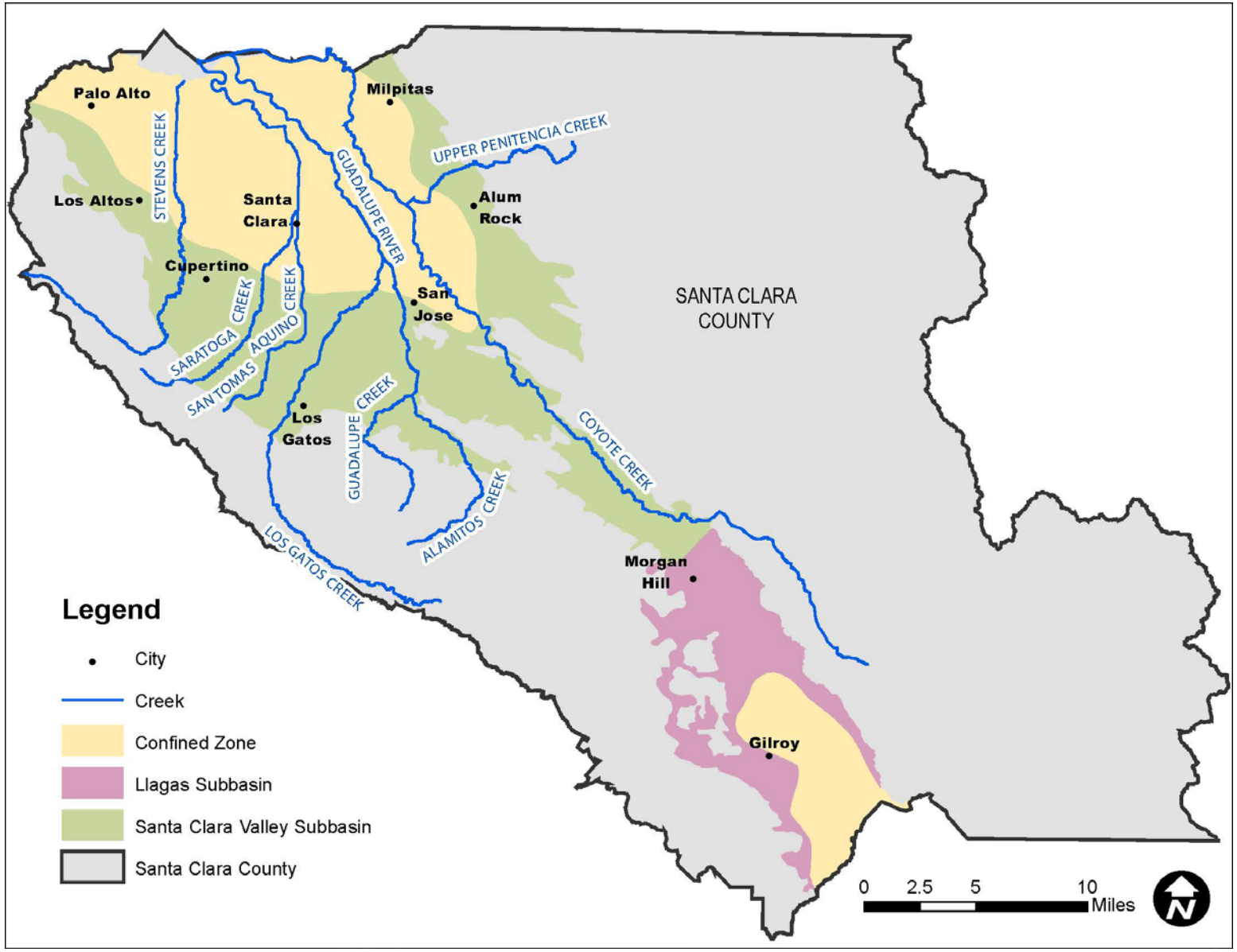


Figure J-3. Santa Clara County Groundwater basins

There is extensive groundwater development in the deeper, or lower, aquifer system of the Pleistocene and Pliocene-age alluvial deposits (USGS 2004). Shallow parts of the upper aquifer are artificially recharged with some of the groundwater in the system dating back less than 60 years and some dating back as much as 2,500 years. Groundwater in lower aquifer generally ranges in age from 16,700 to 39,900 years (Hanson 2015). The Santa Clara subbasin includes continental deposits of unconsolidated to semi-consolidated gravel, sand, silt, and clay. Two members form this group, the Santa Clara Formation of Plio-Pleistocene age and the younger alluvium of Pleistocene to Holocene age (DWR 2003). The combined thickness of these two units probably exceeds 1,500 feet (DWR 2003). The alluvial deposits that form the regional aquifer systems are unconformably underlain by Pliocene-age deposits of the Santa Clara Formation, Tertiary-age sediments that include the Miocene-age parts of the Monterey Formation, and Tertiary-age serpentinites as shown in Figure J-4 (USGS 2004). These underlying deposits form the relatively impermeable base of the regional aquifer systems. The alluvial aquifer systems are composed of a complex sequence of layers of fluvial sand and gravel and fluvial fine-grained silt and clay (USGS 2004). It becomes progressively finer-grained at the central portions of the valley. The Santa Clara Formation is exposed only on the west and east sides of the Santa Clara subbasin. The exposed portions are composed of poorly sorted deposits ranging in grain size from boulders to silt (DWR 2003).

Groundwater in the Santa Clara subbasin is primarily present in the Pleistocene to Holocene alluvium deposits. The permeability of the valley alluvium is generally high and principally all large production wells derive their water from it (DWR 2003). Well logs indicate that permeability increases from west to east and that in the central part of the valley permeability and grain size decrease with depth (DWR 2003).

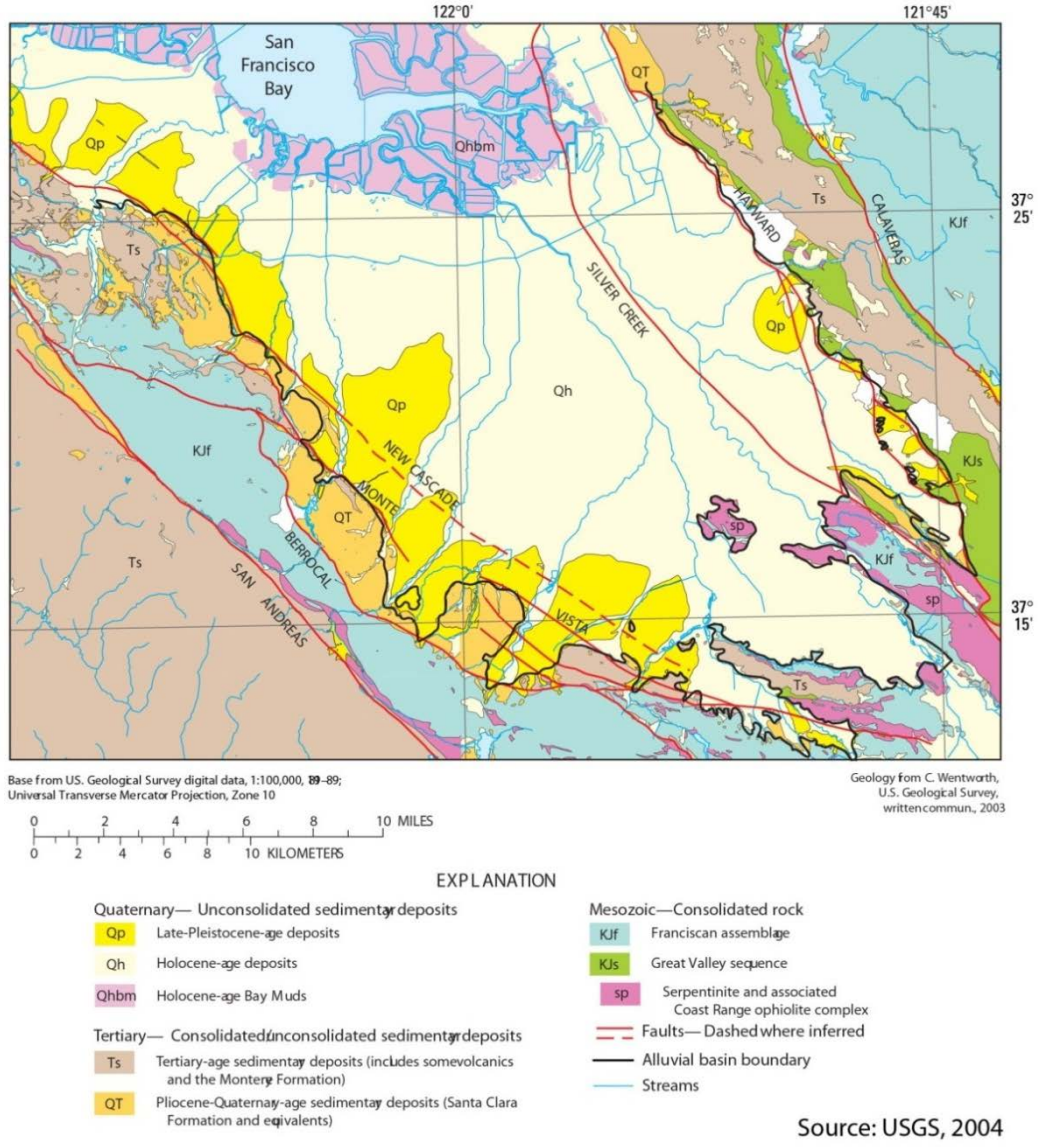


Figure J-4. Santa Clara Valley Geology

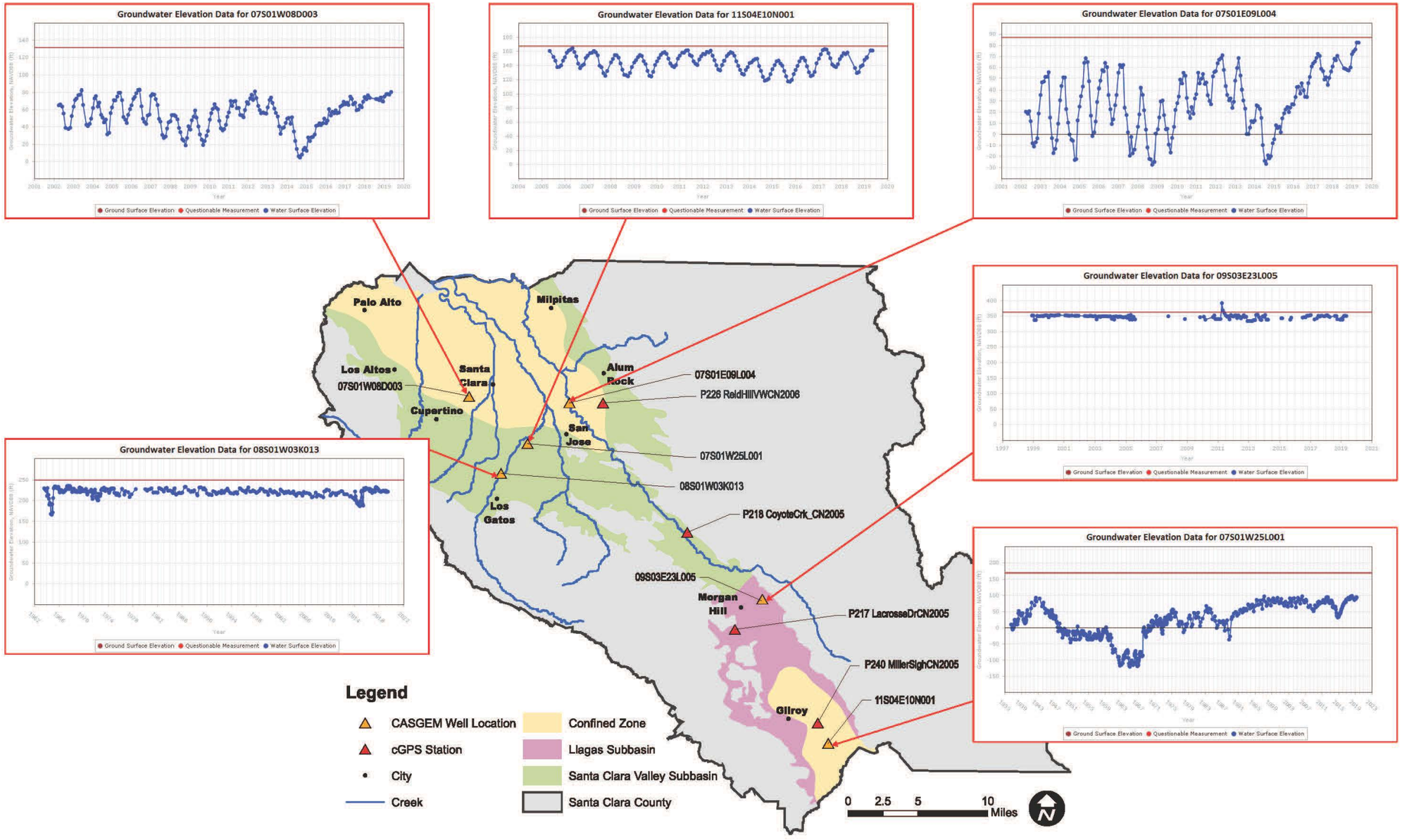
The surface water system in the Santa Clara County includes the natural streamflow network, groundwater recharge percolation ponds, in-stream recharge facilities, ten reservoirs, and a system of channels or canals, pipelines, and storm drains. The main surface water features in the Santa Clara groundwater subbasin are the tributaries to San Francisco Bay including Coyote Creek, Guadalupe River, and Los Gatos Creek. The major streams discharge directly to the San Francisco Bay through the tidal lowlands along the southern end of San Francisco Bay. Other creeks, such as San Francisquito Creek that forms the northwestern boundary of the Santa Clara subbasin, drain directly into the San Francisco Bay. The reservoirs discharge directly into several of the major tributaries and creeks. Different networks of pipelines are used to transport imported water directly to treatment plants where the water is treated

and then delivered to local water retailers. The storm drain channels drain additional runoff from the valley floor to the San Francisco Bay.

SCVWD classifies groundwater recharge into two categories: natural and managed recharges. Natural groundwater recharge occurs principally as infiltration from streambeds that exit the upland areas within the drainage basin and from direct percolation of precipitation that falls on the basin floor. Annual average precipitation for the Santa Clara subbasin ranges from 14 inches in the valley to 45 inches in the upland areas (SCVWD 2015). Other sources classified as natural recharge include net leakage from pipelines, percolation from upland areas, ungauged creeks, and net irrigation return flows to the basin.

Managed recharge refers to the active and intentional recharge of the basin by groundwater recharge ponds and in-stream recharge facilities with releases of local and imported water from reservoirs or the distribution system to the managed recharge facilities. In-stream recharge occurs along stream channels in the alluvial apron upstream from the confined zone. The groundwater recharge ponds include abandoned gravel pits and areas specifically excavated for recharge purposes. In-stream and off-stream facilities provide approximately equal recharge capacity (SCVWD 2016). The District operates off-stream groundwater recharge ponds systems with a cumulative surface area of about 390 acres in 7 major recharge systems countywide. Within the Santa Clara Subbasin, average managed recharge is about 73,500 AF per year (SCVWD 2016).

Groundwater Production, Levels, and Storage SCVWD manages the Santa Clara subbasin. Groundwater is pumped within Santa Clara subbasin by major water retailers, well owners, and agricultural users. Historically, from the early 1900s through the mid-1960s, groundwater level declines from groundwater pumping have induced land subsidence in the Santa Clara subbasin and caused degradation of the aquifer adjacent to the bay from saltwater intrusion. Prior to construction of reservoirs that supply recharge water and the import of surface water via the Hetch Hetchy and South Bay Aqueducts, water levels declined more than 200 feet in the Santa Clara subbasin (USGS 1988). Groundwater levels have generally increased since 1965 as a result of increased recharge and decreased pumping (USGS 1995). Figure J-5 shows the location of the monitoring wells within Santa Clara subbasin and the recent (2011-2015) groundwater elevation at the wells.

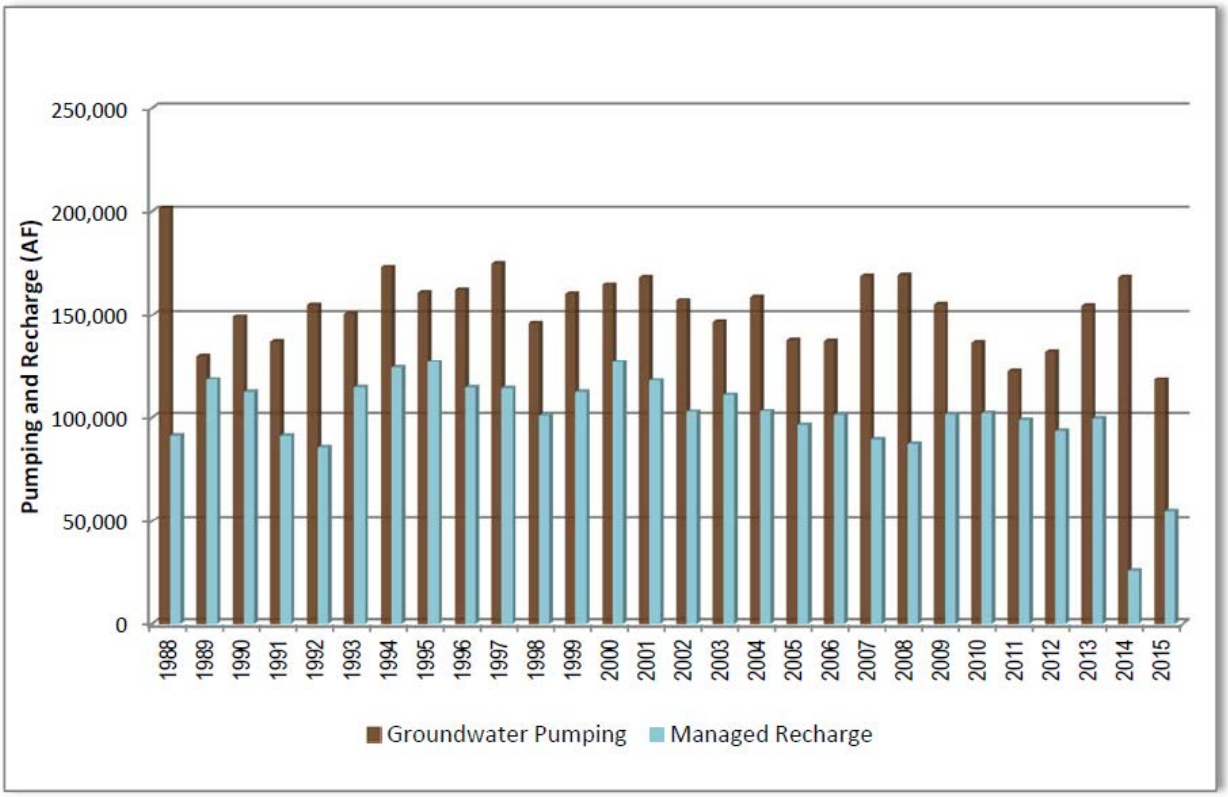


Source: DWR 2019

Figure J-5. Santa Clara County Historic Groundwater Elevations

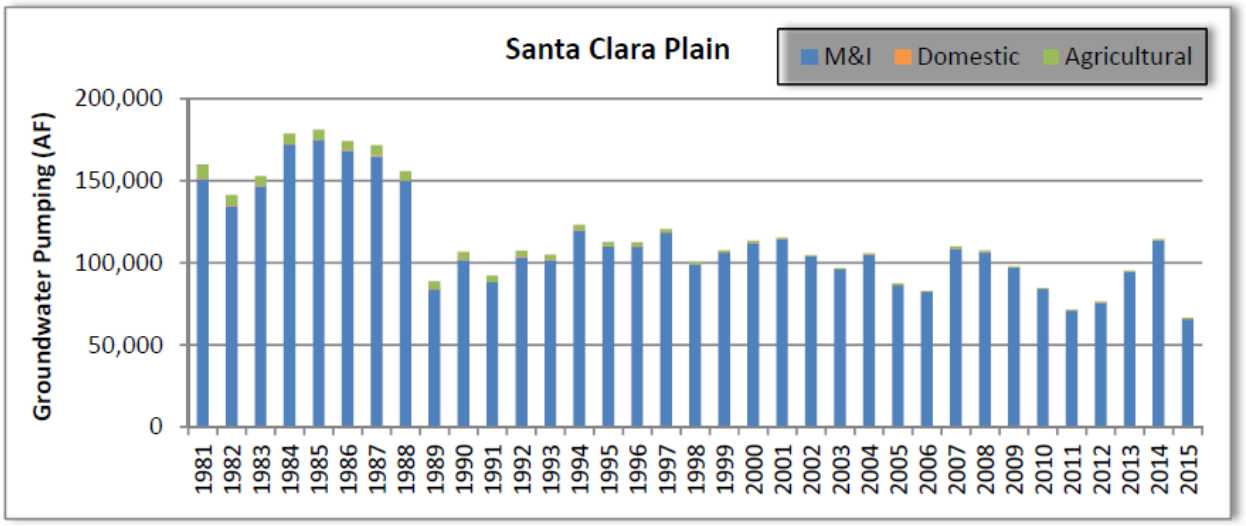
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About 40% of the water used in Santa Clara County water comes from groundwater; North County (Santa Clara Plain area of the Santa Clara Subbasin) meets 31 percent of its water demand through groundwater pumping and South County (Coyote Valley of the Santa Clara subbasin and Llagas subbasin) meets 94 percent of its demand through groundwater (SCVWD 2016). Figures J-6 through J-9 show historical groundwater pumping within Santa Clara County.



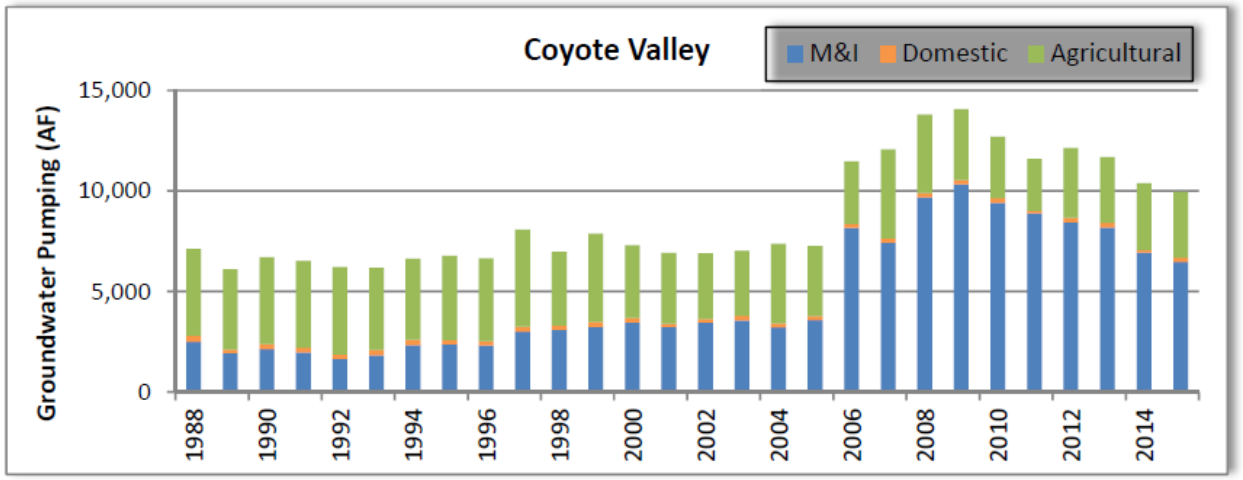
Source: SCVWD 2016

Figure J-6. Santa Clara County Groundwater Pumping and Managed Recharge



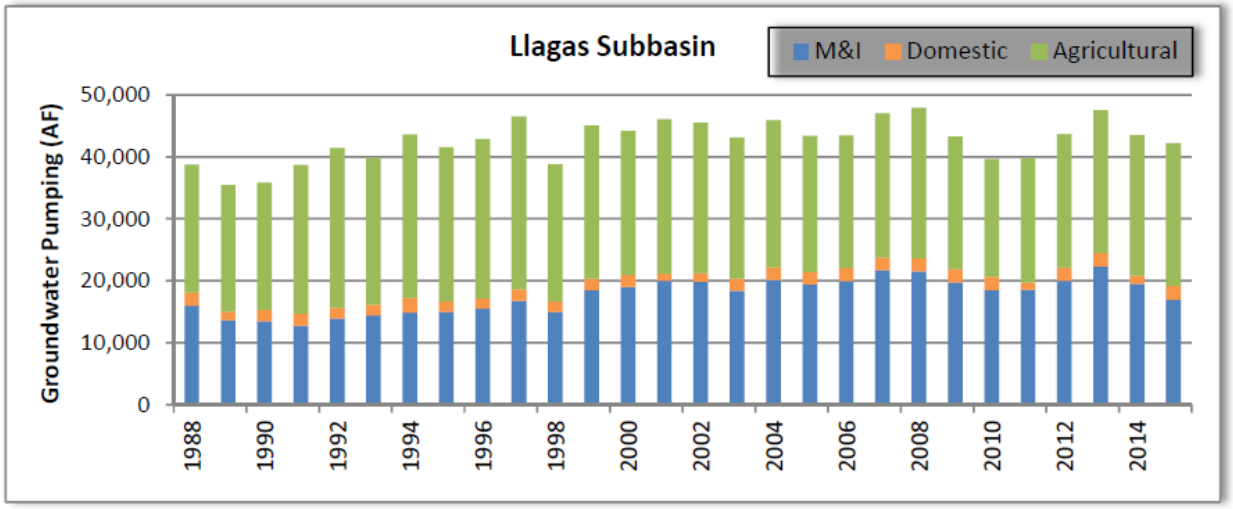
Source: SCVWD 2016

Figure J-7. Santa Clara Plain Groundwater Pumping by Use



Source: SCVWD 2016

Figure J-8. Coyote Valley Groundwater Pumping by Use



Source: SCVWD 2016

Figure J-9. Llagas Subbasin Groundwater Pumping by Use

The operational storage capacity of the Santa Clara subbasin is estimated to be between 373,000 to 383,000 AF (SCVWD 2016). The operational storage capacity is less than the total storage capacity of the basin and accounts for available pumping capacity and the avoidance of land subsidence and problems associated with high groundwater levels.

Groundwater-Related Land Subsidence Historically, Santa Clara County has experienced as much as 13 feet of subsidence caused by excessive pumping of groundwater. One serious consequence of subsidence in the Santa Clara County was that lands near San Francisco Bay sank below sea level between 1940 and 1970, enabling salt water to intrude upstream through the mouths of rivers dramatically affecting the riparian habitat of the rivers. Land subsidence also increased potential for tidal flooding (SCVWD 2000). Land subsidence since 1980's has primarily been elastic with most of this minimal compaction occurring in the upper aquifer (upper 250 feet of sediments) and trending over seasonal and climatic cycles (Hanson 2015). Figure J-10 reflects the elevation of groundwater at the downtown San Jose index well (well ID 7S01E07R013) and the land subsidence measured at First and St. James Streets in San Jose. In addition to the index well, DWR is also analyzing and recording subsidence from cGPS stations across the state (operated by University NAVSTAR Consortium [UNAVCO]). cGPS station Reid Hill_P226 located near Hillview Park in San Jose (see Figure J-5 for location of cGPS stations) has recorded a little over 0.01 feet of subsidence since 2006 (DWR 2016d). cGPS station Coyote Creek P218 located in Coyote Valley near the Coyote Creek Golf Club has recorded approximately 0.02 feet of subsidence since 2005 (DWR 2016d).

SCVWD uses Predictions Relating Effective Stress and Subsidence (PRESS)[1] numerical modeling to simulate current conditions and predict future subsidence under various groundwater conditions. SCVWD has calibrated the model at ten index wells within the subbasin, and has established subsidence thresholds equal to the current acceptable rate of 0.01 feet per year (SCVWD 2001, SCVWD 2012, SCVWD 2016). DWR has categorized Santa Clara subbasin as having a low potential for future land subsidence (DWR 2014b).

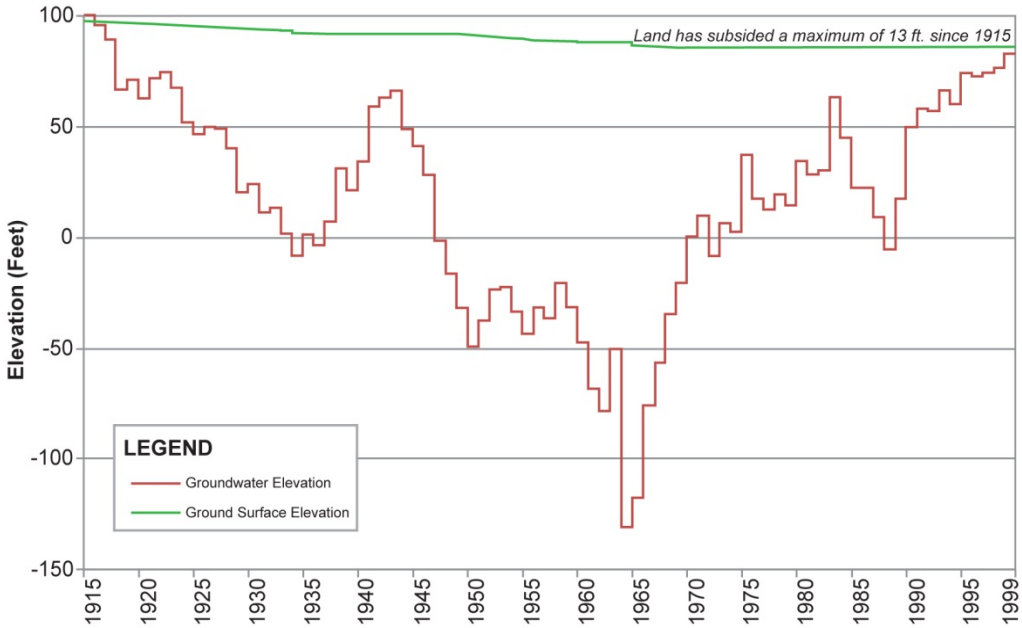


Figure J-10. Land Subsidence at San Jose Index Well (Source SCVWD 2000)

Groundwater Quality DWR has prioritized the Santa Clara subbasin as high priority based on high population, groundwater use, and documented historical impacts (DWR 2018). Though groundwater in the Santa Clara subbasin is typically considered "hard", the groundwater is suitable for most uses and meets drinking water standards at public supply wells without the use of treatment methods (SCVWD 2001). Groundwater alkalinity in the Santa Clara subbasin is generally bicarbonate type with sodium and calcium being the principal cations (DWR 2003).

Groundwater in the northern portion of the basin has elevated mineral levels which could be associated with the historical saltwater intrusion due to land subsidence (SCVWD 2001). Some wells with elevated nitrate concentration have been identified in the southern portion of the basin (SCVWD 2001).

[1] Predictions Relating Effective Stress and Subsidence (PRESS) is a two-dimensional model that relates the stress associated with groundwater extraction to the resulting strain in fine-grained materials such as clays.

J.2.2.2 Llagas Subbasin (DWR Basin 3-03.01)

The Llagas subbasin is part of the Gilroy-Hollister Groundwater Basin DWR Basin 3-03 (DWR 2003). A request for the basin boundary modification was submitted to DWR in concurrence with the Basin Boundary Emergency Regulation (DWR 2016b). At the time of writing this report modification to the basin boundary has been approved, however, no changes have been incorporated into Bulletin 118 (DWR 2016b). Following section was written based on Bulletin 118 (DWR 2003) boundary.

The Llagas subbasin occupies a northwest trending structural depression. The Diablo Range bounds it on the east and the Santa Cruz Mountains form the basin boundary on the west. The subbasin extends from the groundwater divide at Cochran Road near the town of Morgan Hill in the north to the Pájaro River in the south (SCVWD 2016).

Geology, Hydrogeology, and Hydrology The Llagas subbasin similar to the Santa Clara subbasin was formed by continental deposits of unconsolidated to semi-consolidated gravel, sand, silt and clay (DWR 1981). The water bearing formation of the subbasin includes the Santa Clara Formation and the valley fill material (alluvial and alluvial fan deposits) (DWR 1981).

The Santa Clara Formation is of Plio-Pleistocene age. This formation underlies much of the valley and unconformably overlies older non-water bearing sediments (DWR 1981). It consists of fairly well consolidated clay, silt, and sand with lenses of gravel. These sediments are generally of fluvial origin with an estimated maximum thickness of 1,800 feet (DWR 1981). The lower portions of deeper wells within the subbasin likely intersect the Santa Clara Formation. Alluvial fan deposits of Holocene age occur at the margin of the valley basin. The alluvial fan deposits are composed of a heterogeneous mixture of unconsolidated to semi-consolidated clay, silt, sand, and gravel usually locally partially confined (DWR 1981). The alluvial fan deposits range in thickness from 3 feet to 125 feet and overlie the Santa Clara Formation and other older non water bearing deposits (DWR 1981). A number of these wells supply water of excellent quality for irrigation and municipal purposes (DWR 1981). A series of interbedded clay layers, which extends north from the Pajaro River, divides the Llagas subbasin into confined and forebay zones as shown in Figure J-2.

Older alluvium of the Plio-Pleistocene age is distributed in the central portion of the valley from the northern boundary of the subbasin to Gilroy. It consists of unconsolidated clay, silt, and sand formed as floodplain deposits. It characteristically is identified by a dense clayey subsoil that acts as an aquitard to vertical movement of water and limits recharge potential (DWR 1981). It provides adequate yields to wells up to 100 feet in depth and water obtained from this formation is generally suitable for most uses (DWR 1981). Younger alluvium of the Holocene age occurs in the flat lying areas from Gilroy south to the basin's southern boundary. Similarly to the older alluvium, the younger

alluvium has been formed principally as a flood plain deposit but it does not have a well-defined clay subsoil. The younger alluvium has a maximum thickness of about 100 feet and generally overlies the older alluvium and alluvial fan deposits (DWR 1981). Groundwater in the younger alluvium is generally unconfined and the quality of water is acceptable for domestic purposes (DWR 1981).

The dominant geohydrologic feature in the subbasin is an inland valley that is drained to the south by tributaries of the Pájaro River, including Uvas and Llagas creeks. Annual average precipitation for the Llagas subbasin ranges from less than 16 inches in the south to more than 24 inches in the north (DWR 2003).

Groundwater Production, Levels and Storage Figure J-5 shows the recent (2011-2015) groundwater elevation in the Llagas subbasin wells (09S03E23L005M, 11S04E10N001M). While groundwater elevations in the well are not indicative of elevations in all wells within the subbasin, these groundwater levels are suggestive of relative changes in groundwater levels within the subbasin.

SCVWD manages the Llagas subbasin, and groundwater is pumped from the subbasin by major water retailers, well owners and agricultural users. Annual average groundwater pumping within the Llagas subbasin has remained fairly constant over the years. Figure J-5 shows historic groundwater pumping from 2000 to 2015 within Santa Clara and Llagas subbasins.

Natural groundwater recharge based on the 10 years average (2003-2012) average for the Llagas subbasin is estimated to be 22,000 AF per year (SCVWD 2016). In addition to natural groundwater recharge, SCVWD operates an managed recharge program in the Llagas subbasin with about 24,000 AF recharged annually, approximately 52% of total recharge (SCVWD 2016). The operational storage capacity of the Llagas subbasin is estimated to be between 150,000 and 165,000 AF (SCVWD 2016). The operational storage capacity is less than the total storage capacity of the basin and accounts for available pumping capacity and the avoidance of problems associated with high groundwater levels.

Groundwater-Related Land Subsidence Most of the subsidence within Santa Clara County has occurred in the Santa Clara subbasin (SCVWD 2000). UNAVCO's cPGS stations Lacrosse Drive P217 and Miller Slough P240 (see Figure J-5 for location of cGPS stations) are showing a not subsiding trend since 2006 (DWR 2016d).

Groundwater Quality DWR has prioritized the Llagas subbasin as high priority based primarily on groundwater use/reliance and irrigated acreage (DWR 2018). Groundwater alkalinity in the Llagas subbasin is generally high similar to the Santa Clara subbasin. Though the water is hard, it is suitable for most uses and

drinking water standards are met at public supply wells without the use of treatment methods (SCVWD 2001).

The SCVWD continues to engage with land use and regulatory agencies to address nitrate loading to monitor and address elevate nitrate concentrations in the Llagas subbasin (SCVWD 2016). Nitrate concentrations in most wells appear stable or decreasing but elevated concentrations of nitrate still exist in certain portions of the Llagas subbasin (SCVWD 2017). Since 1997, more than 600 wells in south Santa Clara County including the Llagas Subbasin and Coyote Valley have been tested for nitrate. SCVWD offers free basic nitrate testing for domestic well owners as well as rebates for point-of-use nitrate treatment systems (SCVWD 2016). The 2017 median nitrate concentration for the principal aquifer zone of the Llagas subbasin was 5.2 mg/L Nitrate as N, with a maximum value of 24 mg/L (SCVWD 2017).

J.2.3 South Lohantan Hydrologic Region

J.2.3.1 Fremont Valley Groundwater Basin

Fremont Valley Groundwater Basin underlies Antelope Valley-East Kern Water Agency in eastern Kern County and northwestern San Bernardino County. Alluvium is primary water-bearing formation in this basin and is about 1,190 feet thick along the margin of the basin and thins towards the middle of the basin (DWR 2003). Total storage capacity of the basin is estimated to be approximately 4,800,000 AF (DWR 2003).

DWR has prioritized the Fremont Valley Groundwater Basin as a low priority basin with declining groundwater levels and some groundwater quality concerns. The basin has naturally high TDS and other constituents like fluoride and sodium (DWR 2018). DWR has also categorized the subbasin to have a medium to high potential for subsidence (DWR 2014b). cGPS station CalCity_CS2005 located in California City Airport in California City has recorded a little under 0.02 feet of subsidence since 2005 (DWR 2016d).

J.2.3.2 Antelope Valley Groundwater Basin

Antelope Valley Groundwater Basin also underlies Antelope Valley-East Kern Water Agency in the western Mojave Desert. Primary water-bearing formation in this basin are unconsolidated alluvial and lacustrine deposits. The basin is divided into three large structural basins separated by faults and folds along the San Andreas and Garlock fault zones. Groundwater flow in the basin is impeded by several other faults in addition to the San Andreas and Garlock faults. Groundwater storage capacity is estimated to be 70,000,000 AF (DWR 2003).

DWR has prioritized the Antelope Valley Groundwater Basin as a very low priority basin despite declining groundwater levels (DWR 2018). The priority for this basin has been set to very low as a result of conditions with adjudication and non-adjudicated groundwater use of less than 9,500 AF being met (DWR

2018). DWR has also categorized the subbasin as having a high potential for subsidence (DWR 2014b). cGPS station BarnardPro_CS2005 located in the northern end of the basin has recorded a little under 0.03 feet of subsidence since 2005 (DWR 2016d). Station LakeLosAnge SCIGN located in southern end of the basin has recorded a little over 0.01 feet of subsidence since 2000 (DWR 2016d).

J.2.4 Colorado River Hydrologic Region

J.2.4.1 Ames Valley Groundwater Basin

The Ames Valley Groundwater Basin underlies Ames Valley, Homestead Valley, and Pipes Wash in the southcentral San Bernardino County. The primary water-bearing formation in this basin consists of unconsolidated to partly consolidated continental deposits (DWR 2003). Several northwest trending faults within the basin form partial barriers to groundwater flow. Total storage capacity of the basin is estimated to be approximately 1.2 million AF (DWR 2003).

J.2.4.2 Copper Mountain Valley Groundwater Basin

The Copper Mountain Valley Groundwater Basin is approximately one mile north of the town of Joshua Tree and underlies an alluvial valley below and adjacent to Coyote Lake. The primary water-bearing formation in this basin consists of unconsolidated to partly consolidated continental deposits (DWR 2003). The Pinto Mountain fault zone along the southern end of the basin acts as a barrier to groundwater flow (DWR 2003).

J.2.4.3 Warren Valley Groundwater Basin

The Warren Valley Basin is located in located south of the Copper Mountain Valley Groundwater Basin. The Warren Valley Groundwater Basin has been adjudicated since 1977 and is managed by Warren Valley Basin Watermaster. DWR has prioritized the groundwater basin as very low priority despite groundwater supply concerns (DWR 2018). The priority for this basin has been set to very low as a result of conditions with adjudication and non-adjudicated groundwater use of less than 9,500 AF being met (DWR 2018).

J.2.4.4 Coachella Valley Groundwater Basin

The Coachella Valley Groundwater Basin is located in the northwestern portion of the Salton Trough. The primary water-bearing formation in the basin is made of unconsolidated Pleistocene-Holocene valley fill. The basin includes the Indio, Mission Creek, Desert Hot Spring and San Gorgonio Pass subbasins as defined by Bulletin 118. Total storage capacity of the basin is estimated to be approximately 38.7 million AF (DWR 2003). DWR has prioritized the Indio, San Gorgonio and Mission Creek subbasins as medium priority due to groundwater quality concerns (DWR 2018). DWR has also prioritized the Indio subbasin as having a high potential for subsidence (DWR 2014b).

J.2.5 South Coast Hydrologic Region

Metropolitan Water District of Southern California (MWD) is the largest CVP contractors within the South Coast Hydrologic Region. All the groundwater basins discussed in this section are managed by MWD.

J.2.5.1 Northwest Metropolitan Area Groundwater Basins

The Northwest Metropolitan Area Groundwater Basins include Oxnard Plain, Oxnard Forebay, Pleasant Valley, Santa Rosa and West, East, and South Las Posas subbasins as defined by Bulletin 118. All listed basins are typically east-west trending basins that drain into the Pacific Ocean to their west by the Santa Clara River, Calleguas Creek and Conejo Creek. Total storage capacity of the basins is estimated to be between 3 to 5 million AF (MWD 2007). Natural Safe Yield and Operation Safe Yields are estimated to be approximately 45,000 AF and 100,000 AF respectively (MWD 2007).

J.2.5.2 San Fernando Valley Groundwater Basin

The San Fernando Valley Groundwater Basins is located within Los Angeles River Watershed in Los Angeles County. Total storage capacity of the groundwater basin is estimated to be approximately 3.2 million AF (MWD 2007). Natural Safe Yield and Operation Safe Yields are estimated to be approximately 43,600 AF and 96,800 AF respectively (MWD 2007). DWR has prioritized the groundwater basin as very low priority despite groundwater contamination issues in the basin (DWR 2018). The priority for this basin has been set to very low as a result of conditions with adjudication and non-adjudicated groundwater use of less than 9,500 AF being met (DWR 2018). The basin has been adjudicated since 1979 (DWR 2014c).

J.2.5.3 San Gabriel Valley Groundwater Basin

The San Gabriel Valley Groundwater Basin is located in eastern Los Angeles County. Total storage capacity of the groundwater basin is estimated to be approximately 8.6 million AF (MWD 2007). Natural Safe Yield is estimated to be approximately 152,700 AF (MWD 2007). DWR has prioritized the groundwater basin as very low priority despite the presence of superfund sites within the basin (DWR 2018). The priority for this basin has been set to very low as a result of conditions with adjudication and non-adjudicated groundwater use of less than 9,500 AF being met (DWR 2018). The priority for this basin has been set to very low as a result of conditions with adjudication and non-adjudicated groundwater use of less than 9,500 AF being met (DWR 2018). The basin has been adjudicated since 1971 (DWR 2014c). DWR has also categorized the basin to have a high potential for subsidence (DWR 2014b).

J.2.5.4 Coastal Plains of Los Angeles Groundwater Basin

The Coastal Plain of Los Angeles Groundwater Basin lies within central Los Angeles County. The basin includes the Santa Monica, Hollywood, West Coast, and Central subbasins as defined by Bulletin 118. Total storage capacity of the groundwater basin is estimated to be approximately 13.8 million AF

(MWD 2007). Natural Safe Yield and Operation Safe Yields are estimated to be approximately 125,800 AF and 217,300 AF respectively (MWD 2007).

DWR has prioritized the Santa Monica subbasin as medium priority for groundwater contamination and overdraft concerns. The Central and West Coast subbasins were prioritized as very low priority despite overdraft concerns (DWR 2018). The priority for these basins has been set to very low as a result of conditions with adjudication and non-adjudicated groundwater use of less than 9,500 AF being met (DWR 2018). The Central and West Coast basins are adjudicated basins since 1965 and 1961 respectively (DWR 2014c). DWR has also categorized the Central subbasin to have a medium to high potential for subsidence (DWR 2014b).

J.2.5.5 Coastal Plains of Orange County Groundwater Basin

The Coastal Plain of Orange County Groundwater Basin lies in north and central Orange County within the lower Santa Ana River watershed. Total storage capacity of the groundwater basin is estimated to be approximately 66 million AF (MWD 2007). Natural Safe Yield is estimated to be approximately 70,500 AF (MWD 2007). DWR has prioritized the groundwater basin as medium priority due to sea water intrusion concerns (DWR 2018). DWR has also categorized the basin as having a high potential for subsidence (DWR 2014b).

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Appendix K
Draft Cultural Resources Report

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CULTURAL RESOURCES REPORT FOR THE SAN LUIS LOW POINT IMPROVEMENT PROJECT, MERCED AND SANTA CLARA COUNTIES, CALIFORNIA

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Project No. 3459-02

Total Current Project Area for the Lower San Felipe Intake Alternative, the Combination Alternative, the Treatment Alternative, and the San Luis Reservoir Expansion Alternative: 51,475 Acres

USGS 7.5' Topographic Quadrangle Maps: Calaveras Reservoir (1980), Crevison Peak (2015), Cupertino (1991), Los Banos Valley (2015), Mariposa Peak (2015), Pacheco Pass (1971), San Jose East (1980), San Jose West (1980), San Luis Dam (1969), and Santa Teresa Hills (1981), California

December 2018

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Confidentiality Statements

Archaeological remains and historic period built environment resources can be damaged or destroyed through uncontrolled public disclosure of information regarding their location. This document contains sensitive information regarding the nature and location of cultural resources, which should not be disclosed to unauthorized persons.

Information regarding the location, character or ownership of certain historic properties may be exempt from public disclosure pursuant to the National Historic Preservation Act (54 USC 300101 et seq.) and the Archaeological Resources Protection Act (Public Law 96-95 and amendments). In addition, access to such information is restricted by law, pursuant to Section 6254.10 of the California State Government Code.

Management Summary

As proposed by the US Bureau of Reclamation (Reclamation) and the Santa Clara Valley Water District (SCVWD), the San Luis Low Point Improvement Project (SLLPIP) aims to increase the quantity and reliability of water supplies to contractors and consumers dependent on the San Luis Reservoir in Merced County. On behalf of Reclamation and the SCVWD, and under contract to CDM Smith, Pacific Legacy, Inc. conducted a cultural resources investigation for the SLLPIP as it encompasses action alternatives in Merced, Santa Clara, and San Benito counties. These included the Lower San Felipe Intake Alternative, centered on the San Luis Reservoir; the Combination Alternative, encompassing 12 work locations in Santa Clara County; the Treatment Alternative, centered on an existing SCVWD facility in Santa Clara County; the San Luis Reservoir Expansion Alternative, which encompasses the San Luis Reservoir and overlaps the Lower San Felipe Intake Alternative; and the New Pacheco Reservoir Alternative, centered on the existing Pacheco Reservoir in eastern Santa Clara County extending into San Benito County.

In 2017, the Combination Alternative was excluded from consideration as a part of the SLLPIP and design changes were made to the Treatment Alternative. In 2018, the extents of the San Luis Reservoir Expansion Alternative were altered, and the New Pacheco Reservoir Alternative was added to the Project. For completeness, this document describes the research efforts undertaken through 2018 for the Lower San Felipe Intake, Combination, Treatment, and San Luis Reservoir Expansion alternatives while focusing on the most current elements and extents of each. The cultural resources investigation for the New Pacheco Reservoir Alternative remains ongoing due to access and right-of-entry limitations. It is therefore discussed in a separate addendum report that will be updated as necessary (Pacific Legacy 2018).

The cultural resources investigation summarized in this document was carried out in compliance with federal and state historic preservation laws, including the National Environmental Policy Act, Section 106 (54 USC 306108) of the National Historic Preservation Act (54 USC 300101 et seq.), and the California Environmental Quality Act. Archival and records searches were completed for a 0.5-mile radius surrounding the area of potential effects (APE) for the Lower San Felipe Intake Alternative and the San Luis Reservoir Expansion Alternative, while a 300-foot radius surrounding the APE for the Combination Alternative and the Treatment Alternative was examined. Contact with the Native American Heritage Commission (NAHC) and potential Native American stakeholders was initiated in 2012 and in 2013. An inventory survey of the Treatment Alternative APE was conducted in 2002 (Cartier 2002), while inventory surveys within the APE for the other action alternatives were conducted in 2012 and 2016. These efforts were targeted at identifying cultural

resources that may be impacted by the SLLPIP, particularly historic properties that are listed in or may be eligible for listing in the National Register of Historic Places (NRHP) and/or historical resources that are listed in or may be eligible for listing in the California Register of Historical Resources (CRHR).

Approximately 855.5 acres within the 2,097.5-acre Lower San Felipe Intake Alternative APE were subject to inventory survey in 2012. Twenty-four cultural resources were encountered within the APE, including six previously recorded districts, archaeological sites, or built environment resources. Twelve archaeological sites or built environment resources and six isolated finds were newly identified. Two resources within the Lower San Felipe Intake Alternative APE were previously evaluated for listing in the NRHP and/or the CRHR. One is the San Luis Gonzaga Archaeological District (P-24-000489), which is listed in the NRHP and the CRHR; the other is a California Historical Landmark (CHL-829, P-24-00643), which is listed in the CRHR.

The Combination Alternative APE was initially defined as a discontinuous 113-acre area surrounding 21 groundwater production wells, 18 pipeline segments, and one recharge pond. Many of these areas were excluded from consideration in 2012 after an inventory survey had been completed. The final APE for the Combination Alternative totaled just 28.5 acres and encompassed eight groundwater production wells, three pipeline segments, and one recharge pond. One previously recorded historic period site (CA-SCL-799H) was documented and excavated within the Combination Alternative APE in 1996; it was heavily disturbed by prior development and was not evaluated for listing in the NRHP or the CRHR. The site lies beneath a paved road and no traces of the resource were observed in 2012.

The Treatment Alternative APE, which will involve improvements within the boundaries of an existing SCVWD water treatment plant (WTP), will encompass the 11.8-acre Santa Teresa WTP in the Santa Teresa hills. A second existing facility, the Rinconada Hills WTP, was removed from consideration in 2017, though cultural resource findings for that facility are included in this document for completeness. No cultural resources were revealed within either WTP during a 2002 inventory survey (Cartier 2002) or during a 2016 archival and records search, and thus no additional inventory survey was conducted for the alternative in 2016.

The San Luis Reservoir Expansion Alternative APE, which overlaps the Lower San Felipe Intake Alternative APE, comprises 5,022 acres and nine potential disturbance areas, including the San Luis Reservoir shoreline. Approximately 4,083 acres within the San Luis Reservoir Expansion Alternative APE were subject to inventory survey between 2012 and 2016. Thirty-seven cultural resources were documented within the APE, including nine previously recorded districts, archaeological sites, or built environment resources. Nineteen archaeological sites or built environment resources and nine isolated finds were newly identified. Three resources within the San Luis Reservoir Expansion

Alternative APE have been previously evaluated for listing in the NRHP and/or the CRHR. One is the San Luis Gonzaga Archaeological District (P-24-000489), which is noted above. Another is a prehistoric site (CA-MER-130) included in the NRHP and the CRHR that is regarded as a contributing element to the San Luis Gonzaga Archaeological District. The third comprises the B.F. Sisk Dam and its key features, which have been recommended eligible for listing in the NRHP and the CRHR as a part of a historic district (JRP 2018).

Drawing on information from inventory surveys and site-specific documentary research, Pacific Legacy produced survey-level evaluations for cultural resources within the Lower San Felipe Intake Alternative APE and the San Luis Reservoir Expansion Alternative APE. Among the resources evaluated for the Lower San Felipe Intake Alternative, one prehistoric resource (CA-MER-94) is recommended eligible for listing in the NRHP and the CRHR based on findings from prior excavations; an evaluation for one resource (CA-MER-26/H, prehistoric component) remains pending further investigation; one historic period industrial site (CA-MER-492H) is recommended not eligible for individual listing in the NRHP/CRHR and is regarded as a non-contributing element of the recently defined B.F. Sisk Dam/San Luis Reservoir Historic District (JRP 2018). Twelve other resources are recommended not eligible for listing in the NRHP and the CRHR (CA-MER-477H, CA-MER-484H, CA-MER-485H, CA-MER-486H, CA-MER-487H, CA-MER-488H, CA-MER-489H, CA-MER-490H, CA-MER-491H, CA-MER-493H, CA-MER-494H, and CA-MER-495H).

Nine districts, archaeological sites, or built environment resources (CA-MER-477H, CA-MER-484H, CA-MER-489H, CA-MER-491H, CA-MER-492H, CA-MER-493H, CA-MER-494H, CA-MER-495H, and P-24-000489) intersect the San Luis Reservoir Expansion Alternative APE as well as the Lower San Felipe Intake Alternative APE. Eligibility recommendations for eight of those resources are noted above. For those cultural resources that lie only within the San Luis Reservoir Expansion Alternative APE, seven (CA-MER-510H, CA-MER-511H, CA-MER-512H, CA-MER-513H, CA-MER-514H, and CA-MER-520H, and CA-MER-521H) have been determined not eligible for inclusion in the NRHP with SHPO concurrence and recommended not eligible for listing in the CRHR (Polanco 2018). An additional four historic period resources (CA-MER-515H, CA-MER-516H, CA-MER-518H, and CA-MER-519H) are recommended not eligible for listing in the NRHP or CRHR, and one (CA-MER-509H) is recommended not eligible for inclusion in either register as an individual resource or as a element of the B.F. Sisk Dam/San Luis Reservoir Historic District. The evaluation of five prehistoric sites (CA-MER-15, CA-MER-28, CA-MER-82, CA-MER-83, and CA-MER-517) remains pending further investigation.

This report begins with an introduction to the SLLPIP, specifically its geographic and regulatory setting (Section 1.0), followed by an overview of the natural environment (Section 2.0) and cultural history (Section 3.0) of the

SLLPIP vicinity. Archival and records search results are presented (Section 4.0) along with a discussion of the methods that were used during the inventory surveys (Section 5.0). The results of those surveys are detailed (Section 6.0), and conclusions and recommendations are offered regarding the known or potential significance of cultural resources encountered within the APE for the SLLPIP action alternatives (Section 7.0). Maps of previously recorded cultural resources and prior cultural resource studies associated with each action alternative are included (Appendix A), as are maps of cultural resources relocated or discovered within the APE for each action alternative (Appendix B). Confidential cultural resource records produced in 2012 and 2016 are provided (Appendix C), along with NAHC correspondence (Appendix D) and photographic documentation (Appendix E). Depending on which alternative is selected, many of the cultural resources discussed in this document may not be impacted by ground disturbing activities associated with the SLLPIP. The information and recommendations provided in this report, however, should assist Reclamation and the SCVWD in managing cultural resources associated with this and future projects.

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Acronyms and Abbreviations

amsl	above mean sea level
ACHP	Advisory Council on Historic Preservation
APE	Area of Potential Effects
BP	before present
BLM	US Bureau of Land Management
CCIC	Central California Information Center
CCS	Cryptocrystalline silicate
CFR	Code of Federal Regulations
CHL	California Historical Landmark
CHRIS	California Historical Resources Information System
CRHR/CR	California Register of Historical Resources/California Register
CVP	Central Valley Project
EIS/EIR	Environmental Impact Statement/Environmental Impact Report
GPS	Global Positioning System
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NRHP/NR	National Register of Historic Places/National Register
NWIC	Northwest Information Center
PRC	Public Resources Code
Reclamation	US Bureau of Reclamation
ROW	Right-of-Way
SCVWD	Santa Clara Valley Water District
SHPO	State Historic Preservation Officer
SLLPIP	San Luis Low Point Improvement Project
SR	State Route
SWP	State Water Project
TAF	thousand acre-foot
USGS	United States Geological Survey
WTP	Water Treatment Plant

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Chapter 1
Project Background

As proposed by the US Bureau of Reclamation (Reclamation) and the Santa Clara Valley Water District (SCVWD), the San Luis Low Point Improvement Project (SLLPIP) aims to increase the quantity and reliability of water supplies to contractors and consumers dependent on the San Luis Reservoir in Merced County. On behalf of Reclamation and the SCVWD, and under contract to CDM Smith, Pacific Legacy, Inc. conducted a cultural resources investigation for the SLLPIP as it encompasses action alternatives in Merced, Santa Clara, and San Benito counties. These include the Lower San Felipe Intake Alternative, centered on the San Luis Reservoir; the Combination Alternative, encompassing 12 work locations in Santa Clara County; the Treatment Alternative, centered on an existing SCVWD facility in Santa Clara County; the San Luis Reservoir Expansion Alternative, which is centered on the San Luis Reservoir and overlaps the Lower San Felipe Intake Alternative; and the New Pacheco Reservoir Alternative, centered on the existing Pacheco Reservoir in eastern Santa Clara County extending into San Benito County.

Although the cultural resources investigation for the SLLPIP was begun in 2009, considerable changes have been made in Project design since that time. In 2017, the Combination Alternative was excluded from consideration as a part of the SLLPIP and engineering changes were made to the Treatment Alternative. In 2018, changes were made to the extents of the San Luis Reservoir Expansion Alternative, and the New Pacheco Reservoir Alternative was added to the Project. For completeness, this document describes the research efforts undertaken from 2009 to 2018 for the Lower San Felipe Intake, Combination, Treatment, and San Luis Reservoir Expansion alternatives but focuses on the most current elements and extents of each. The cultural resources investigation for the New Pacheco Reservoir Alternative remains ongoing due to access and right-of-entry limitations. For that reason, it is discussed in a separate addendum report that will be updated as appropriate (Pacific Legacy 2018).

The cultural resources investigation for the SLLPIP was carried out in compliance with federal and state historic preservation laws, including the National Environmental Policy Act, Section 106 (54 USC 306108) of the National Historic Preservation Act (54 USC 300101 et seq.), and the California Environmental Quality Act. Archival and records searches were completed for a 0.5-mile radius surrounding the area of potential effects (APE) for the Lower San Felipe Intake Alternative and the Reservoir Expansion Alternative, while a 300-foot radius surrounding the APE for the Combination Alternative and the Treatment Alternative were examined. Contact with the Native American Heritage Commission (NAHC) and potential Native American stakeholders was initiated in 2012 and in 2013. An inventory survey of the two existing SCVWD

facilities encompassed by the Treatment Alternative was conducted in 2002 (Cartier 2002), and inventory surveys within the APE for the other action alternatives were conducted in 2012 and 2016. These efforts were targeted at identifying cultural resources that may be impacted by implementation of the SLLPIP, particularly historic properties that are listed in or may be eligible for listing in the National Register of Historic Places (NRHP) and/or historical resources that are listed in or may be eligible for listing in the California Register of Historical Resources (CRHR).

1.1 Project Location and Setting

The SLLPIP encompasses two broad areas: the San Luis Reservoir in Merced County and the Santa Clara Valley in Santa Clara County. The San Luis Reservoir is located approximately 40 miles southeast of San Jose and 10 miles west of Los Banos (*see* Figure 1-1). It is one of California's largest off-stream reservoirs with a storage capacity of over two million acre-feet. Water from the Sacramento-San Joaquin Delta is delivered to the San Luis Reservoir via the California Aqueduct, a component of California's State Water Project (SWP), and the Delta-Mendota Canal, a component of Reclamation's Central Valley Project (CVP). The reservoir has a surface area of more than 12,700 acres at its current full capacity. It measures approximately 9 miles in length, 5 miles in width, and features some 65 miles of shoreline. With the exception of water, transportation, and power infrastructure, the San Luis Reservoir area has remained largely undeveloped. In contrast, SLLPIP locations in Santa Clara County lay mostly in developed areas in San Jose, Campbell, and Los Gatos.

1.2 Project Description and Purpose

Reclamation and the SCVWD propose to implement the SLLPIP to optimize water supplies while reducing risks to water contractors and consumers. As San Luis Reservoir water levels recede during the summer and fall months when water demands are greatest, a thick layer of algae grows on the surface. When water levels drop, algae can clog water intakes and interrupt water service. The SLLPIP seeks to avoid supply interruptions by increasing the certainty of meeting the requested delivery schedule throughout the year to contractors dependent on water from the San Luis Reservoir and by increasing the reliability and quantity of yearly allocations to contractors.

A wide range of management measures and alternatives have been examined in order to alleviate interruptions in water service and to maintain water quality. A multi-level screening process identified four alternatives in 2018 that would be fully analyzed and subject to environmental review. As noted above, these include the Lower San Felipe, Treatment, San Luis Reservoir Expansion, and New Pacheco Reservoir alternatives. The Lower San Felipe, Treatment, San Luis Reservoir Expansion alternatives are described briefly below, along with

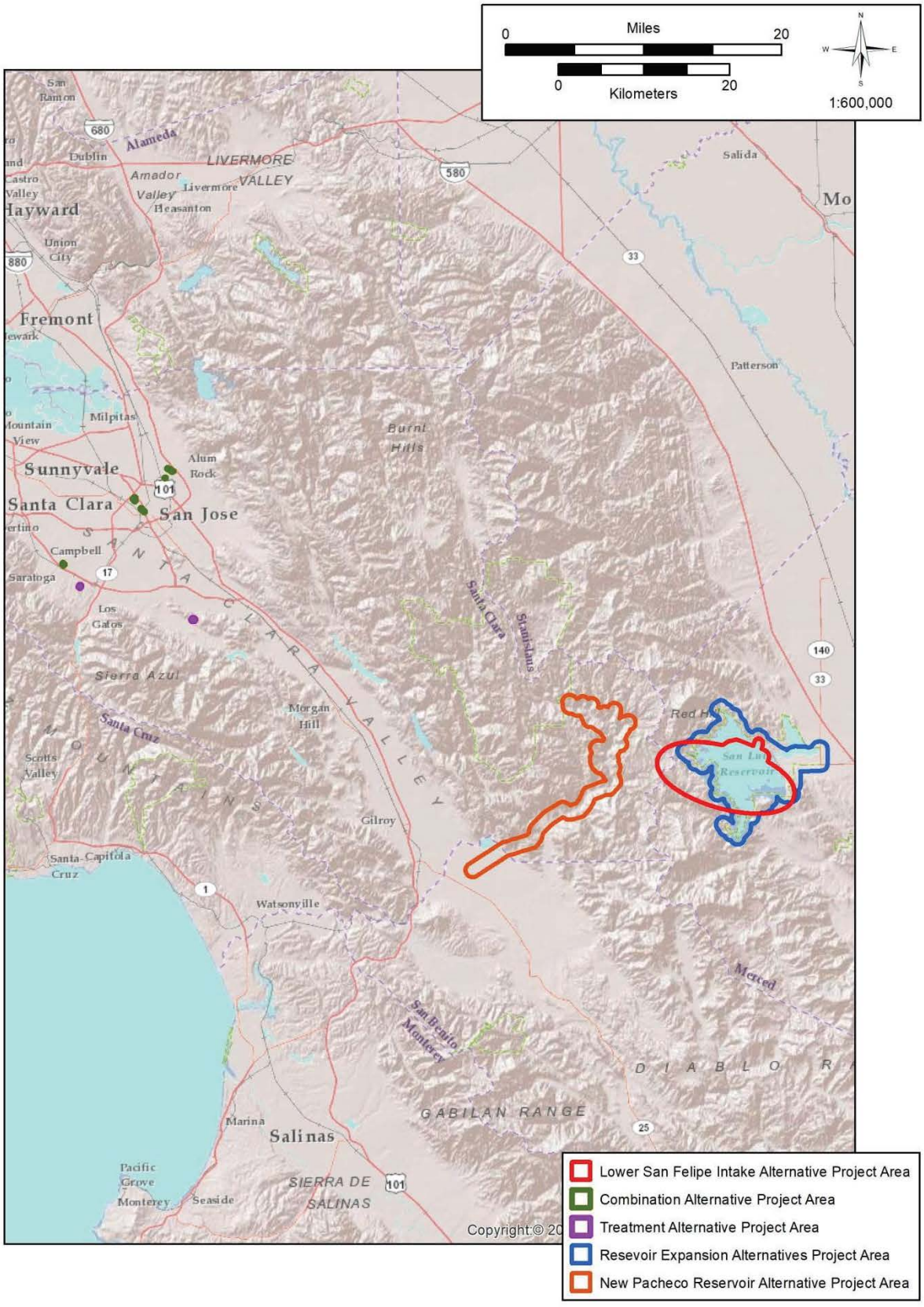


Figure 1-1. San Luis Low Point Improvement Project Vicinity Map.

the Combination Alternative, which was subject to investigation but later dropped as a viable action alternative.

The Lower San Felipe Intake Alternative (Merced County) would include the construction of a new intake connected to the existing San Felipe Division Intake to allow operation of the San Luis Reservoir below the three hundred thousand acre-foot (TAF) level without creating the potential for a water supply interruption to the San Felipe Division.[1] This alternative would involve the construction of a new aeration facility, improvements to Dinosaur Point Road, the use of a staging area at Basalt Point, dredging within the reservoir basin, the construction of a new intake tunnel within the dredging area, a new intake at Gate Shaft Island, and a new tunnel through Dinosaur Point.

The Combination Alternative (Santa Clara County), excluded from consideration as a part of the SLLPIP in 2017, would have included multiple structural components and management measures to maximize operation flexibility and supply reliability in the San Felipe Division. This alternative was centered in the City of San Jose and the Town of Los Gatos in Santa Clara County. It included increased groundwater aquifer recharge and recovery capacity, desalination, re-operation of SCVWD raw and treated water systems, and institutional measures.

The Treatment Alternative (Santa Clara County) would include technological retrofits at the existing SCVWD Santa Teresa Water Treatment Plant (WTP), which was built in 1989. Although these retrofits would include the construction of new facilities, all construction would occur within the existing WTP boundaries and would not encroach on neighboring parcels. A second facility, the Rinconada WTP, was originally included as a part of the Treatment Alternative but was removed from consideration in 2017.

The San Luis Reservoir Expansion Alternative (Merced County) includes the placement of additional fill material on the B.F. Sisk Dam embankment at the San Luis Reservoir to raise the dam crest, thereby increasing the reservoir's storage capacity. This alternative also would build upon dam embankment expansion and foundation modifications to address seismic concerns that are currently being investigated by Reclamation as a part of the B.F. Sisk Dam Safety of Dams Modification Project. As a part of this alternative, the dam crest would be raised by adding additional embankment material; stability berms and downstream crack filters would be installed; modifications to the Dinosaur Point boat launch would be made to increase the operating elevation of the ramps; the crest of an existing dike protecting the Pacheco Pumping Plant would be raised; and modifications would be made at multiple locations along

[1] The San Felipe Division of the Central Valley Project is located in the Central Costal area of California and covers portions of Monterey, San Benito, Santa Clara, and Santa Cruz counties. Water for the San Felipe Division is transported from the San Luis Reservoir through the Pacheco Tunnel under the Diablo Mountains and distributed through a series of buried conduits and pipes (Simonds 1994).

State Route (SR) 152 to prevent inundation of the roadway when the enlarged reservoir is filled to capacity.

Increasing the storage capacity of the San Luis Reservoir would potentially increase the yield of CVP and SWP deliveries when water supplies in excess of the reservoir's existing storage capacity are available. The increased yield could increase SCVWD's capacity to access their CVP supply prior to the reservoir being drawn below the three hundred TAF level, thus avoiding the potential for a water supply interruption. The three alternatives being considered under the San Luis Reservoir Expansion Alternative include the CVP Reservoir Expansion Alternative, the Shared CVP and SWP Reservoir Expansion Alternative, and the Increased Carryover Storage Alternative. Each differs in its operations mode and water distribution while sharing the same construction footprint and potential impact areas, thus each is effectively treated in this investigation as a single action alternative. In 2018, following design changes made to the Crest Raise Alternative under the B.F. Sisk Dam Safety of Dams Modification Project, changes also were made to the footprint of the San Luis Reservoir Expansion Alternative with which it overlaps. These changes included the addition of a haul route between the Basalt Hill Borrow Area and a potential construction staging area as well as a change in the footprint of the Basalt Hill borrow area**,** Borrow Area 6, and potential construction staging areas (*see* Section 1.3.4).

The final alternative examined as a part of the environmental review process is the No Project/No Action Alternative. The No Project/No Action Alternative defines the impacts of taking no action or not implementing the SLLPIP. All of the alternatives outlined above, as well as the New Pacheco Reservoir Alternative, are presented in an Environmental Impact Statement/Environmental Impact Report (EIS/EIR) currently being developed by Reclamation and the SCVWD (Reclamation 2018).

1.3 Area of Potential Effects

Each action alternative examined as a part of the SLLPIP environmental review process encompasses its own APE, or area within which the proposed action may directly or indirectly cause alterations in the character or use of significant cultural resources. The Combination Alternative APE was set within an urban environment and the Treatment Alternative APE is confined to an existing facility. The footprints for each of these alternatives were thus constrained by their setting and by surrounding infrastructure (e.g., roads, existing pipelines, fencelines, etc.). The Lower San Felipe Intake Alternative APE and the San Luis Reservoir Expansion Alternative APE are centered near the San Luis Reservoir and are much less circumscribed. The APE for each action alternative is described below.

1.3.1 Lower San Felipe Intake Alternative

The Lower San Felipe Intake Alternative APE encompasses six locations within and around the San Luis Reservoir that may be subject to ground disturbing activities. Cumulatively, those locations span approximately 2,097.5 acres and include an aeration facility, the Basalt Point use area, the Dinosaur Point area, Dinosaur Point Road, the intake or dredging area surrounding the proposed pipeline or tunnel, and Gate Shaft Island (*see* Figure 1-2). For the purposes of this investigation, a Project Area was defined for the Lower San Felipe Intake Alternative comprising a generalized 0.5-mile radius surrounding the APE. The Project Area encompasses Dinosaur Point Road from SR 152 to San Luis Reservoir, the center of the reservoir surrounding the proposed intake pipeline or tunnel, the Basalt Point use area, the proposed intake structure, and the proposed aeration facility near the Romero Overlook. This 24,964-acre Project Area was subject to archival and records searches in advance of a 2012 inventory survey of the Lower San Felipe Intake Alternative APE.

1.3.2 Combination Alternative

The Combination Alternative APE encompassed a 100-foot radius surrounding eight groundwater production wells, three pipeline segments, and one recharge pond that would have been subject to ground disturbing activities. The APE for these locations totaled approximately 28.5 acres that spanned seven discontinuous areas in Santa Clara County (*see* Figure 1-3). Because it lay within a mostly urban environment subject to numerous prior cultural resource studies, a 300-foot radius surrounding the Combination Alternative APE was established as the alternative Project Area, thus limiting the extents of the archival and records searches. The final Project Area for the Combination Alternative encompassed approximately 122.3 acres. Twelve additional groundwater production wells and associated pipelines were initially identified as a part of the alternative but were dropped from consideration subsequent to archival and records searches and a 2012 inventory survey. The alternative as a whole was removed from consideration under the SLLPIP in 2017.

1.3.3 Treatment Alternative

The Treatment Alternative APE encompasses the full extents of the existing SCVWD Santa Teresa WTP. It spans 11.8 acres and is located northwest of Graystone Lane in the Santa Teresa hills above San Jose (*see* Figure 1-4). Proposed retrofits at the facility would include upgrades to plant electrical systems, plant infrastructure, and solids handling facilities. Because these retrofits would be confined to the facility footprint, a 300-foot radius surrounding the Treatment Alternative APE was established as the alternative Project Area to focus the efforts of a 2016 archival and records search. The Rinconada WTP, a 6.5-acre facility located east of More Avenue near the Rinconada County Club in Los Gatos, was initially included as a part of the alternative but was removed from consideration in 2017.

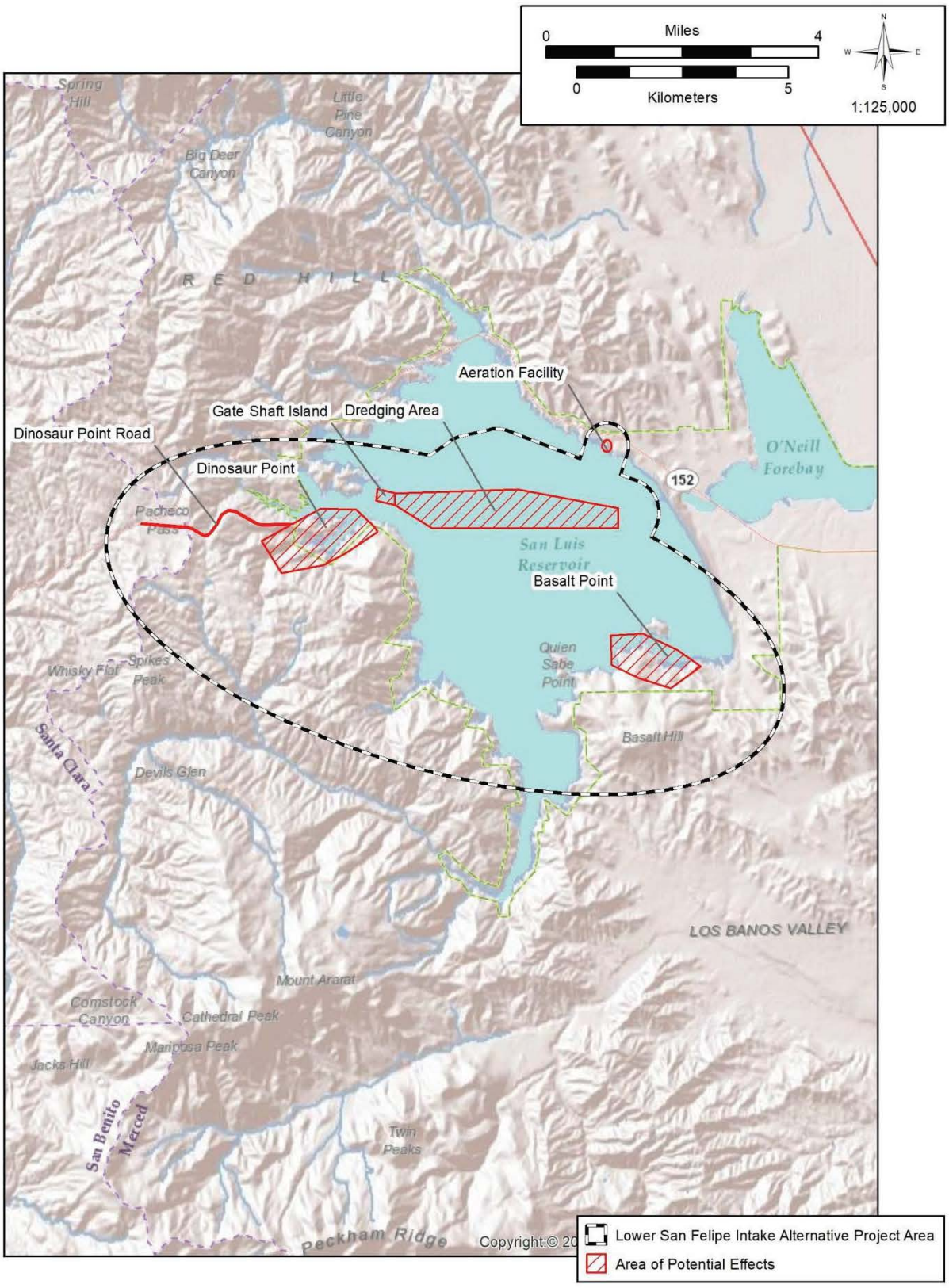


Figure 1-2. The Lower San Felipe Intake Alternative Project Area and Area of Potential Effects.

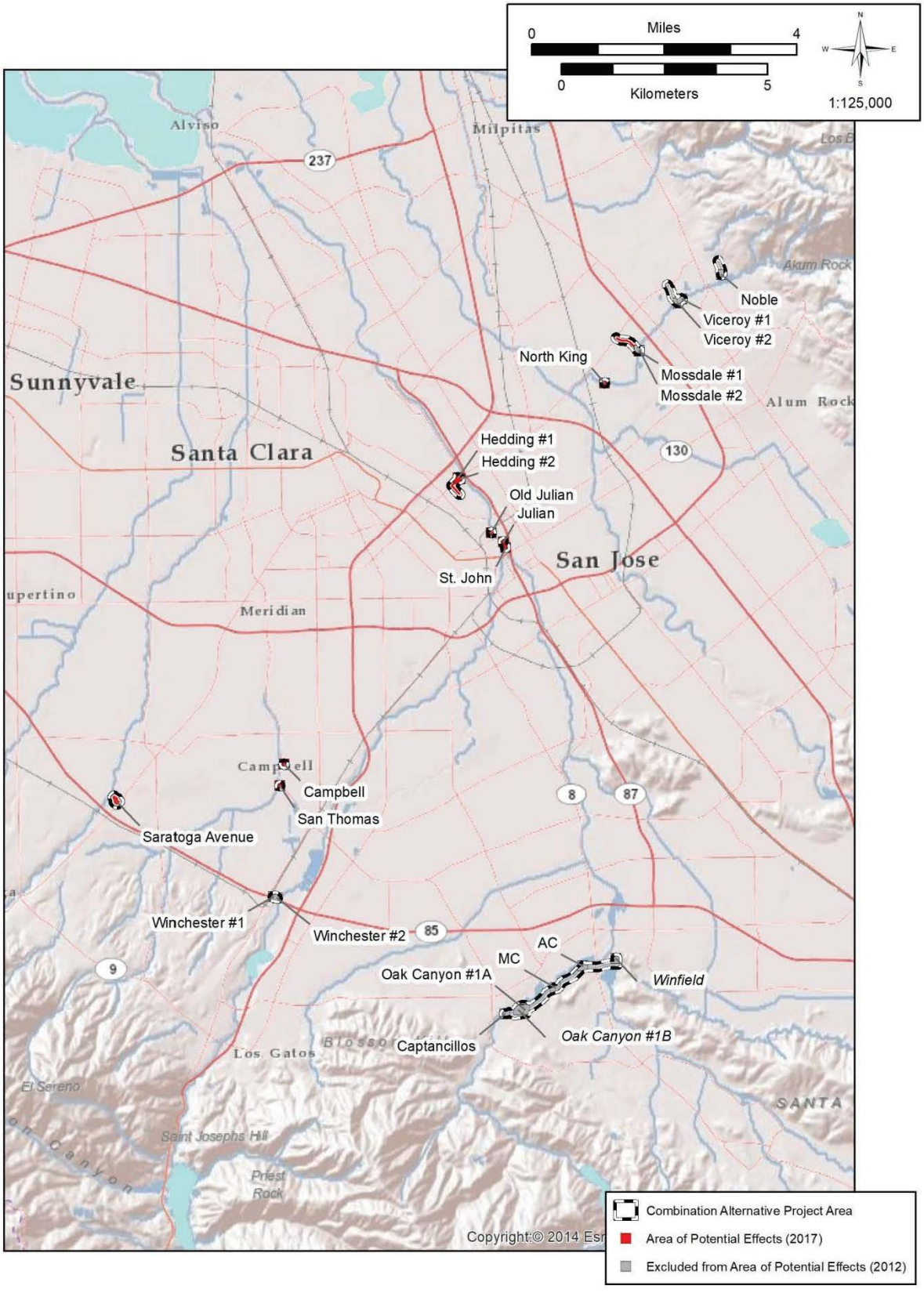


Figure 1-3. The Combination Alternative Project Area and Area of Potential Effects.

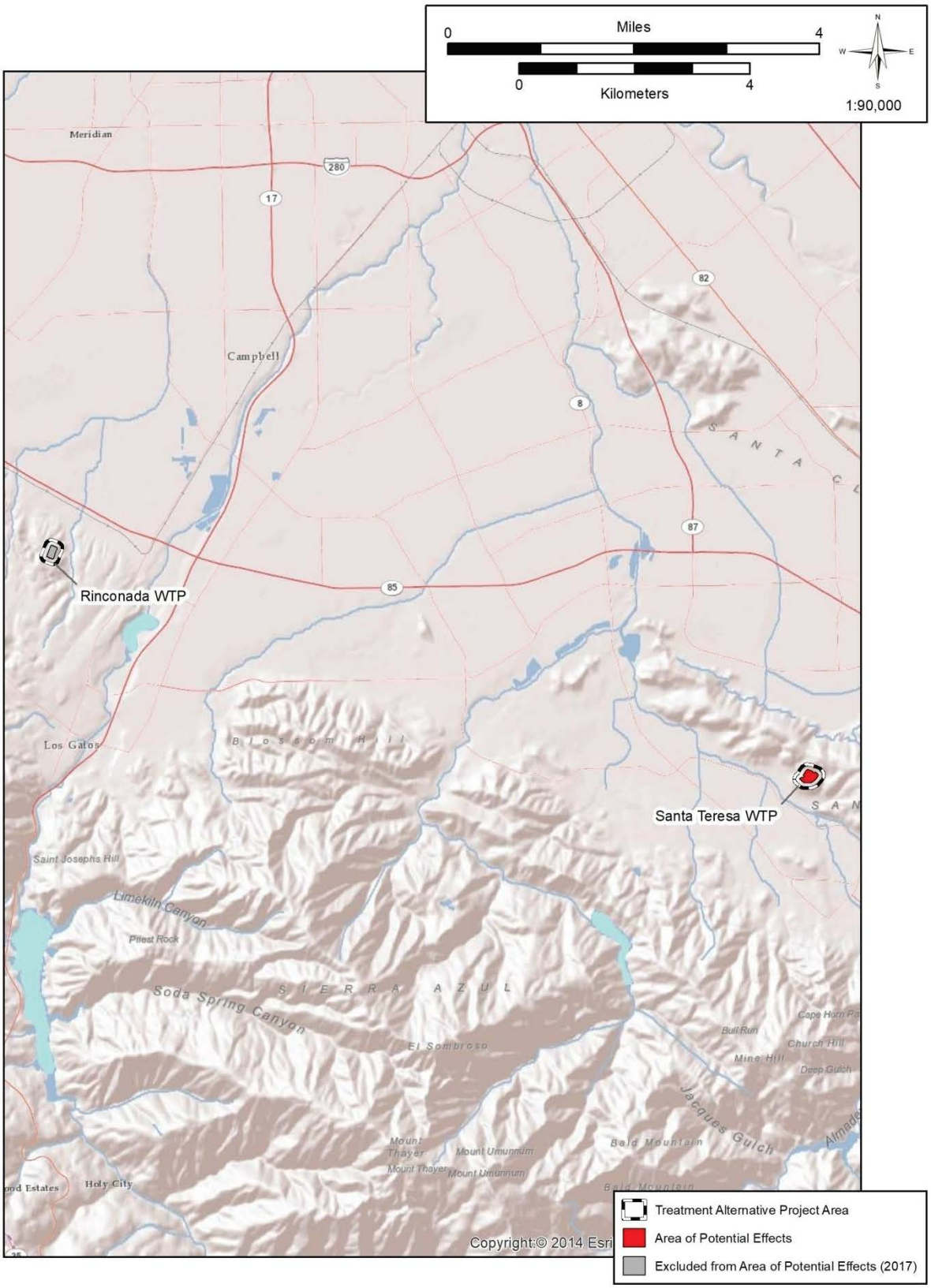


Figure 1-4. The Treatment Alternative Project Area and Area of Potential Effects.

1.3.4 San Luis Reservoir Expansion Alternative

The San Luis Reservoir Expansion Alternative comprises three alternatives that share a common APE and encompass nine main potential impact locations within and around the San Luis Reservoir. Included among these potential impact locations is the existing reservoir shoreline, which may become inundated if the storage capacity of the San Luis Reservoir is increased (*see* Figure 1-5). The San Luis Reservoir Expansion Alternative APE spans approximately 5,022 acres and partially overlaps the Lower San Felipe Intake Alternative APE. The APE includes the Basalt Hill borrow area, Borrow Area 6, the Cottonwood Bay levee modification and levee raise areas, the Dinosaur Point boat launch modification area, downstream fill impact areas, haul roads, a Highway 152 impact area, and potential construction staging areas. Ground disturbing activities within these areas may directly alter significant cultural resources as a result of construction, excavation, staging, maintenance, hauling, and other actions. Significant cultural resources also may be altered if the maximum pool level of the reservoir is increased, potentially resulting in mechanical and biochemical impacts along the expanded shoreline (*see* Section 6.4). A Project Area was defined for the San Luis Reservoir Expansion Alternative that encompasses a 0.5-mile radius surrounding the APE and includes the total extents of the reservoir. This 32,370-acre Project Area was subject to archival and records searches in advance of the 2016 inventory survey of the San Luis Reservoir Expansion Alternative APE. As was noted above, construction of the CVP Reservoir Expansion Alternative, the Shared CVP and SWP Expansion Alternative, and the Increased San Luis Reservoir Carryover Storage Alternative would share the same footprint and have the same potential for construction-related disturbance to cultural resources.

In 2018, changes were made to the extents of APE for the San Luis Reservoir Alternative with the addition of a haul route between the Basalt Hill Borrow Area and a potential construction staging area just west of the B.F. Sisk Dam. Changes also were made to the extents of the Basalt Hill borrow area, Borrow Area 6, and two additional potential construction staging areas. This resulted in the exclusion of 251 acres (including 157 acres subject to inventory survey in 2016) that were previously included in the APE and the addition of 799 acres that were not initially included in the APE. Many of the areas that were added in 2018 comprise downstream fill impact areas or potential construction staging areas.

1.4 Regulatory Context

Reclamation is the lead federal agency under NEPA for the SLLPIP and the SCVWD is the lead state agency under CEQA. As a federal undertaking, the

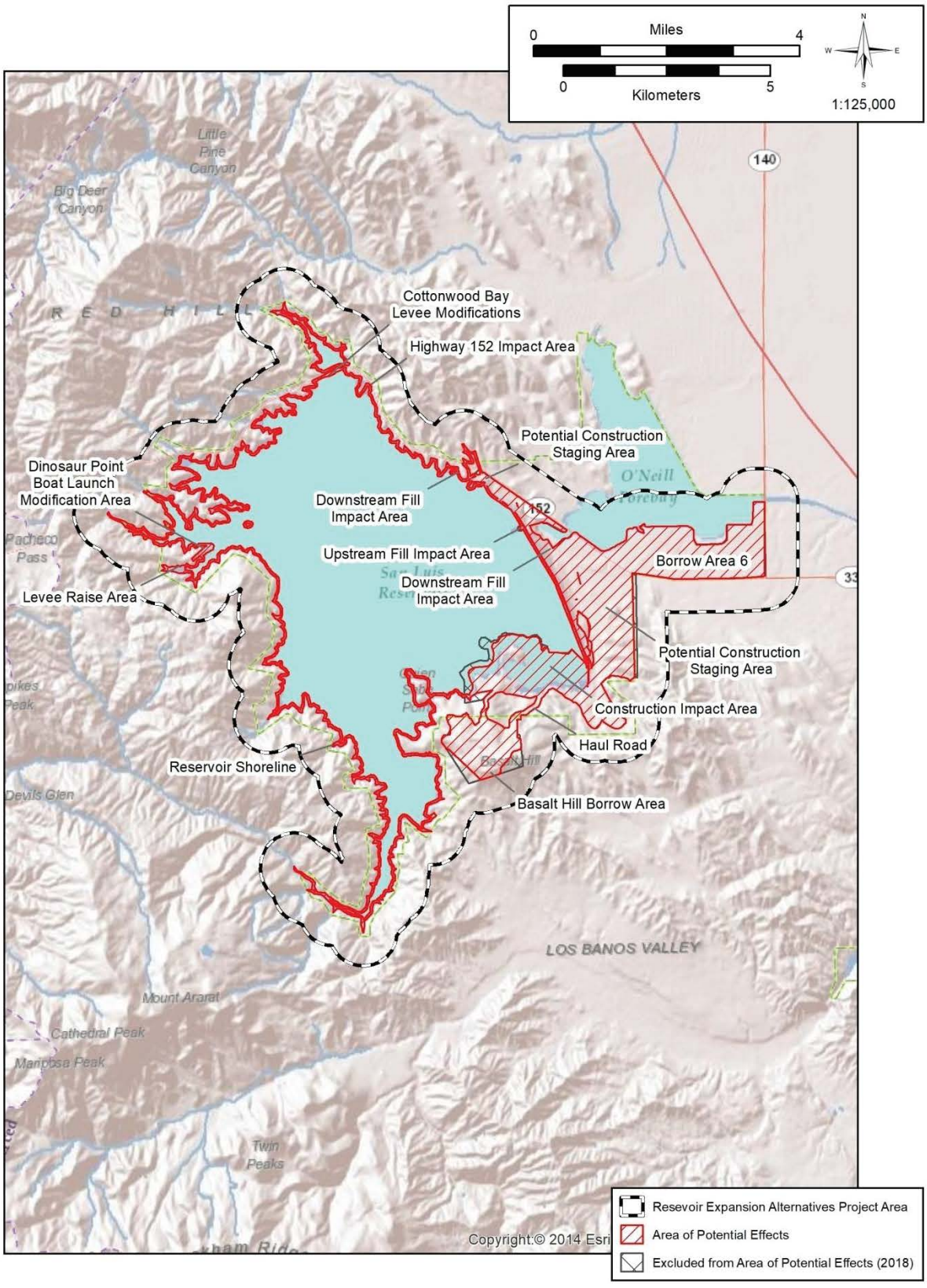


Figure 1-5. The San Luis Reservoir Expansion Alternative Project Area and Area of Potential Effects.

SLLPIP is subject to Section 106 of the NHPA[2] (54 USC 300108), which states

> The head of any Federal agency having direct or indirect jurisdiction over a proposed Federal or federally assisted undertaking in any State and the head of any Federal department or independent agency having authority to license any undertaking, prior to the approval of the expenditure of any Federal funds on the undertaking or prior to the issuance of any license, shall take into account the effect of the undertaking on any historic property. The head of the Federal agency shall afford the [Advisory] Council [on Historic Preservation] a reasonable opportunity to comment with regard to the undertaking.

The implementing regulations of Section 106 of the NHPA are found in 36 CFR Part 800, which identifies the steps and consultation requirements that must be taken to comply with Section 106 of the NHPA. Pursuant to 36 CFR 800.16(l)(1), a historic property is defined as

> any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria.

The criteria for determining NRHP eligibility are found in 36 CFR Part 60.

In the event that historic properties within the APE for an undertaking will be subject to adverse effects, the lead federal agency is required to consider ways to avoid, minimize, or mitigate ("resolve") such effects, in consultation with the Advisory Council on Historic Preservation (ACHP), the SHPO, and other Section 106 consulting parties. This often requires the development and execution of a Memorandum of Agreement (MOA) or Programmatic Agreement among the consulting parties (36 CFR 800.6).

Section 106 regulations allow federal agencies to conduct "nondestructive project planning activities before completing compliance with Section 106" (36 CFR 800.1[c]), provided any subsequent consideration of alternatives to avoid, minimize, or mitigate adverse effects is not restricted during the planning process. At this time, Reclamation does not have an undertaking with the potential to affect historic properties as the feasibility and environmental studies are planning activities. Should Congress authorize an identified SLLPIP alternative or other Project that addresses the San Luis "low point" problem,

[2] Following ACHP guidelines, "Section 106" is referred to as that section of the original public law that enacted the NHPA as opposed to its current legal citation (54 USC 306108). It is a reference that has been in constant use for almost 50 years. The provisions of the newly codified NHPA may be found under 54 USC 300101 et seq.

and a federal agency has an undertaking as defined in 36 CFR 800.14(y) and 800.3(a)(1), that federal action will then be subject to NHPA Section 106 compliance and other federal cultural resources laws as applicable.

Because two of the Project's action alternatives include lands owned and administered by Reclamation, additional cultural resource policies and procedures are also relevant. Among these is the Native American Graves Protection and Repatriation Act (NAGPRA) (Public Law 101-601; 25 USC 3001-3013), which describes the rights of Native American lineal descendants, Indian tribes, and Native Hawaiian organizations with respect to the treatment, repatriation, and disposition of Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony, referred to collectively in the statute as "cultural items," with which they can show a relationship of lineal descent or cultural affiliation. NAGPRA also establishes procedures for the inadvertent discovery or planned excavation of Native American cultural items on federal or tribal lands.

Additional mandates applicable to Reclamation administered lands are outlined in the manuals "Policy for Cultural Resources Management" (LND P01; Reclamation 2012a), "Directives and Standards for Cultural Resource Management" (LND 02-01; Reclamation 2012b), and "Administration of the Archaeological Resources Protection Act (ARPA) on Bureau of Reclamation Land" (LND 02-04; Reclamation 2014). Reclamation is also guided by the "Policy for Museum Property Management" (LND P05; Reclamation 2012c) and "Directives and Standards for Museum Property Management" (LND 02-02; Reclamation 2012d).

1.4.1 National Register of Historic Places

The NRHP is "an authoritative guide to be used by federal, state, and local governments, private groups, and citizens to identify the Nation's cultural resources and to indicate what properties should be considered for protection from destruction or impairment" (36 CFR 60.2). Eligibility for inclusion in the NRHP is determined by applying the following criteria, which were developed by the National Park Service in accordance with the NHPA and outlined in 36 CFR 60.4:

> The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and
>
> A) That are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> B) That are associated with the lives of persons significant in our past; or
>
> C) That embody distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high

artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D) That have yielded, or may be likely to yield, information important in prehistory or history.

Any prehistoric or historic period district, site, building, structure, or object that meets one or more of the criteria above and possesses sufficient integrity may be eligible for inclusion in the NRHP as a historic property.

Typically, cemeteries, birthplaces, or graves of historic period figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, commemorative properties, and properties that have achieved significance within the past 50 years are not considered eligible for listing in the NRHP. Such properties may qualify, however, if they are integral parts of districts that do meet the criteria or if they fall within the following categories:

- A religious property deriving primary significance from architectural or artistic distinction or historical importance; or
- A building or structure removed from its original location but which is significant primarily for architectural value, or which is the surviving structure most importantly associated with a historic person or event; or
- A birthplace or grave of a historical figure of outstanding importance if there is no appropriate site or building directly associated with his productive life.
- A cemetery which derives its primary significance from graves of persons of transcendent importance, from age, from distinctive design features, or from association with historic events; or
- A reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or
- A property primarily commemorative in intent if design, age, tradition, or symbolic value has invested it with its own exceptional significance; or
- A property achieving significance within the past 50 years if it is of exceptional importance (36 CFR 60.4).

1.4.2 California Environmental Quality Act

State historic preservation regulations affecting the SLLPIP include the statutes and guidelines contained in CEQA. CEQA requires lead agencies to consider

carefully the potential impacts of a project on historical resources. A "historical resource" includes, but is not limited to, any object, building, structure, site, area, place, record, or manuscript that is considered historically or archaeologically significant (PRC 5020.1). Section 15064.5 of state CEQA *Guidelines* specifies criteria for evaluating the significance or importance of cultural resources as follows:

1. The resource is associated with events that have made a contribution to the broad patterns of California history;

2. The resource is associated with the lives of persons important in our past;

3. The resource embodies the distinctive characteristics of a type, period, region or method of construction, or represents the work of an important individual or possesses high artistic values; or

4. The resource has yielded, or may be likely to yield, important information in prehistory or history.

The technical advice series produced by the California Governor's Office of Planning and Research offers guidance on procedures to identify historical resources, evaluate their importance and potential for listing in the CRHR, and estimate potential impacts on historical resources. The advice series strongly recommends that Native American concerns and the concerns of other interested persons and corporate entities including, but not limited to, museums, historical commissions, associates, and societies be solicited as part of the process of cultural resources inventory. In addition, California law 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.

1.4.3 California Register of Historical Resources

The CRHR, which is similar to the NRHP, is an authoritative guide that was created to identify the state's historical resources and to indicate what properties are subject to protection, to the extent prudent and feasible, from substantial adverse change. The criteria for CRHR eligibility are based upon NRHP criteria. Certain resources are determined by the statute to be automatically included in the CRHR, including California properties formally determined eligible for or listed in the NRHP, California Historical Landmarks (CHL) numbers 770 and above, and California Points of Historical Interest.

Per the CRHR, historical resources may consist of buildings, structures, objects, or archeological sites. Each of these entities is assessed for its historical, architectural, archaeological, cultural, or scientific importance. Per CEQA *Guidelines*, (Section 15064.5[b]), project activities may have a significant impact on the environment if they would cause a substantial adverse change in the significance of a historical resource. Activities that could result in a

substantial adverse change include demolition, replacement, substantial alteration, and/or relocation of the resource. Steps that must be implemented in order to comply with state CEQA *Guidelines* include the following:

- Identify cultural resources;
- Evaluate the significance of the cultural resources based on established thresholds of historical, architectural, archaeological, cultural, or scientific importance;
- Evaluate the effects of a project on all cultural resources; and
- Develop and implement measures to mitigate the effects of the project on significant cultural resources.

The State Office of Historic Preservation has broad authority under federal and state law for the implementation of historic preservation programs in California. The SHPO comments on effect determinations and eligibility for listing in the NRHP and the CRHR.

1.5 Report Organization and Project Participants

This report begins with an introduction to the SLLPIP, specifically its geographic and regulatory setting (Section 1.0), followed by an overview of the natural environment (Section 2.0) and cultural history (Section 3.0) of the SLLPIP vicinity. Archival and records search results are presented (Section 4.0) along with a discussion of the methods that were used during the inventory surveys (Section 5.0). The results of those surveys are detailed (Section 6.0), and conclusions and recommendations are offered regarding the known or potential significance of cultural resources encountered within the APE for the SLLPIP alternatives discussed in this document (Section 7.0). Maps of previously recorded cultural resources and prior cultural resource studies associated with each alternative are included (Appendix A), as are maps of cultural resources relocated or discovered within the APE for each alternative during inventory survey (Appendix B). Confidential records for cultural resources within the APE for the SLLPIP alternatives discussed in this document are provided (Appendix C), along with NAHC correspondence (Appendix D) and photographic documentation (Appendix E).

The following Pacific Legacy personnel assisted in the cultural resources investigation for the SLLPIP and/or assisted in the production of this report:

- John Holson (MA), over 35 years experience, Principal Investigator;
- Lisa Holm (PhD), over 22 years experience, Senior Archaeologist/GIS Analyst;
- Marc Greenberg (MA), 20 years experience, Field Supervisor;
- Mary O’Neill (BA), over 17 years experience, Field Supervisor;

- Christopher Peske (BA), 6 years experience, Field Supervisor;
- Elena Reese (MA), 22 years experience, Historian;
- Daniel Trout (BA), 15 years experience, Field Technician;
- Jack Sprague (BA), 9 years experience, Field Technician;
- Joshua Varkel (BA), 4 years experience, Field Technician;
- Lucian N Schrader III (MA), 17 years experience, Field Supervisor;
- Evan Elliot (MA), 14 years experience, Field Supervisor;
- Graham Dalldorf (MA), 20 years experience, Geomorphologist;
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- Katey Fittingoff (BA), 2 years experience, Field Technician;
- Brian Marks (PhD), 3 years experience, Field Technician;
- Chloe Atwater (BA), 2 years experience, Field Technician;
- Shanna Streich (MA), 9 years experience, Supervisor;
- Shauna Mundt (MA), 4 years experience, Field Technician; and;
- Kylie Tauitavuki (BA), 2 years experience, Field Technician.

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Chapter 2
Natural Environment

The following section presents an overview of the geology and landscape history of the SLLPIP vicinity, including the area in and around the San Luis Reservoir and the Santa Clara Valley, with a focus on the potential to encounter buried cultural resources in each main area. Several geoarchaeological studies have been produced for both the Santa Clara Valley and the San Luis Reservoir area. A thorough account of late Quaternary landscape evolution within the Santa Clara Valley may be found in a geoarchaeological study by Rosenthal and Meyer (2004a), which focused on the southern portion of the valley, while a detailed geoarchaeological overview of the San Luis Reservoir area was included as part of a larger study by Rosenthal and Meyer (2004b) for Caltrans' District 10. The discussion below examines the physiography and geology of both areas and offers a brief account of recent geoenvironmental history. It concludes with an account of late Quaternary geology and soils within each Project Area so that landscape change and geomorphic processes within the APE for each alternative may be better understood.

2.1 Physiography and Geology

The San Luis Reservoir area lies within the eastern Diablo Range foothills, which area a part of the larger Coast Ranges physiographic province. These foothills generally range in elevation from 200-2,500 feet above mean sea level (amsl) and are characterized by a weakly to moderately dissected, rolling topography at the eastern extent of the range where they grade into and are buried by the deep alluvium of the Great Valley physiographic province. The western foothills are more deeply dissected, with steep slopes. The foothills are northwest trending, sub-parallel to the San Andreas Fault, and underlain by Great Valley Sequence bedrock units in the east and rocks of the Franciscan complex in the west, though several isolated outcrops of Miocene basalt are present (Lettis 1982; Wagner et al. 1991). Broad, terraced valleys generally separate the foothills, which represent sites of localized subsidence and uplift, respectively. The valleys are northwest trending and typically underlain by thick sequences of Quaternary alluvium. San Luis Reservoir is situated in one of these valleys, the San Luis Flat, which is created by a pull-apart basin in the Ortigalita Fault Zone, a major Holocene dextral strike slip fault zone that constitutes the eastern part of the larger San Andreas Fault system (Bryant and Cluett 2000).

The Santa Clara Valley is one of the many prominent northwest trending valleys in the Coast Range physiographic province. The regionally important transform plate boundary along the San Andreas Fault is situated in the Santa Cruz Mountains that border the valley to the west. The Santa Cruz Mountains have bedrock geology similar to the Diablo Range, and also are underlain by the Franciscan Complex as well as Great Valley Sequence (Wagner et al. 1991). The Santa Clara Valley is a structural basin that has been filled with Quaternary alluvium, the depth of which varies substantially depending on location. Older alluvial deposits characterize the higher elevation portions of the valley margins, while the lower elevation portions are characterized by late Quaternary alluvium, including widespread Holocene deposits from Coyote Creek and the Guadalupe River that both flow northwest through the valley and drain into the San Francisco Bay (Knudsen et al. 2000).

2.2 Late Quaternary Geology, Geomorphology, and Soils

Previous geological studies of the San Francisco Bay region indicate that the area has undergone a series of dramatic landscape-scale changes since people first inhabited the region circa 15,000 years ago. Due to lower sea levels, the San Francisco Bay did not exist during the late Pleistocene. Instead, the area was characterized by a broad inland valley intersected by well-established and incised drainages. Also during that time, the combined runoff from the Sacramento and San Joaquin rivers flowed through what is now the San Francisco Bay as a single inland drainage before reaching the Pacific Ocean near the Farallon Islands (Atwater et al. 1977). Toward the end of the Pleistocene, the melting of continental glacial ice caused a rapid rise in worldwide sea levels, known as eustatic sea level change. In response, the Pacific shoreline migrated eastward, reaching the opening near the Golden Gate about 10,000 years ago. The San Francisco Bay eventually formed as continued sea level rise drowned the low-lying inland valley areas.

By about 7,000 years ago, the rate of worldwide sea-level rise began to slow dramatically, and relatively slow submersion of more inland portions of the bay and the Sacramento-San Joaquin Delta began (Atwater 1980, 1982; Shelmon and Begg 1975; Stanley and Warne 1994; Wells and Goman 1995). The decrease allowed sedimentation to keep pace with submergence rates, causing extensive tidal flats and marshes to form around the margins of the bay (Atwater et al. 1979). About 26 feet of inundation subsequently occurred in the delta through the Middle and Late Holocene (Rosenthal and Meyer 2004b). This resulted in continued expansion of the bay and estuaries, largely in response to the decomposition, compaction, and subsidence of the intertidal deposits (Atwater 1979; Atwater et al. 1977, 1979).

At the bay margin, the combination of rising water levels and increasing sedimentation rates created higher baselines for streams that entered the Bay. As the lower channels of drainages such as Coyote Creek and the Guadalupe River became choked, sediments were pushed onto the surface of surrounding floodplains, burying exposed surfaces and slowly constructing channel margin levees (Helley et al. 1979). Concurrently, older landforms adjacent to upstream reaches in these drainages were eroded by lateral channel migration, as stream sinuosity increased to maintain equilibrium gradients in response to rising baselines. This led to the formation of an "alluvial apron around the bay plain and the extensive valleys of the region" that is graded to the present sea level (Helley et al. 1979: 18). As a result, many of the Late Pleistocene and Early Holocene land surfaces were overlain by thick deposits of younger alluvium that are generally less than 5,000 years old. These older land surfaces usually exhibit well-developed buried soil profiles (paleosols) that represent a significant stratigraphic boundary in the region. A paleosol is an "old soil" that formed because of weathering at or near the ground surface during a past interval of relative landform stability, making it available for human use and occupation in the past. Alternating periods of landform stability that produce paleosols and periods of instability and deposition that bury them have been documented throughout Central California during the Holocene (Meyer and Dalldorf 2004; Meyer and Rosenthal 2008; Rosenthal and Meyer 2004b).

Further inland from the bay margin, upland valleys of the Diablo Ranges also witnessed profound landscape changes in the late Quaternary, though likely more as a direct result of climatic changes rather than eustatic sea level change. Geological studies in Contra Costa County and the foothills of the western San Joaquin Valley demonstrate that many valleys in the region were partially filled with alluvium by several cycles of deposition in the Holocene that were separated by periods of landscape stability and soil formation (Lettis 1982; Marchand and Allwardt 1981; Pape 1978; Rogers 1988). Geoarchaeological studies in eastern Contra Costa County in the Los Vaqueros area determined that distinct episodes of deposition occurred in different valleys during the Early, Middle, and Late Holocene (Meyer 1996; Meyer and Rosenthal 1997).

During the Late Holocene, ongoing but much more gradual sea level rise caused the expansion of tidal marshes at the bay margin in newly filled valleys. By the 1850s, before Euro-American settlement and reclamation, tidal marshes had expanded in the region to cover twice as much surface area as all the inland water of the Bay and Delta combined (Atwater et al. 1979). Post Euro-American settlement land use changes, including reclamation efforts for conversion to agriculture, channelization of drainages, widespread grazing, and more recent urbanization in the Santa Clara Valley, have led to further landscape changes.

This brief review indicates that the timing, magnitude, and extent of landscape changes were sufficient to have potentially buried cultural resources both in the Santa Clara Valley as well as in the valleys of the Diablo Range, such as the San Luis Flat.

2.2.1 Late Quaternary Surficial Geology

Late Quaternary surficial geology has been mapped for portions of the San Luis Reservoir area and for the entire Santa Clara Valley by Knudsen et al. (2000). In the San Luis Reservoir area, only the westernmost portion that lies within Santa Clara County has been mapped. That area is marked by Early to Late Pleistocene undifferentiated alluvium (Qoa) that is more than 30,000 years old. Qoa deposits are described as moderately to deeply dissected alluvial fan, stream terrace, basin, and channel deposits. For other portions of the San Luis Reservoir area, surficial geologic mapping does not appear to be available, though a study by Lettis (1982) described deposits for the western San Joaquin Valley and eastern Diablo Range. Much of the San Luis Reservoir area in Merced County appears to be situated on steeply sloping erosional hillslopes underlain by bedrock. Some now inundated portions of the San Luis Reservoir area, however, are situated in a structural basin formerly known as the San Luis Flat (*see* Figure 2-1).

Lettis (1982) describes two Holocene units, Patterson and Dos Palos alluvium, that are present in the eastern foothills of the Diablo Range and on the floor of the San Joaquin Valley, respectively. Patterson alluvium underlies present stream channels and low terraces inset into older Late Pleistocene/Early Holocene San Luis Ranch alluvium. Patterson alluvium is purported to form extensive, deep fill in valleys of the eastern Diablo Range, including Carrisalito Flat, which is located approximately 10 miles south of San Luis Reservoir. A gastropod shell obtained from a depth of 0.5 meters in a low terrace along San Luis Creek just east of O'Neill Forebay provided a Late Holocene date for Patterson alluvium (Lettis 1982: 77). Although the San Luis Reservoir had already inundated the San Luis Flat when Lettis (1982) conducted his research, thus preventing him from mapping that location, it seems likely that Holocene deposits of Patterson alluvium covered portions of San Luis Flat along Cottonwood Creek, San Luis Creek, and other unnamed drainages that were subsequently flooded.

Surficial geology in the Santa Clara Valley consists of a variety of deposits that primarily range in age from Late Pleistocene to Latest Holocene (Knudsen et al. 2000). Because surficial geologic mapping tends to be somewhat generalized and the locations that make up the Project Area for the Combination Alternative and the Treatment Alternative are so confined, only a general description of mapped Santa Clara Valley deposits that may be present in the SLLPIP footprint are provided. At the valley margin, relatively older units are exposed at the surface, including Pleistocene alluvial fan deposits (Qpf), and older undifferentiated alluvial deposits (Qoa). Valley bottom units spanning the Holocene are widespread and have buried or eroded older deposits. Valley bottom units have been mapped as channel deposits (Qhc), undifferentiated alluvial deposits (Qha), alluvial fan deposits (Qhf, Qhff, Qhfy, Qhf1), alluvial fan levee deposits (Qhl, Qhly), and stream terrace deposits (Qht, Qhty). Due to extensive urbanization, modern artificial fill (af) and artificial channel (ac) units are also present throughout the valley.

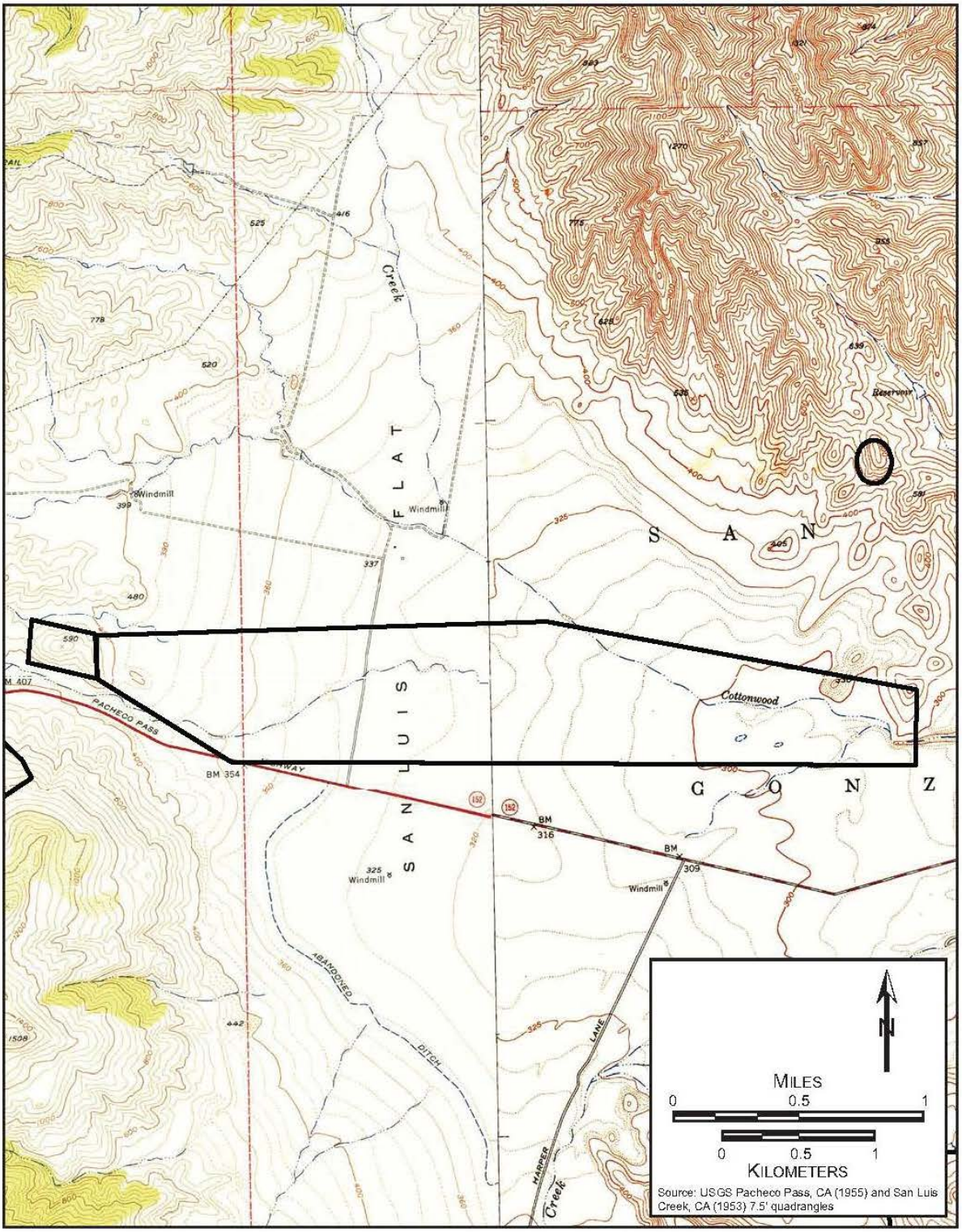


Figure 2-1. A View of the San Luis Flat Area before Dam Construction.

2.2.2 Soils

The US Department of Agriculture's Natural Resources Conservation Service (USDA-NRCS) has mapped soils for the San Luis Reservoir and Santa Clara Valley areas as a part of the Soil Survey Geographic (SSURGO) database for Merced and Santa Clara counties (USDA-NRCS 2007). SSURGO mapping does not extend to inundated areas such as the San Luis Reservoir, but otherwise covers both rural and urban areas. Due to inundation, portions of the San Luis Reservoir Expansion Alternative and roughly half of the Lower San Felipe Intake Alternative APE are not mapped as part of the SSURGO database.

With the exception of Hillgate silt loam, all of the soils found around the San Luis Reservoir are formed on erosional landforms (i.e., hillslopes) in residuum (*see* Figure 2-2 and Table 2-1). Hillgate silt loam is formed in alluvium from mixed sources, more specifically on the Qoa unit described in the preceding section on surficial geology. Its well-developed soil profile with numerous Bt horizons is a byproduct of extended subaerial weathering through time (Birkeland 1999; Birkeland et al. 1991), which suggests it has been exposed at the surface since the late Pleistocene. In addition to mapped soils, it is likely that a number of unmapped soils series were present at lower elevations, such as moderately sloped portions of San Luis Flat, including the Lost Hills, Pleasanton, and Ortigalita series (Lettis 1982). These soils are commonly mapped on San Luis Ranch alluvium and are moderately developed with A/Bt/C soil profiles. Soil series on more gently sloped areas of San Luis Flat, especially along Cottonwood Creek and San Luis Creek, would likely have been Panoche, Mocho, Orestimba, Oxalis, Clear Lake, or Levis series soils (Lettis 1982: 126). These soils are commonly mapped on Patterson alluvium, have A/C profiles, and often contain paleosols.

In the Santa Clara Valley, numerous mapped SSURGO soils are present (USDA-NRCS 2010b). Soil series mapped on the valley bottom in Santa Clara Valley include the Campbell, Botella, Elder, Hangerone, Flaskan, Still, Clear Lake, Landelspark, and Newpark series. These soils nearly all have weakly to moderately developed profiles with evidence of a buried soil, and are often mapped as intermixed with various components of urban land, xerorthents, and artificial fill. Soil series mapped at the valley margin include the Santerhill, Montara, Alumrock, and Zeppelin series. Valley margin soils typically have well-developed soil profiles or weakly developed ones on erosional landforms such as hillslopes.

2.2.3 Buried Cultural Resource Sensitivity

The sensitivity for buried cultural resources has been successfully modeled using ages of depositional landforms and soils as a primary variable in Central California (Meyer and Rosenthal 2008; Rosenthal and Meyer 2004a, 2004b). These models generally rely on the probability that more recent Holocene

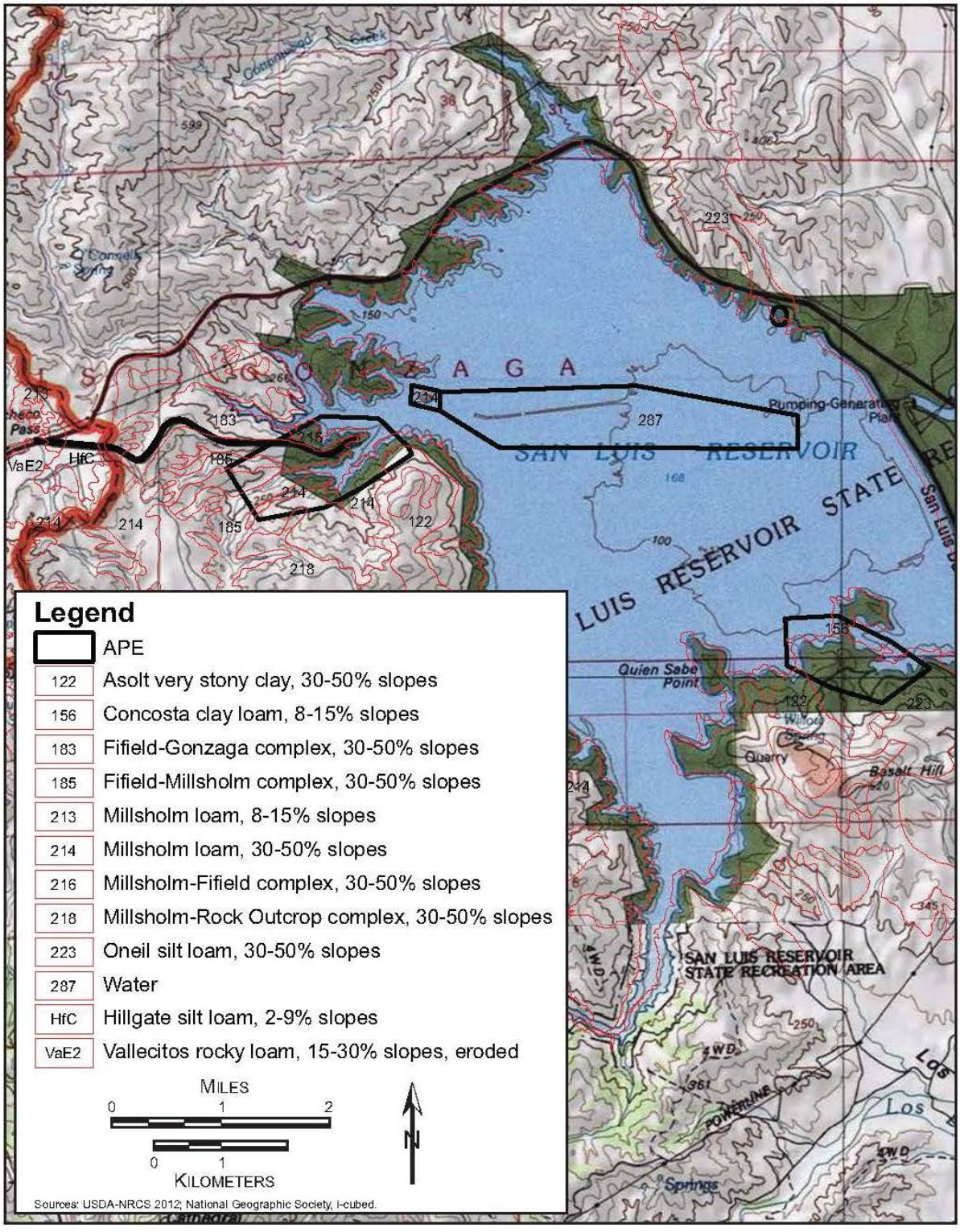


Figure 2-2. SSURGO Soil Map Units within the San Luis Reservoir Area.

Table 1-1. SSURGO Soil Units in the San Luis Reservoir Area.

Map Unit Name[1]	Soil Order	Soil Profile
Asolt very stony clay, 30-50% slopes	Vertisol	A1/A2/A3/C/R
Conosta clay loam, 8-15% slopes	Alfisol	A1/A2/Bat/Bt/BCt/Cr
Fifield-Gonzaga complex, 30-50% slopes	Mollisol	A/Bt/C1/C2/R (Fifield); A1/A2/ABt/Bt1/Bt2/R1/R2 (Gonzaga)
Fifield-Millsholm complex, 30-50% slopes	Mollisol/ Inceptisol	A1/Bt/C1/C2/R (Fifield); A1/A2/Bt/R (Millsholm)
Hillgate silt loam, 2-9% slopes	Alfisol	A1/A2/A3/2Bt1/2Bt2/2Bt3/2Bt4
Millsholm loam, 8-15% slopes	Inceptisol	A1/A2/Bt/R
Millsholm loam, 30-50% slopes	Inceptisol	A1/A2/Bt/R
Millsholm-Fifield complex, 30-50% slopes	Mollisol/ Inceptisol	A1/A2/Bt/R (Millsholm); A1/Bt/C1/C2/R (Fifield)
Millsholm-Rock Outcrop complex, 15-30% slopes	Inceptisol	A1/A2/Bt/R
Oneil silt loam, 30-50% slopes	Mollisol	A1/A2/A3/AC/Ck/R
Vallecitos rocky loam, 15-30% slopes	Alfisol	A1/A2/Bt1/Bt2/R
Water (Not Mapped)	-	-

[1] From USDA-NRCS 2007, 2010a

deposits possess a greater potential to bury cultural resources than older Holocene deposits. Because human occupation is generally thought to have occurred in the Latest Pleistocene (after 15,000 years ago), landforms that pre-date this period and remain exposed at the surface have very low buried cultural resource sensitivity. Most of the area around the San Luis Reservoir consists of erosional landforms with younger soils or depositional landforms that are Late Pleistocene in age. All of the soils listed in Table 2-1 are estimated to have a very low sensitivity for buried cultural resources, an assessment reinforced by previous regional geoarchaeological studies (Rosenthal and Meyer 2004b). Younger landforms, however, were present within the San Luis Flat prior to the inundation of the reservoir and may be exposed during drought years or periods of significant drawdown. These landforms include Holocene age terraces consisting of Patterson alluvium along drainages. Because Patterson alluvium is considered to be Late Holocene in age, such landforms are considered highly sensitive. Although they have not been mapped in detail due to inundation, the eastern half of the Lower San Felipe Intake Alternative APE encompassing the dredging area should be considered highly sensitive for buried cultural resources. The extent to which this area was graded or cut for fill material related to construction of the San Luis Dam, however, could lower this sensitivity assessment. The extent of post-inundation erosion may also influence this assessment.

Many buried cultural resources have been documented within the Santa Clara Valley (Meyer 2000, Rosenthal and Meyer 2004a). In general, the valley bottom is characterized by landforms dating to the Late or Latest Holocene, while older

landforms of Early Holocene or Late Pleistocene age are present along the valley margin. The dynamic geomorphic history of the Santa Clara Valley during the Holocene has created a mosaic of different landform types, but in general the valley has a high sensitivity for buried cultural resources. This sensitivity assessment is further bolstered by the documented presence of buried soils (paleosols) in mapped SSURGO soil series that were once available for human occupation. Recent anthropogenic landscape changes, including large scale, mechanical cutting and filling, create local areas of lower sensitivity.

2.3 Climate and Hydrology

The San Luis Reservoir and Santa Clara Valley areas are characterized by a Mediterranean climate consisting of wet, cold winters and hot, dry summers. The Western Regional Climate Center (WRCC 2013) has documented climatological data from six weather stations within the SLLPIP vicinity for roughly a century, depending on the specific weather station. Two weather stations collected data near the San Luis Reservoir. From 1963 to 2007, the San Luis Dam weather station reported annual temperatures from 38° F in January to 92° F in July while the average was 74° F. Data also was collected at the Pacheco Pass weather station from 1949 to 1977, but it generated insufficient data for temperature generalizations. Four weather stations collected data within the Santa Clara Valley near the Combination Alternative Project Area and Treatment Alternative Project Area. The San Jose weather station and San Jose International Airport weather station collected data from 1893 to 2012 and 1998 to 2012, respectively and reported annual temperatures of 41° F in January to 82° F in July with an average temperature of 68° F. Between 1893 and 2012, the Santa Clara University weather station reported annual temperatures of 38° F in January to 82° F in July with an average of 67° F. During the same period, the Los Gatos weather station reported annual temperatures ranging from 39° F in January to 85° F in July with an average of 70° F. The growing seasons in the San Luis Reservoir and Santa Clara Valley areas range from 215 to 260 days per year. This season is defined as the period between the last freezing temperature of the spring and the first freezing temperature of the fall. The last freezing temperature generally occurs in March, while the first occurs in November or December.

Precipitation in the SLLPIP vicinity varies considerably from year to year and based on microclimate. Generally, the average amount of precipitation decreases from the northwest to the southeast. The average precipitation at San Luis Dam is 10.45 inches and 12.77 inches at Pacheco Pass. The average precipitation at San Jose is 14.66 inches, 12.72 inches at San Jose International airport, 14.04 inches for Santa Clara University, and 24.78 inches for Los Gatos.

San Luis Reservoir comprises the largest water body in Merced County. As an off-stream storage reservoir, it does not block any major river drainages to

obtain water. Instead, water is pumped into the reservoir during wetter months via the California Aqueduct and Delta-Mendota Canal for later use. The reservoir has a catchment area of 84.6 square miles. San Luis Creek is considered the main tributary to San Luis Reservoir, though Cottonwood Creek also empties into the reservoir. The San Luis Reservoir has a storage capacity of 2,041,000 acre feet (Autobee 2011). The high point of the reservoir pool is at 544 feet amsl. The low point of the reservoir pool varies over the year in part due to demand, supply, and water allocation guidelines. The base of the dam rests at 225 feet amsl.

The main drainage for the Santa Clara Valley is the Guadalupe River. Coyote Creek is a major drainage in the Diablo Range that feeds into the Guadalupe River. Other tributaries to the Guadalupe River include Penitencia Creek, Guadalupe Creek, Los Gatos Creek, Smith Creek, and Saratoga Creek. Stevens Creek drains the western portion of the Santa Clara Valley and from the Santa Cruz Mountains to the west.

2.4 Vegetation and Fauna

A range of vegetation communities exists within the SLLPIP vicinity, in large part a product of the diverse topography and hydrology of the two main areas. The varied vegetation communities support a wide variety of fish, mollusks, waterfowl, and large and small mammals. At least five distinct natural communities occur within the San Luis Reservoir and Santa Clara Valley areas. These communities include Valley and Foothill Grassland, Oak Woodland, Northern Mixed Chaparral, Coast Range Mixed Coniferous Forest, and Riparian Forest.

The Valley and Foothill Grassland occur primarily on hill slopes that are barren of trees or brush growth as well areas of the valley floor not subsumed by the San Luis Reservoir. Most of the plant species within this community are non-native grass species such as wild oat (*Avena barbata*) and rip-gut brome (*Bromus diandrus*). This community is generally associated with Oak Woodland that tends to occur on areas downslope from ridgelines. Oak Woodlands mark the transition between savannah-like grassy plains in the lowlands and forest-like stands of trees at higher elevations. This community is dominated by coast live oak (*Quercus agrifolia*) and valley oak (*Q. lobata*). Other species may include poison oak (*Toxicodendron diversilobum*) and non-native grass species.

Oak Woodland communities were an important part of the Native American subsistence economy, and acorns comprised a staple food item. It has been suggested that acorn procurement was critical in encouraging more sedentary lifeways among California Native Americans. In addition to acorns, Oak Woodlands also provide habitat for species of fauna that were an important part of the prehistoric diet. These animals included mule deer (*Odocoileus*

hemionus), Roosevelt elk (*Cervus canadensis*), ground squirrel (*Citellus* sp.), rabbit (*Sylvilagus* spp.), and Black-tailed Jackrabbit (*Lepus californicus*).

Oak Woodlands often replace areas of chaparral that have been cleared. Clearing and other modern activities have most likely removed much of the chaparral communities from the North Coast Ranges (Fredrickson 1973: 141), yet Northern Mixed Chaparral communities continue to exist within the SLLPIP vicinity. These communities are dominated by such plants as chamise (*Adenostoma fasciculatum*), scrub oak (*Quercus dumosa*), Manzanita (*Arctostaphylos* sp.), and buckbrush (*Ceanothus cuneatus*). Chaparral communities provide habitat for mule deer (*Odocoileus hemionus*), Roosevelt elk (*Cervus canadensis*), and small mammals such as striped skunk (*Mephitis mephitis*) and badger (*Taxidea taxus*). Many bird species such as California quail (*Lophortyx californicus*) and mourning dove (*Lenaidura macroura*) find refuge in the chaparral.

Mountain slopes on the western side of the Santa Clara valley continue to be dominated by Coast Range and mixed Coniferous Forest communities. Species in these communities include Douglas fir (*Pseudotsuga menziesii*), California buckeye (*Aesculus californica*), big leaf maple (*Acer macrophyllum*), and madrone (*Arbutus menziesii*). The ground cover in these areas often includes Manzanita (*Arctostaphylos* sp.) and Christmas berry (toyon or *Heteromeles arbutifolia*). This community provided habitat for many large mammals such as grizzly bear (*Ursus californicus*), black bear (*Euarctos americanus*), mountain lion (*Felis concolor*), mule deer (*Odocoileus hemionus*), and Roosevelt elk (*Cervus canadensis*). Many species of birds, such as the golden eagle (*Aquila chrysaetos*) and red-tailed hawk (*Buteo jamaicensis*), and small mammals thrived in these forests.

Along the riparian corridors, Riparian Forest flourishes with black walnut (*Juglans californica*), white alder (*Alnus rhombifolia*), Oregon ash (*Fraxinus latifolia*), and red willow (*Salix laevigata*). Although not riparian obligates, California buckeye (*Aesculus californica*), elderberry (*Sambucus mexicana*), and valley oak (*Quercus lobata*) also occur along the banks of drainages. The San Luis Reservoir pool elevation fluctuates a great deal, preventing the establishment of riparian vegetation typically associated with lake edges such as sedges (*Carex* sp.), bulrush (*Scirpus fluviatilis*), and cattail (*Typha latifolia*).

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Chapter 3
Cultural Setting

3.1 Archaeological Background

3.1.1 Central California Archaeology and the Development of Cultural Sequences

The archaeological investigation of the San Francisco Bay Area began in earnest in 1902 with Max Uhle's excavation of the Emeryville Shellmound. At Emeryville, Uhle (1907: Plate 4) recognized ten strata in the mound, though his profile drawings indicate many more strata that he grouped together. From an analysis of burials, artifacts and stratigraphy, Uhle (1907) concluded "there is some support for the suggestion that cultural differences are expressed in the history of the mound." Further investigations by Nels Nelson (1996 [1906]) affirmed much of Uhle's original analysis of the deposit. Nelson (1996 [1906]) identified eleven strata on the opposite side of the mound from where Uhle had originally trenched, though he did not reach a conclusion as to possible cultural differences represented by these strata.

Nelson (1909, 1910) continued his investigations of Bay Area prehistory with a survey of shellmound locations and a more extensive excavation of the Ellis Landing Shellmound near Richmond. At Ellis Landing, Nelson (1910) recognized a distinction between the upper and lower parts of the mound, but he relied heavily on evolutionary principles of cultural development, which obscured the more subtle indications of culture change evident in California shellmounds. Nelson ultimately concluded that no major cultural breaks were present and that the people living at the mound throughout its occupation "were all essentially of the same type of culture" (Nelson 1910: 402).

Alfred Kroeber (1909: 4) drew upon the work of Nelson and Uhle to assert "in California … neither archaeology nor ethnology has yet been able to discover either the presence or the absence of any important cultural features in one period that are not respectively present or absent in the other." With his control of the Department of Anthropology at the University of California and his belief that the archaeology of the Bay Area could lead to few insights concerning the historical development of Native American culture, Kroeber shifted the resources of the Department away from archaeology and more towards salvage ethnography (Gerow with Force 1968: 2). The scattered archaeological work that was conducted in the Bay Area during the pre-war period—such as at the Emeryville Shellmound—further undermined Uhle's early observations of culture change in the archaeological sequence of the region.

While California archaeology in general, and Bay Area archaeology specifically, suffered from assumptions regarding lack of culture change, a breakthrough for the discipline was made with the publication of *Prehistoric Man of the Santa Barbara Coast* (Rogers 1929) and "Chumash Prehistory" (Olson 1930). These publications were the first studies in California prehistory to recognize and name cultural sequences based on archaeological materials. It was not until the publication of *The Archaeology of the Deer Creek-Cosumnes Area* (Lillard and Purves 1936), however, that Central California had a stratigraphically based cultural sequence equivalent to that of Rogers (1929) and Olson (1930). This important publication laid the groundwork for what would become known as the "Central California Taxonomic System," or the CCTS (Gerow with Force 1968: 5).

While these publications sparked a reappraisal of the earlier work done in the Bay Area, the archaeological investigations that led to the creation of the CCTS were primarily focused on the Central Valley where the sites, due to the presence of rich and abundant grave lots, were considered much more productive for discovering evidence of cultural change. In general terms, the CCTS was a cultural sequence divided into three successive cultural periods: the Early, Middle (also called Transitional), and Late Horizons (Heizer and Fenenga 1939; Lillard and Purves 1936; Lillard et al. 1939). The creation of a cultural sequence for Central California marked a turning point for California archaeology, leading Heizer and Fenenga (1939) to conclude that traditional views of California prehistory as uniform and stable were no longer tenable and that culture change had been ongoing and pronounced.

One of the primary goals of this new paradigm in Central California archaeology was to integrate the culture history of the Central Valley and Bay Area (Beardsley 1948, 1954; Heizer and Fenenga 1939: 396; Lillard et al. 1939: 61). This task was complicated, however, by the advent of radiocarbon dating and an increase in the amount of data available for analysis. Rapid development of the Bay Area meant that more sites and cultural materials were being discovered, which in turn led to an increasing appreciation for the diversity and variation in regional assemblages. The CCTS could not account for these new discoveries without significant revision (Gerow with Force 1968: 5), as the system was based on the belief that "the Bay constituted a local marginal and culturally backward area into which outside influences either failed to spread or spread slowly or halfheartedly" (Heizer 1949: 39).

Being based on the diffusionist notion of "climax" areas or regions (Kroeber 1920, 1939), the CCTS considered the Central Valley as the area in which dominant cultural trends developed and later spread into surrounding areas. In contrast, Gerow with Force (1968) proposed that several different early cultures existed in Central California and that these cultures later converged to create the cultures of the Middle Horizon. Even though this proposition demanded a thorough revision of the CCTS, Gerow with Force (1968) did not offer an alternative to the existing system. Instead, the authors worked within the

confines of the CCTS to integrate the new data within the old system, though other archaeologists were also growing dissatisfied with the status quo (Bennyhoff and Fredrickson 1994; Fredrickson 1973, 1994a).

Fredrickson's (1994a) undertook to overhaul the CCTS and began by separating the cultural and temporal dimensions of the system. "The three-part Central California cultural sequence proved to be implicitly unilineal, fostered by the deliberate linking, through the concept of the horizon, of the cultural and the temporal dimensions" (Fredrickson 1994a: 5-6). Fredrickson's revision of the sequence for California eventually produced three major chronological periods: Paleo-Indian, Archaic, and Emergent. For the cultural dimensions of the revised taxonomic framework, Fredrickson's most important contribution was the concept of the "pattern" (Bennyhoff and Fredrickson 1994: 20-22; Fredrickson 1994b: 40-43). An archaeological pattern, as typically defined, represents a basic adaptation generally shared by a number of separate cultures over an appreciable period within a given geographic area. The pattern is characterized by similar technological skills and devices (specific cultural items); similar economic modes (production, distribution, consumption), including trade and wealth practices (often inferential); and similar mortuary and ceremonial practices (Bennyhoff and Fredrickson 1994: 21).

The increasing complexity of the revised CCTS reflected the increasing diversity of the archaeological record. Yet with the rise of the "New Archaeology" in the 1960s and 1970s, interest in archaeological taxonomy waned. The new paradigm emphasized the primacy of the environment as the regulating force for culture change at the expense of historical and social factors that may have helped to shape human history (Fredrickson 1992 in Hughes 1994: 92). Classification systems like the CCTS grouped archaeological cultures in such a way to be able to study their historical and social relationships. With the lack of interest in these relationships, the program of classification was largely abandoned. In addition to the shift in paradigm, the sociopolitical tenor of the discipline also began to change. Grave lots, which were the traditional source of data for taxonomic questions, were less accessible to researchers due to avoidance during archaeological projects or out of respect for the wishes of Native American communities. Both the interest in taxonomy and the data necessary for its study became increasingly rare.

3.1.2 Archaeological Background for the San Luis Reservoir Area

Within Fredrickson's revised CCTS, the Windmiller, Berkeley, and Augustine patterns are particularly relevant to the Central Valley area. Best known from archaeological manifestations in the Delta and nearby grasslands, Windmiller Pattern sites (ca. 3000 BC to 1000-500 BC) are also recognized in the Sacramento Valley north of Sacramento, the Sierra Nevada foothills, and the Coast Ranges. The artifact assemblages include a variety of flaked and ground stone, baked clay, and shell items, implying a diverse subsistence base and exchange or trade relationships with distant areas. Most of the non-obsidian rock sources (e.g., quartz crystals, calcite, alabaster, and schist) for Windmiller

Pattern artifacts are from Sierra Nevada sources (Moratto 1984), whereas much of the obsidian used for chipped stone artifacts is from the western Great Basin and North Coast Ranges (Jackson 1974). The Windmiller burial pattern is unique in that virtually all of the interments are ventrally extended with the head oriented to the west. Artifacts associated with burials are common and imply social stratification, with males generally having higher status than females. It has been suggested that Windmiller people lived in small, highly mobile groups and that some Windmiller groups occupied the Sierra Nevada foothills during the summer and the Sacramento Valley during the winter. A riverine-marshland orientation is generally recognized for the Windmiller Pattern (Moratto 1984: 206, 552). Windmiller deposits in the Central Valley and Delta are typically situated on low, broad mounds and some are known to underlie complex archaeological deposits (e.g., villages or permanent habitation sites) dating to subsequent periods. Windmiller assemblages have also been identified in cave settings in the Sierra foothills.

The Berkeley Pattern (ca. 1000-500 BC to AD 500) represents a gradual subsistence shift to increased reliance on acorns, fish, and birds. Stone bowl mortars and pestles are found in large quantities. An extensive bone tool kit was also developed along with unique knapping techniques and particular types of shell beads and pendants. Burial practices also differed from Windmiller sites, with flexed burials in variable orientations. Large shell heaps have been the focus of study in the Delta and San Francisco Bay regions, and many of these sites show subsequent occupation during Augustine Pattern times (Moratto 1984).

Augustine Pattern (ca. AD 500-1800) artifact assemblages reflect an intensification of hunting, gathering, and fishing necessitated by an expanding population (Moratto 1984). Acorns, freshwater and anadromous fish, and waterfowl were principal subsistence foods. Mortuary practices showed significant variability and included cremation. Trade networks became more regularized, with serrated obsidian points, black steatite pipes and beads, magnesite cylinders and beads, charmstones, clam shell disk beads, and other durable goods traded into the Central Valley from the North Coast Ranges.

Between 1962 and 1968, several archaeological studies were conducted in the SLLPIP vicinity prior to the construction of the San Luis, Los Banos, and Little Panoche reservoirs (Moratto 1984). Olsen and Payen (1969) and Moratto (1984) defined a series of four cultural complexes (Positas Complex, ca. 3300-2600 BC; Pacheco Complex, ca. 2600 BC-AD 300; Gonzaga Complex, ca. AD 300-1000; and Panoche Complex, ca. AD 1500-1850) based on artifact types and burials at 4-MER-S94 (also known as CA-MER-94, which lies within the Lower San Felipe Intake Alternative APE) and other sites in the western Central Valley. The Positas Complex is represented by artifacts recovered from the base of CA-MER-94 consisting of perforated flat cobbles, small shaped mortars, short cylindrical pestles, a few flake scrapers, milling slabs and mullers, and spire-lopped *Olivella* shell beads.

The Pacheco Complex is represented by artifacts recovered from CA-MER-94 B and C components and is divided into two phases. Phase B (ca. 2600-1600 BC) is marked by large leaf-shaped bifaces, thick rectangular *Olivella* beads, and rare rectangular *Haliotis* ornaments. Phase A (ca. 1600 BC-AD 300) artifacts include various bead types (spire-ground, saucer, and split-drilled *Olivella* beads, *Macoma* clam disc beads, *Haliotis* disc beads, *Haliotis cracherodii* shell ornaments, and stone beads); perforated canine teeth; bird bone awls; scapula grass cutters; polished stone rings, pins, and flat pebble pendants; abundant millingstones, mortars, and pestles; and large to medium projectile points, often stemmed or side-notched. The beads and ornaments relate to the Middle Period in Central California. Coastal influences are reflected in the form and material of some of the projectile points, the presence of *Mytilus* and clamshell in middens, and flexed burials at a time when extended burials were prevalent in the area (Olsen and Payen 1969).

The Gonzaga Complex is represented by CA-MER-3B, CA-MER-14, and CA-MER-94 (Schulz 1970a, 1970b). The majority of diagnostic artifacts from this period have been recovered in association with both extended and flexed burials. Diagnostic artifacts include various bead types (whole spire-ground, thin centrally-perforated rectangular, split-punched, oval, and thin rectangular *Olivella* beads; freshwater mussel shell disc beads and whole limpet shells; and a variety of *Haliotis* ornaments), rare square stem, tapered stem, and serrated projectile points; some bone awls, bone pins, incised mammal bone tubes, bird bone whistles, and scapulae grass cutters; polished stone spool-shaped ear ornaments and small cylindrical plugs; and abundant milling tools such as bowl mortars, shaped pestles, and rarer slab mortars. A single house was discovered with two superimposed floors, a circular basin and a basin with a mud rim and firepit but no postholes. The Gonzaga Complex is similar to Phase I of the "Late Horizon" in the San Joaquin Delta (Moratto 1984).

The Panoche Complex is represented by several sites, including CA-MER-94, CA-MER-27, CA-MER-119, CA-MER-3A, CA-FRE-128, and CA-FRE-129. Diagnostic artifacts include several bead types (clamshell disc beads; steatite disc beads; side-ground, spire-ground, disc, and lipped *Olivella* beads; and *Haliotis* epidermis disc beads and circular and rectangular *Haliotis* ornaments); small side-notched and serrated projectile points; many flaked stone scrapers; bone awls, scapulae grass cutters, bird bone whistles and tubes, and bone beads; polished stone ear spools, conical pipes, and pins; and a variety of mortals and pestles. Flexed burials as well as primary and secondary cremations were noted at Panoche Complex sites. Larger circular assembly houses as well as smaller circular dwellings also were discovered. The Panoche Complex resembles the San Joaquin Delta "Late Horizon" Phase 2 and shows parallels with tribes from the southern coast (Moratto 1984).

3.1.3 Archaeological Background for the Santa Clara Valley

Until recently, the cultural history of the Central California coast and inland region has been poorly documented. Over the past 30 years, however, this has changed as hundreds of inventory surveys and excavations have been conducted in the area. The majority of this work was undertaken to comply with CEQA, NEPA, and Section 106 of the NHPA.

Three key investigations have addressed models of cultural change for the southern Santa Clara Valley (Bergthold 1982; Hildebrand and Mikkelson 1993; King and Hickman 1973) that are particularly relevant to the SLLPIP vicinity. Research in the central Santa Clara Valley near Coyote Creek (Cartier et al. 1980; Dietz 1977; Hall et al. 1988; Hildebrandt 1983; Stickel 1981) is relevant as well. King and Hickman (1973) developed a model of subsistence and settlement change based on a 12,000-acre survey area containing 50 prehistoric sites. They proposed a diachronic sequence beginning with a Millingstone Horizon (7,000-4,000 BP), continuing with a Middle Horizon (4,000-1,500 BP), and concluding with a Protohistoric Period (1,500-400 BP). According to the model, adaptive change involved a slow process of initial settlement, increasingly permanent or sedentary settlement, and eventual overpopulation and overexploitation of resources.

Though older sites may remain undiscovered, archaeological evidence suggests that initial settlement of the southern Santa Clara Valley took place during the Millingstone Horizon. Sedentary settlement peaked during the Middle Horizon, with reliance on a subsistence economy characterized by the storage of food (primarily acorns), inter-regional exchange, warfare, and population pressure. These elements eventually reached a threshold that resulted in a shift to a more mobile settlement pattern and the dispersal of population concentrations during the Protohistoric Period. Hildebrandt and Mikkelson (1993) reevaluated previous research in the area as a background for their test excavation of 14 sites in the San Felipe Sink area, and developed a general sequence of culture change for the vicinity. Again divided into three periods (Early Period, 4,500-2,500 BP; Middle Period, 2,500-850 BP; and Late Period, post-850 BP), the sequence described decreasing mobility through time due to population pressure and the subsequent limitation of resource access.

The Early Period was characterized by a high degree of mobility, with sites in the San Felipe Sink containing a wide array of faunal remains from both the immediate area and the coast. These faunal remains suggest that the area was occupied from spring through fall, with a possible complementary winter settlement pattern noted on the coast (Dietz et al. 1988). In the Middle Period, mobility appears to have decreased, as sites with faunal constituents indicate possible year-round occupation. Marine shell became less prevalent, structures more substantial, and the variety of tools much greater. Residential mobility was all but gone in the Late Period, as the lack of marine shell and predominance of local flora and fauna in the sites suggests. This reduction in territorial bases and increased emphasis on local resources appears consistent

with the Spanish explorers' accounts of California Native American settlement patterns.

Jones et al. (2007) acknowledged the importance of issues of subsistence, settlement, and ecology in developing models of culture change, but employed a chronological system that reflected the significant variability and stylistic/typological transitions seen in artifact assemblages from the Central Coast and adjacent inland areas. The system relied on six periods Paleo-Indian (pre-8,000 cal BC); Millingstone or Early Archaic, (8,000-3,500 cal BC); Early, (3,500-600 cal BC); Middle, (600 cal BC - cal AD 1000); Middle/Late Transition, (cal AD 1000 - 1250; and Late, (cal AD 1250–1769). Three cultures (the Millingstone Culture, the Hunting Culture, and the Late Period) are used to reflect broader patterns.

Evidence of occupation during the Paleo-Indian Period in the region is limited to isolated fluted projectile points. The Millingstone Culture, which dates to the Millingstone or Early Archaic Period, is defined by the presence of large numbers of handstones, milling slabs, and crude core tools with lesser numbers of flaked stone tools and large side-notched projectile points (Jones et al. 2007). Contracting stemmed points, lanceolate points, and crescents have been recovered from Millingstone contexts. Millingstone occupations have been located in a variety of settings from the coast to the near shore interior valleys. Faunal remains indicate a varied diet that included shellfish, fish, birds, and mammals, particularly deer and rabbits.

The Hunting Culture spans the Early and Middle periods and is defined by an abundance of stemmed and notched projectile points and large bifaces. The Early Period is marked by the presence of contracting stemmed, Rossi square-stemmed, and large side-notched projectile points. Groundstone assemblages include handstones, pitted stones, and portable mortars and pestles. Bipointed bone gorges used for line fishing and Class L rectangular *Olivella* beads also appear in the Early Period. Middle Period sites include contracting-stemmed and large-stemmed points, but no square-stemmed or large side-notched points. Groundstone artifacts consist of slabs, handstones, portable mortars, and pestles. *Olivella* G2 saucer beads replace earlier Class L beads. Bone gorges are still present along with circular shell fishhooks. Pitted stones and grooved stone net sinkers are common. Hunting Culture sites have been found mainly in coastal areas but have also been identified in nearby valleys as well. Faunal remains typically include deer, rabbits, sea otters, birds, and fish with preferences dependent on locale. Acorns may also have been part of the Hunting Culture diet.

Middle/Late Transition Period sites exhibit increasing numbers of arrow points and decreasing numbers of stemmed points. This transition seems to have occurred at different times in different areas. The Late Period is generally defined by an abundance of Desert side-notched and Cottonwood projectile points. Small, serrated points and contracting-stemmed points are present at

some sites. Other artifacts include bedrock mortars, hopper mortars, several bead types (Class E lipped, Class K cupped, steatite disk, and Class M rectangular), small bifacial bead drills, and circular fishhooks. Unlike sites from earlier periods, Late Period sites are more frequently encountered in the interior than on the coast.

3.2 Ethnographic Background

The crest of the Diablo Range is generally regarded as the dividing line between the ethnographic territories of the Northern Valley Yokuts in the Central Valley and the Costanoan, or Ohlone, to the west in the Santa Clara Valley (Kroeber 1925). This section discusses both groups.

3.2.1 Northern Valley Yokuts

Territory

The San Luis Reservoir area lies within the traditional territory of the Northern Valley Yokuts, which extended south from the confluence of the Calaveras and San Joaquin Rivers to the point at which the San Joaquin River turns abruptly east. It encompasses the central San Joaquin Valley east from the Diablo Range to the Sierra Nevada. Linguistically, the Northern Valley Yokuts are relative newcomers to the central San Joaquin Valley. They were pushed north by the Numic-speaking Monache beginning about 500 years ago (Kroeber 1959). Approximately 50 linguistically identifiable tribes were known to exist under the umbrella of "Yokuts" (Kroeber 1976). The Kahwatchwah Yokut tribe lived in the San Luis Reservoir area (Latta 1949).

The pre-contact Yokuts population has been estimated as three to four hundred people in each tribe, with 15,000-20,000 people for the entire group (Kroeber 1976). Another estimate, based on available food resources, suggests that the population was as high as 31,000 or more (Baumhoff 1963: 221). The Northern Valley Yokuts territory included riparian woodlands, freshwater marshes, valley grasslands, oak woodlands, open river channels, lakes, and sloughs (Schulz 1981). Little ethnographic information exists for the Northern Valley Yokuts. The rapid spread of disease and the Euro-American invasion of their territory for mining and related activities in the early to mid-19th century led to rapid population declines and displacement of the Northern Valley Yokuts (Wallace 1978).

Subsistence

The Northern Valley Yokuts relied heavily on fishing in rivers, sloughs, and streams throughout their territory in the central San Joaquin Valley. Salmon spawned during the fall in the San Joaquin River and its tributaries, and sturgeon was also an important food resource. Dragnets, stone sinkers, and antler-tipped harpoons were used for fishing. Aquatic birds, such as duck and

geese, and plant foods were an integral part of the subsistence base. Fire was commonly used to encourage seed-bearing grasses and plants.

Food processing implements included the mortar and pestle, hand and milling stones, and wood mortars. Baskets were also used in seed winnowing and acorn storage. The bow and arrow were the primary means for hunting mammals such as tule elk, deer, and pronghorn antelope. Projectile points or arrowheads were made of local chert, jasper, and chalcedony. Obsidian was rare, and only available through trade. In terms of volume, acorns were the single most important food in Native Central California. During the winter months, when hunting and fishing could be difficult and fresh plant foods were unavailable, consumption of acorn products may have exceeded that of all other foods combined (Schulz 1981).

Settlement

Most Northern Valley Yokut houses were circular or oval semi-subterranean single-family dwellings of tule mats over pole frames. Large communal residences sheltering ten or more families also were constructed (Moratto 1984). Sweathouses and larger ceremonial chambers have been documented ethnographically (Gayton 1936, 1948). Settlements were reported on mounds above permanent waterways, likely because these elevated ground surfaces were safe from flooding and contained abundant food resources.

Trade

Trade occurred north and south along the San Joaquin River. Tule rafts were used for transportation as well as trade (Gayton 1936). Baskets, blankets, and flaked stone were traded from the Miwok in exchange for dogs (Barrett and Gifford 1933). Trade between the Yokuts of the San Luis Reservoir area and the Ohlone occurred along routes through what would later become "Pacheco Pass." Abalone and mussel shells were imported from the coast. Obsidian was most commonly acquired from sources on the eastern slopes of the Sierra Nevada Range.

3.2.2 Ohlone

Territory

The inhabitants of the Santa Clara Valley were known ethnographically as the Ohlone, or as the Costanoan after the Costanoan language group. The Costanoan languages belong to the Utian family of the Penutian language stock (Shipley 1978) and were spoken from the San Francisco Bay Area southward along the coast to Point Sur and inland to the Diablo Ranges and portions of the northern San Joaquin Valley (Milliken 1995). The designation Costanoan derives from the Spanish word *Costaños*, or "coast people." The term is misleading, however, as it amalgamates and homogenizes 10,000 or more people who lived in the region into a single ethnolinguistic unit. In reality, the term "Costanoan" subsumes as many as forty or fifty politically independent groups—some of which spoke mutually unintelligible but genetically related

languages—under a single umbrella. Many present-day descendants of the area's Native peoples prefer the term Ohlone, which is said to have derived from the name of a coastal village in San Mateo County (Levy 1978).

Knowledge of Ohlone culture is largely based on information gathered from Spanish expeditions between 1769 and 1776, documents maintained at missions, the works of ethnographers and linguists, and from Native descendants. Primary ethnographic sources include Harrington (1933, 1942) and Kroeber (1925). Overviews are provided in Heizer (1974), Levy (1978a), Margolin (1978), and Milliken (1983, 1991, 1995), among other texts. Galvan (1968) and Williams (1890) offer Native accounts of Ohlone history, and an excellent example of contemporary ethnohistory can be found in Cambra et al. (1996).

Political Organization

As defined by Kroeber (1925) the basic Ohlone political unit was the "tribelet," an autonomous, self-governing, territorially defined unit over which recognized authority was given to one person, in most instances the leader or chief. Each tribelet would be composed of one or more villages and a number of camps within its recognized and protected resource exploitation zone. Studies by C.D. King and others suggest that over time several of these tribelets amalgamated into larger tribal units (Breschini et al. 1983). Due to geographic barriers and distance between Ohlone tribelets, however, the integration of smaller political units into larger ones was the exception rather than the rule.

Recent scholarship has questioned Kroeber's interpretation of the Ohlone political system. According to Milliken, socio-political groups were essentially clusters of unrelated family groups that formed loose cooperative communities in the event of ceremonial festivals, group harvesting efforts, and inter-family conflict resolution (Milliken 1995). These disparate multi-family communities joined for the majority of the year to form a large village centrally located between their lands. In other instances, rather than forming a single village, these family units distributed themselves into as many as five semi-permanent villages.

The nature of political authority among Central California tribes has been differentially characterized by early explorers and missionaries as both egalitarian and hierarchical. Records from Mission San Juan Bautista for example attempted to fit local Native Americans into a Spanish system, and described tribal leadership by *capitanes*, or male village leaders. Paradoxically, Father Arroyo de la Cuesta, also of Mission San Juan Bautista, described in his correspondence with Spanish officials a primarily egalitarian, leaderless society in which social control was embedded within the dynamics of deep-seated inter-family feuds. It is evident from Arroyo de la Cuesta's observations that he did not view these divisions in Native leadership as comparable with the hierarchical ranks of bureaucratic Spanish society. He did note, however, that though the "pagan state" lacked distinguished *capitanes*, distinct male

leadership roles did arise in battles, banquets, and ceremonies (Arroyo de la Cuesta in Geiger and Meighan 1976).

Spiritual Practices

Early accounts of the Ohlone suggest that they practiced a religion based on sun worship. According to these accounts, the Ohlone often greeted the sun with gestures, demonstrations, and offerings (Kroeber 1925). Sun worship, however, was probably a small part of a much broader pattern of interacting with the natural environment, and early interpretations of sun worship were probably due to the early explorers' cultural misunderstanding of the ceremonies they observed.

Merriam's ethnographic accounts of the late 19th and early 20th centuries describe references to bear shamanism, a practice also observed among other Native American groups. Within shamanistic cultures, shamans serve as spiritual and physical healers, ritual leaders, and as powerful channels of supernatural power. Merriam, having observed shamanistic ritual, described the use of poisons by shamans, including deadly substances like the venom of rattlesnakes, extracts from the lungs of turtles and frogs, and less caustic substances such as human saliva (Merriam 1966).

Subsistence, Trade, and Material Culture

The Ohlone were hunter-gatherers who occupied semi-permanent camps and villages from which they could take advantage of seasonal changes in resource availability. Dwellings at these habitation sites were dome-shaped, with pole frameworks and thatch roofs and walls. Other structures that could be found in an Ohlone village included acorn granaries; sweat houses for the men, often along stream banks; menstrual houses for women; and dance houses and assembly houses, generally in the center of a village (Broadbent 1972). From these villages the Ohlone visited the mountains, valleys, and sloughs to collect resources.

The early explorer Vizcaíno noted a diverse diet among the Ohlone people, which included seeds (dock, tarweed, and chia), nuts (pine nuts, buckeye, hazel, and pepper/bay nuts), berries (Manzanita), grasses, roots, and insects that were gathered locally. The single most important food item among the Ohlone was the acorn, at least four species of which were collected and processed into meal or flour (Breschini et al. 1983). *Pinole* is a ground meal or flour derived from the processed seeds of several plants, including tarweed (Merriam 1966). Tobacco was prepared in a mortar and used as an emetic substance or, more rarely, smoked in the manner of Europeans (Merriam 1966). Tea was commonly prepared from the flowers, leaves, and bark of the Manzanita, elderberry, coffeeberry, toyon, and nettles.

Terrestrial animals formed a large portion of the Ohlone diet, and included birds and small mammals, which were hunted, clubbed, trapped, and snared. Fish were hooked or caught by hand, and explorers reported that sea otters were

often clubbed in the water or snared if encountered on land. Shellfish provided an important seasonal food resource, and it is likely that the Ohlone dove for certain prized species, such as *Mytilus edulis,* freshwater mussel (*Gonidea sp.*), marine clams (*Protothaca* sp.), and snails (*Tegula* sp.). Broadbent (1972) reported that frogs, toads, and owls were specifically forbidden from consumption among the Ohlone, a taboo that may have been embedded in socio-cultural beliefs or may simply have reflected cultural preferences.

To promote the growth of seed-bearing annuals and to control the growth of rampant chaparral species, the Ohlone periodically burned vegetation in areas surrounding village sites or in areas of food gathering and hunting. As noted by historical and ethnographic observers, these operations were extremely efficient in controlling vegetation and involved considerable skill and foresight. Gordon states that the burning sequences had the overall effect of bringing to the open "an increased supply of food plants and game" (Gordon 1974: 27), and by the time of initial European settlement in the San Francisco Bay Area, regional vegetation had already been altered considerably by controlled burning.

An abundance of information exists on the material culture of the Ohlone. Mission-era accounts of clothing worn by Rumsen Ohlone neophytes at the Carmel Mission note that women often wore "a short apron of red and white cords twisted and worked as closely as possible, which extends to the knee" (Breschini et al. 1983: 299). According to these accounts, men typically went naked except for the few who covered themselves with a small cloak of rabbit skin above the waist. Other materials employed in the manufacture of clothing were green and dry tule, sea otter furs, and deerskin. Personal ornamentation included black and white face and body paint, which was created from mined cinnabar and typically worn by men. Red ochre was worn as body paint by Ohlone warriors in battle. In daily life, the Ohlone wore ornaments created from abalone shell.

Shell beads were widely used by the Ohlone as a form of currency. *Olivella* shells, mussels, abalone shells, salt, dried abalone, woven baskets, and other items were traded for prized goods with nearby villages and with more distant villages located in other environmental zones. Among the items received by the Ohlone in such transactions were stores of the prized piñon nut and obsidian for tool making. Regional interaction among the Ohlone, and with neighboring cultures such as the Salinan and Yokuts, took place through trade, ceremonies, warfare, and intermarriage. Group exchange and "gifting" occurred at feasts of seasonal resources and at seasonal ceremonial dances and festivals (Milliken 1991: 70). Intermarriage usually occurred between adjacent groups and was rare between those at greater distances (Milliken et al. 1993). Both marital and trade issues were affected by and effected warfare between the tribes (Amoros in Heizer 1974), which has been described as common at the time of Spanish contact (Fages 1937). These well-documented animosities often flared because of territorial disputes and infringements, frequently associated with resource

access and control (e.g., Broadbent 1972; Fages 1937; Mason 1912; Langsdorff 1968).

3.3 Historic Period Background

3.3.1 The Spanish Period

Although European contact with Native Americans in California commenced as early as 1542 with the explorations of Juan Rodriguez Cabrillo (Erlandson and Bartoy 1995), the historic period in Central California began in earnest with the expansion of the Spanish frontiers northward from Mexico into Alta California during the 18th century. In 1769, Sergeant José de Ortega, the scout for the expedition of Gaspar de Portolá, discovered the entrance to the San Francisco Bay. The interior of the Bay Area was first explored in 1775 by Juan Mañuel de Ayala and José Cañizares (Hoover et al. 1990: 330). These expeditions were partially focused on the identification of sites for the establishment of missions. Using a tripartite system of military presidios, religious missions, and civilian pueblos, the Spanish government rapidly established a network of settlements from San Diego to San Francisco. One of the first colonizing parties in northern Alta California, under José Joaquín Moraga and Padre Francisco Palou, arrived in San Francisco in 1776 and founded the Presidio of San Francisco and *Misión San Francisco de Asís* (also known as Mission Dolores) (Hoover et al. 1990: 333). The following year, *Misión Santa Clara de Asís* and *El Pueblo de San José* were established in the South Bay (Hoover et al. 1990: 400).

Exploration from the central coast into the San Joaquin Valley began with the Gabriel Moraga expeditions of 1806, 1808, and 1810. The 1806 expedition started in San Juan Bautista, probably entered the valley along San Luis Creek in Merced County, and explored portions of the San Joaquin and Merced Rivers. During the 1810 expedition, Moraga's route brought him back to San Juan Bautista by way of San Luis Creek and Pacheco Pass (Hoover et al. 1990: 198). It has been suggested that the route through Pacheco Pass may have originally been a Yokut or Miwok trade route between the Santa Clara and San Joaquin Valleys (Marschner 2000).

At about the same time as Moraga's explorations, Russia started colonizing coastal lands southward from Alaska into California. The Russians established Fort Ross in 1812 near the modern town of Jenner. The Spanish countered this incursion by establishing *Misión San Rafael Arcangel* and *Misión San Francisco de Solano* in Sonoma to establish a northern frontier.

By the beginning of the 19th century, the Spanish had established an interior road called *El Camino Viejo*. The route ran from the Los Angeles coast north along the western edge of the San Joaquin Valley to the Patterson Pass (near Tracy) and then west to San Antonio (current East Oakland) (Hoover et al. 1990). One of the stopping points for water along the route was at *El Arroyo de San Luis Gonzaga* at *Rancho Centinela* just east of the San Luis Reservoir area

(Hoover et al. 1990: 199). Little is known of *Rancho Centinela*, however it is thought to have been a Spanish-era outpost for *vaqueros*, or stockmen, who drove livestock across Pacheco Pass to the Santa Clara Valley. An adobe, which may have dated to as early as 1810, stood at the *vaquero* camp location until it was demolished in 1900 (Latta 1936: 14-15; Snoke 2010).

3.3.2 The Mexican Period

Mexico gained independence from Spain in 1822, and Alta California became a part of the Mexican frontier. The newly established Mexican government attempted to colonize their northern frontier by secularizing mission lands in 1834 and by granting large tracts of land to *Californio* citizens as a reward for loyal service. These ranchos were meant to stake the Mexican claim to the area and halt the possibility of further Russian incursion into Mexican territory (Hoover et al. 1990).

Secularization brought an influx of Mexican settlers to California and allowed for the emergence of a new class of wealthy landowners known as *rancheros*. This led to an emphasis on ranching and agricultural activities in California that became known as the "hide and tallow trade" (Hoover et al. 1990). By the 1840s, there were an estimated 150,000 to 200,000 hides exported annually from Alta California (Burcham 1982: 126-127). During the 1830s and 1840s, there were a series of raids and counter expeditions between the Miwok and Yokut tribes and the Mexican colonists. Although never constructed, Governor Alvarado proposed in 1843 that a fort or stockade be built in Pacheco Pass to secure the route from raiding parties (Beck and Haase 1974: 23).

In 1843, Juan Pérez Pacheco and José María Mejía were granted *Rancho San Luis Gonzaga*, which comprised the eastern Pacheco Pass region, including much of the San Felipe Intake Alternative and San Luis Reservoir Expansion Alternative Project areas, as well as the former *Rancho Centinela* property. The land had previously been granted in 1841 to Francisco Rivera, but was revoked when Rivera did not establish a residence on the land (Hoover et al. 1990: 200). The grant was bounded by the San Joaquin River to the east; Los Banos Creek to the south; and *Rancho Ausaymas y San Felipe* to the west, which was held by Juan's father Francisco Pérez Pacheco (Beck and Haase 1974). Juan Pérez Pacheco built a one-story adobe house near the route through the pass and raised cattle for the hide and tallow trade. Over the years, the Pacheco family built a second adobe that collapsed during the 1868 earthquake (Hoover et al. 1990: 200; Marschner 2000: 259). The original 1840s adobe survived intact until 1962 when it was unsuccessfully moved in advance of dam construction (Hoover et al. 1990: 200) (*see* Section 3.3.3).

When Juan Pérez Pacheco died in 1855, the property reverted to his father Francisco, who died just five years later in 1860. Francisco's property, including *Rancho San Luis Gonzaga* and half of *Rancho Ausaymas y San Felipe*, passed first to his wife and then to his only surviving child Ysidora after his wife died in 1892. Ysidora married Mariano Malarin in 1850 and had two

daughters. One married Dr. Ramon Roca while the other married Dr. Luis Fatjo. The Fatjos and their children inherited the Merced portion of *Rancho San Luis Gonzaga* (Hoover et al. 1999: 200). In 1949, Paula Fatjo, the great-great granddaughter of Francisco Pérez Pacheco, moved to the *rancho* and remodeled the original 1843 adobe (Pierce 1977: 107). *Rancho San Luis Gonzaga* remained an operating cattle ranch during Paula Fatjo's time, though she also bred and boarded Arabian horses there until her death in 1992 (Pierce 1977: 107-111, Bissonnette 2007).

At the west end of Pacheco Pass, was *Rancho San Ysidro* (Old Gilroy), granted in 1810 to Ygnacio Ortega. Ortega died in 1833, and the *rancho* was divided among his heirs, Ysabel Ortega, Quentin Ortega, and María Clara de la Asunción (wife of John Gilroy). The resulting *Rancho Ysidro* and *Rancho La Polka* lay to the west and southwest of the San Luis Reservoir vicinity.

In the 1840s, relations between Mexico and the US became strained as the US expanded westward toward the Pacific Ocean. Political stresses erupted into the Mexican-American War of 1846-1848. At the close of the war, Alta California became part of the US with the signing of the Treaty of Guadalupe Hidalgo.

3.3.3 The American Period

In 1848, at the close of the Mexican-American War, James Marshall discovered gold on the American River and the California Gold Rush began. The discovery brought tens of thousands of immigrants from around the world that pushed further into the California interior than the Spanish or Mexican settlers that had come before. The wealth and expanding population of California curtailed the usual territory phase, and California became a state in 1850 (Hoover et al. 1990).

Due to the rapid influx of settlers into the state, legal determination of ownership of lands awarded by Spanish or Mexican authorities was often disputed. The new American government passed the Land Act of 1851, which placed the burden of proof-of-ownership on the grantees so that the few Native Americans who had received grants lost their titles, as did many Hispanic landowners. By congressional action, grant claims were heard by a board of Land Commissioners and then appealed in federal courts. By 1885, 97% of the claims had been decided. In some instances, however, land ownership was not decided until after a claimant's death. Such was the case with Juan Pérez Pacheco's claim to *Rancho San Luis Gonzaga.* Though he died in 1855, the land was not patented in his name until 1871.

As gold mining in California declined in the 1860s, agriculture and ranching, which had been established to feed the miners, expanded to become important industries for the state economy. Farming in the American Period was characterized by three types of pursuits: cattle and sheep ranching, grain farming, and irrigation agriculture. Cattle and sheep ranching were dominant until the 1880s. During that time, free-ranging, comparatively wild Spanish

cattle were replaced by American breeds of livestock and dairy cows. Sheep breeds were also improved in the late 1850s and 1860s by breeding with merino sheep (Burcham 1982).

During the American Period, ranching and dairying activities expanded in the Pacheco Pass region as the *ranchos* were subdivided and portions sold off or leased. General information regarding American Period ranches within and near the San Luis Reservoir vicinity is presented below. Water conveyance and transportation, two other key factors that guided the development of the region, are also discussed below.

Ranches and Agriculture in the San Luis Reservoir Project Area

Rancho San Luis Gonzaga became known as San Luis Ranch during the American Period. With the onset of the Gold Rush, Juan Pérez Pacheco realized that selling beef to miners was more lucrative than selling hides, and thus he shifted the economic focus of his *rancho*. The Pachecos also partnered with the Butterfield Overland Stage Company and provided a stopover station for the stage route. Due in part to these strategies, and unlike many *Californio* ranchers, the Pachecos were able to retain most of their lands (Marschner 2000: 259; Wood 2005: 46). During the 1930s and 1940s, the 1840s adobe was used as a restaurant, the Old Adobe Inn (Wood 2005: 47). The adobe survived until 1962 when Paula Fatjo attempted to move the adobe to a location west of the proposed San Luis Reservoir in advance of its construction (Hoover et al. 1990: 200; Wood 2005: 46). The remains of the adobe currently lie within Pacheco State Park (Bissonnette 2007).

During the 1850s, Pedro and Bernardo Altube, Spanish Basque immigrants, herded cattle from Southern California and pastured them at the abandoned *Rancho Centinela* adobe prior to their sale (Ziesing et al. 1997: 51). They and their partners, Juan Bautista Arambide, Bernardo Ohaco, and Carlos Garat, acquired the property during the 1860s and 1870s, raised cattle and sheep, and built a second adobe (Snoke 2010; Ziesing et al. 1997: 52). The Bascos, as they were known, came into direct competition with the expanding Miller and Lux cattle empire in the San Joaquin Valley during the 1860s. By 1871, the Altube brothers sold their holdings and moved to Nevada to start their Spanish Ranch in Elko County. The Arambide and Garat families followed them later in the decade (Ziesing et al. 1997: 53).

Henry Miller and Charles Lux came to California during the 1850s as butchers and formed a partnership in 1858 to buy cattle for slaughter (Pierce 1977: 174). From these beginnings, they expanded to become one of the largest cattle ranching corporations on the west coast with land holdings in California, Oregon, and Nevada. When Lux died in 1887, Miller bought out Lux's heirs and continued to expand the empire, which lasted through the 1920s before financial debts curtailed the company's growth (Igler 2001: 180; Pierce 1977: 183). In the San Joaquin Valley, Miller and Lux leased Pacheco lands for grazing and in the 1870s or 1880s built a wood frame-line cabin and corrals

near the Pacheco adobe. The line cabin was standing as of 2004 (Wood 2005: 47).

The remains of the Domengine Sheep Ranch are located on the southern shore of current San Luis Reservoir. John Domengine, a French Basque, immigrated to California during the Gold Rush, ranched cattle near Santa Clara until 1865, and then worked for Miller and Lux as a sheep ranch foreman until 1867. Around 1867, he started his own sheep ranch on the San Luis Ranch and ran it until 1873 when he sold his holdings to Simon Camy. In 1872, John's son, Adolph Domengine, joined his father at the sheep ranch and continued to work for the new owner until 1874, when Camy's ranching enterprise moved to Fresno (Vandor 1919: 2181-2182).

John Dowdy came to California from North Carolina in 1854 (Thompson and West 1876: 109). US Census records suggest John Dowdy and other family members were residing in the Gilroy Township by 1870, and may have been there by 1860 (US Census Bureau 1860: 246, 1870: 99A). An 1882 General Land Office (GLO) plat map shows a "Dowdy Barn and House" northeast of Pacheco Creek near the Stanislaus-Santa Clara County border (BLM 2016). By 1898, the Dowdys had patented 1,144 acres of land in the area (Parkman and McGuire 1984: 108). The current Dowdy Ranch Headquarters complex in Henry W. Coe State Park west of Pacheco Creek was built from ca. 1910 to the 1950s by Franklin, George, and John Dowdy (Parkman and McGuire 1984: 203; US Census Bureau 1910: 9B).

The O'Connor Dairy Ranch was established by 1882 along Pacheco Creek (BLM 2016). No O'Connors are noted in the 1876 directories for Santa Clara County, which suggests that they may not have moved to the area before the late 1870s (Thompson and West 1876). The O'Connor Ranch was shown on the 1921 and 1947 Gilroy Hot Springs 15-minute US Geological Survey (USGS) topographic maps as well as the 1955 Pacheco Peak 15-minute USGS topographic map (USGS 1921, 1947, 1955). US Census data for 1910 and 1920 show that the Timothy O'Connor family along the Pacheco Pass toll road were raising stock on a cattle ranch and were likely associated with the dairy (US Census Bureau 1910: 9B, 1920: 9B). By 1989, the ranch was owned by the Andresen family of Pacheco Land and Cattle, Inc. (Hylkema 1989: 1).

Water Conveyance

During the late 19th century, the aridity of the western San Joaquin Valley began to pose problems for agricultural production. Wells were initially used for irrigation, but as groundwater was depleted canal projects were undertaken to move water from the San Joaquin River to the west. Henry Miller was involved in early attempts to develop irrigation within the western Central Valley. He organized the San Joaquin & Kings River Canal and Irrigation Company and, in 1871, built a canal from the San Joaquin River to the town of Los Banos (Outcalt 1925:221). In 1874, Miller extended the canal to Los Banos Creek and then to the town of Newman four years later (Outcalt 1925:222). The canals

provided much of the irrigation for Miller's properties and for local agriculture. Upon Miller's death in 1916, his daughter and son-in-law inherited the bulk of his vast land holdings along with his water rights (Outcalt 1925:402).

In 1887, the California Legislature passed the Wright Act, which formed irrigation districts across California (Stene 2011:3). The Wright Act was amended in 1897 to ensure that there was sufficient bond funding for irrigation projects (Stene 2011:4). The Merced Irrigation District was established during the 1870s and 1880s for the eastern side of Merced County and developed many miles of canals (Merced Irrigation District 2014). In 1902, the U.S. government passed the Reclamation Act, which established the U.S. Reclamation Service (within the U.S. Geological Survey), which later became the U.S. Bureau of Reclamation. The Reclamation Act encouraged the occupation of previously undeveloped lands through the construction of irrigation systems and the distribution of water through reclamation. The construction of irrigation systems led to an increase in homesteading, which in turn fostered economic development.

By the 1920s, the depletion of groundwater reservoirs was a widely recognized problem within the western San Joaquin Valley. During the 1930s, the federal government began the CVP, a massive irrigation scheme that involved building dams and canals throughout California. In 1939, Henry Miller's heirs agreed to exchange their San Joaquin River riparian water rights, which would be impacted by the construction of Friant Dam and its diversion of the river through the Madera and Friant-Kern Canals, for substitute water diverted from the Sacramento River. They did not abandon their riparian water rights, but agreed not to exercise them as long as the government could provide substitute water through "exchange contracts." These contracts are still in effect, and some of Miller and Lux's original canals continue to convey irrigation water today (San Joaquin River Exchange Contractors 2014).

During the early 1940s, America's entry into World War II increased demand for agricultural products and further depleted groundwater in the western Central Valley (US Bureau of Reclamation 2011). By the 1950s, the west side of the Central Valley had become the focus of both the federal CVP and the newly formed SWP (Stene 2011:10). A 1954 federal investigation identified the area along Pacheco Pass in the Diablo Mountains as the ideal site for the San Luis Reservoir (Reclamation 2011). Despite opposition from a variety of regional factions, a state bond measure to fund irrigation in the western Central Valley was narrowly passed in 1960. To avoid the unnecessary expense of parallel aqueducts, the State of California agreed to partner with the federal government in the creation of the San Luis Unit in 1961 (Stene 2011:13-14). The San Luis Reservoir in the Diablo Mountains west of Los Banos would be filled with water supplied by the federal Delta-Mendota Canal and the state's California Aqueduct (Stene 2011:14). A ground-breaking ceremony officiated by John. F. Kennedy marked the start of construction in 1962, and all construction was completed for the project by 1967. Typically, water from the

Delta is pumped into the reservoir in winter and early spring, and released in summer when water supplies are low (Department of Water Resources 1974:276).

The 117-mile long Delta-Mendota Canal, completed by Reclamation in 1951, was built to convey water diverted from the Sacramento River to the Mendota Pool, for exchange contract delivery. The canal transports water from the Tracy Pumping Plant (C.W. Bill Jones Pumping Plant) along the western side of the San Joaquin Valley for irrigation and potential storage at San Luis Reservoir, then travels east across the valley for delivery to Mendota Pool, where it is conveyed through various private canals to exchange contract irrigators. At its Mendota Pool terminus, the water conveyed through the Delta-Mendota Canal is also used to recharge the San Joaquin River, which is diverted upstream at Friant Dam by the Madera and Friant-Kern canal systems (Stene 1994:13-14).

The California SWP was first envisioned in 1919 by Lt. R.B. Marshall who proposed conveying water from the Sacramento River watershed to the San Joaquin Valley and then over the Tehachapi Mountains to Southern California. A State Water Plan was introduced in 1931, however funding remained unavailable during the Great Depression. After World War II, the SWP was reintroduced and finally passed in 1960. In 1963, construction was begun on the California Aqueduct, a series of canals, tunnels, and pipelines that implement Marshall's early 20th century vision. The main line of the canal was completed in 1971, with subsequent branches or extensions completed as late at 1997 (California Department of Water Resources 2014).

The aqueduct begins at the San Joaquin-Sacramento River Delta at the Banks Pumping Plant, which pumps from the Clifton Court Forebay. Water is pumped by the Banks Pumping Plant to the Bethany Reservoir, which serves as a forebay for the South Bay Aqueduct via the South Bay Pumping Plant. From the Bethany Reservoir, the aqueduct flows by gravity to the O'Neill Forebay at San Luis Reservoir. From the O'Neill Forebay, it flows to the Dos Amigos Pumping Plant and then on for roughly 95 miles before it diverges in Kings County into a main line and a Coastal Branch. In southern Kern County, the main line splits into a West Branch and an East Branch, which together serve Los Angeles, San Bernardino, and Riverside counties. The Department of Water Resources operates and maintains the Gianelli Power Plant, a pumped-storage hydroelectric plant at the base of the B.F. Sisk Dam, which impounds San Luis Reservoir. The San Luis Canal portion of the California Aqueduct comprises the federally built portion of the SWP and delivers both federal and state water to the San Luis Reservoir.

Transportation Development

In 1856 to 1857, a toll road was built through Pacheco Pass by Andrew D. Firebaugh, and two stations (Bell Station and one near Mountain House) were added to collect tolls. The road was used by the Butterfield Overland Stage from 1858 through 1861, and *Rancho San Luis Gonzaga*, also known as the San Luis

Station, became a prominent stopping place (Hoover et al. 1990: 199). A telegraph line followed the toll route through the pass (BLM 2016). The ranch complex expanded during the 1850s through the 1880s to include a hotel, a post office, a store, a tavern, and a blacksmith shop. In 1894, the San Luis Ranch also became a station for the short-lived Bicycle Mail Route that existed for two weeks while the American Railway Union went on strike (Wood 2005: 46). By 1878, Merced and Santa Clara counties had purchased the toll road and replaced it with a new road built as a public highway, a portion of which is now a segment of the Whiskey Flat Trail in Pacheco State Park.

In 1915, the Pacheco Pass road became a part of the state highway system, and the state built a third road through the pass (Hoover et al. 1990: 199). Finished in 1923, SR 152 between Bell Station and Pacheco Pass had a number of curves and steep grades. In 1939, beginning roughly 1 mile east of Bell Station, a 2.6-mile realignment was established that improved the accessibility and safety of the route (CAhighways.org 2010). A 3.3-mile long segment of the road was rebuilt in 1950 as a four-lane expressway, spanning the 1939 alignment and the Merced County border. In 1963 through 1965, a 12-mile long, 4-lane expressway was established from the County border eastward to bypass the San Luis Reservoir, which by then was under development. Whereas the 1940s-era alignment of SR 152 cut through the San Luis Flat, the 1960s-era reroute bypassed it to the north before curving to pass to the south of what would become the San Luis Forebay. A portion of SR 152, the “Highway 152 Tree Row” west of Gilroy between Santa Theresa Boulevard and the Uvas Creek Bridge, was listed in the NRHP in 2007.

Chapter 4
Background Research Methodology and Findings

4.1 Archival and Records Searches

Archival and records searches for the SLLPIP were conducted at the Central California Information Center (CCIC) of the California Historical Resources Information System in November 2009 (CCIC File number 75541), August 2012 (CCIC File number 8330I), and May 2016 (CCIC File number 9765I). Archival and records searches also were conducted at the Northwest Information Center (NWIC) in December 2009 (NWIC File number 09-0584), October of 2012 (NWIC File number 12-0279), March 2013 (NWIC File number 12-0938), and October 2016 (NWIC File number 16-0652). The full Project Area extents for each alternative were subject to archival and records searches, including a 0.5-mile radius surrounding the APE for the Lower San Felipe Intake and San Luis Reservoir Expansion alternatives and a 300-foot radius encompassing the APE for the Combination and Treatment alternatives. The locations and unique identifiers[3] for all prior studies and previously recorded cultural resources were obtained from nine 7.5-minute USGS topographic reference maps on file with the CCIC or NWIC. They included the Calaveras Reservoir (1980), Crevison Peak (2015), Cupertino (1991), Los Banos Valley (2015), Mariposa Peak (2015), Pacheco Pass (1971), San Jose East (1980), San Jose West (1980), San Luis Dam (1969), and Santa Teresa Hills (1981) California maps.

The CCIC and NWIC also provided listings of properties in the following historic registers maintained by the State of California:

- NRHP Directory of Determinations of Eligibility (California Office of Historic Preservation, Volumes I and II 1990);
- Historic Property Data File for Merced and Santa Clara counties (California Department of Parks and Recreation 2012);
- California Inventory of Historic Resources (California Department of Parks and Recreation 1976); and

[3] Unique identifiers for prior studies within Santa Clara County begin with “S-” to indicate “Study” while unique identifiers for prior studies within Merced County begin with “ME-” for Merced. Previously recorded cultural resources may or may not be assigned a state Trinomial number, which begins “CA-“, but will have a Primary number. Primary numbers consist of a “P-” followed by a two-digit numeric county code (“43-“ for Santa Clara and “24-” for Merced) followed by a six digit number indicating the order in which it was assigned (e.g., P-24-000116, etc.).

- California Historical Landmarks (California Office of Historic Preservation 1996);
- California Points of Historical Interest (California Department of Parks and Recreation 1992).

In addition, the CCIC and NWIC provided further ancillary information, which included the following:

- Caltrans State and Local Bridge Survey (California Department of Parks and Recreation 2011);
- Caltrans Statewide Historic Bridge Inventory (California Department of Transportation 2013), which includes listings of bridges previously evaluated for listing in the NRHP and determined eligible for listing be not re-evaluated, bridges that remain unevaluated, and local agency bridges;
- Historic Highway Bridges of California (California Department of Transportation 1990);
- Historic American Landscapes Survey (HALS) Inventory – Northern California (California Office of Historic Preservation 2009);
- Linear Resource Concordance List for Canals, Ditches, Levees, Railroads, Roads, Trails, and Transmission Lines (California Office of Historic Preservation 2013);
- List of Railroads by County (California Office of Historic Preservation 2013);
- List of Historic Survey Reports (Bibliography) (California Office of Historic Preservation 1994); and
- Survey of Surveys: A Summary of California's Historical and Architectural Resource Surveys (Department of Parks and Recreation 1989).

The archival and records searches included a review of all relevant 7.5-minute and 15-minute USGS topographic maps encompassing the Project Area for each alternative on file with the CCIC and NWIC. In general, reports for prior studies conducted within the Project Area for each alternative were copied in full if they resulted in positive findings (i.e., if they reported on the discovery of cultural resources) or in part if they yielded negative findings (i.e., they reported on no newly discovered cultural resources). Cultural resource records for archaeological sites, built environment resources, and isolated finds were copied in full. Those materials were collated by county and entered into a geographic information system (GIS) database depicting the spatial extents and basic attributes of each previously recorded cultural resource or prior study. These materials were also scanned and archived for later submission as a part of the administrative record for the SLLPIP EIS/EIR (Reclamation and SCVWD 2018). Materials available online such as historic period topographic maps and GLO plat maps were not copied at the CCIC and NWIC. Instead, they were

downloaded and analyzed as necessary to aid in the identification of potential but unrecorded historic period resources.

4.2 Prior Studies and Previously Recorded Cultural Resources

4.2.1 Lower San Felipe Intake Alternative

Archival and records searches revealed that 28 prior cultural resource studies have been carried out within the Lower San Felipe Intake Alternative Project Area (*see* Table 4-1 and Appendix A, Figures A-1a through A-1d). Of those 28 studies, 17 intersected portions of the Lower San Felipe Intake Alternative APE. The most expansive of these was an overview completed by the California Department of Parks and Recreation (2005) for the San Luis Reservoir Recreation Area EIS/EIR; it encompassed the proposed aeration facility, the Basalt Point use area, the intake area, and Gate Shaft Island and included portions of both Dinosaur Point and Dinosaur Point Road.

Table 4-1. Previous Cultural Resource Studies Conducted within the Lower San Felipe Intake Alternative Project Area.

Study Number	Study Type	Author	Date	Results	Intersects APE
ME-000603	Reconnaissance	Foster	1982	Negative	No
ME-000604	Reconnaissance	Foster	1984	Negative	Yes
ME-000605	Inventory Survey	Foster	1985	Negative	No
ME-000655	Site-specific Study	Nissley	1975	Positive	Yes
ME-000657	Site-specific Study	Olsen	1968c	Positive	Yes
ME-000709	Reconnaissance	Wren	1987	Positive	No
ME-001462	Site-specific Study	Olsen and Payen	1969	Positive	Yes
ME-001954	Reconnaissance	Thornton	1993	Positive	No
ME-003228	Site-specific Study	Jensen	1976	Positive	Yes
ME-003263	Reconnaissance	Price	1998	Negative	No
ME-003345	Site-specific Study	Stoppini	1975	Positive	Yes
ME-004312	Reconnaissance	Jensen	2001	Negative	No
ME-005590	Inventory Survey	Wulzen	2004	Negative	Yes
ME-005777	Inventory Survey	Wulzen	2005	Negative	Yes
ME-005844	Reconnaissance	Losee	2005	Negative	No
ME-005908	Reconnaissance	Bonner	2005	Positive	No
ME-006017	Inventory Survey	Whatford	1996a	Positive	Yes
ME-006474	Inventory Survey	Wulzen	2008a	Positive	Yes
ME-006535	Inventory Survey	Wulzen	2007a	Negative	No
ME-006834	Geotechnical Testing	Fry	2008	Negative	No
ME-006882	Overview (EIS/EIR)	California Department of Parks	2005	Positive	Yes

Study Number	Study Type	Author	Date	Results	Intersects APE
		and Recreation			
ME-007007	Inventory Survey	Chotkowski	2009	Negative	Yes
ME-007015	Inventory Survey	Wulzen	2003a	Negative	Yes
ME-007269	Reconnaissance	Chotkowski	2010a	Negative	No
ME-007405	Management Plan	Chotkowski	2010b	Negative	Yes
ME-007933	Inventory Survey	GANDA	2010	Positive	Yes
ME-008185	Inventory Survey	Wulzen	2009	Positive	Yes
NA	Built-Environment Inventory	ICF International	2013	Positive	Yes

Forty-two cultural resources have been previously recorded within the Lower San Felipe Intake Alternative Project Area (*see* Table 4-2). Eleven of those resources intersect the Lower San Felipe Intake Alternative APE, including six prehistoric archaeological sites (CA-MER-8, CA-MER-17, CA-MER-26, CA-MER-27, CA-MER-94, and CA-MER-437); one prehistoric district (P-24-000489); three historic period resources (P-24-000643, P-24-001818, and P-24-001822); and one historic period district or *rancho* (P-24-001856). Two have been evaluated for listing in the NRHP and/or the CRHR. One resource, the San Luis Gonzaga Archaeological District (P-24-000489), has been listed in the NRHP and the CRHR. The Californian Inventory of Historic Resources (1976) described the San Luis Gonzaga Archaeological District as comprising prehistoric midden sites of the Panoche Complex representing permanent or semi-permanent base camps and special use areas that likely contain cemeteries. The district boundary is arbitrarily defined on records and basemaps archived at the CCIC, but its spatial extents are not characterized by features that would be recognizable during inventory survey. The second resource (P-24-000643), a commemorative plaque marking Lieutenant Gabriel Moraga's 1805 exploration of the region, is listed as CHL-829. All California Historical Landmarks No. 770 and above are considered automatically eligible for listing in the CRHR; the resource has not been evaluated for listing in the NRHP. Figures A-1a through A-1d in Appendix A depict all previously recorded cultural resources within the Lower San Felipe Intake Alternative Project Area.

Table 4-2. Previously Recorded Cultural Resources within the Lower San Felipe Intake Alternative Project Area.

Resource Designation	Description	Author	Date	NRHP/CRHR	Intersects APE
CA-MER-8[1] P-24-000109	Prehistoric lithic scatter with one handstone	Treganza	1960	NEV	Yes (Intake Area)
CA-MER-9[1] P-24-000110	Prehistoric house-pits with lithic scatter and one mortar	Treganza	NA-b	NEV	No
CA-MER-15 P-24-000116	Prehistoric village site with bedrock mortars and flaked stone	Riddell	1962b	NEV	No

Resource Designation	Description	Author	Date	NRHP/CRHR	Intersects APE
CA-MER-16 P-24-000117	Prehistoric village site with two burials	Riddell	1963	NEV	No
CA-MER-17 P-24-000118	Prehistoric house-pits and midden deposit	Olsen	1963	NEV	Yes (Basalt Point Use Area)
CA-MER-19 P-24-000120	Prehistoric midden deposit with pestle and flaked stone	Olsen	1964b	NEV	No
CA-MER-20 P-24-000121	Prehistoric midden deposit with pestle	Olsen	1964c	NEV	No
CA-MER-21 P-24-000122	Prehistoric midden deposit with bedrock mortar	Olsen	1964d	NEV	No
CA-MER-22 P-24-000123	Prehistoric midden deposit	Olsen	1964e	NEV	No
CA-MER-23 P-24-000124	Prehistoric midden deposit with pestle fragment	Olsen	1964f	NEV	No
CA-MER-24 P-24-000125	Prehistoric village site with mortars and pestles	Riddell	1964	NEV	No
CA-MER-26 P-24-000126	Prehistoric midden deposit with flaked stone	Olsen	1965a	NEV	Yes (Dinosaur Point)
CA-MER-27 P-24-000128	Prehistoric midden deposit with flaked stone and groundstone	Olsen	1965b	NEV	Yes (Dinosaur Point)
CA-MER-28 P-24-000129	Prehistoric “occupation” deposit with flaked stone	Olsen	1965c	NEV	No
CA-MER-41 P-24-000142	Prehistoric midden deposit with fire-affected rock fragments, flaked stone and groundstone	Olsen	1966a	NEV	No
CA-MER-42 P-24-000143	Prehistoric midden deposit with flaked stone	Olsen	1966b	NEV	No
CA-MER-56/H[1] P-24-000157	Site of historic period San Luis Ranch Adobe	Latta	1950	NEV	No
	Prehistoric site with lithic scatter, handstones, mortars, and burials	Treganza	1960	NEV	No
CA-MER-82 P-24-000182	Prehistoric occupation deposit with flaked stone and fire-affected rock	Olsen	1966c	NEV	No
CA-MER-83 P-24-000183	Prehistoric midden deposit	Olsen	1966d	NEV	No
CA-MER-94 P-24-000194	Prehistoric village site with sandstone bowl and flaked stone	Riddell	1962c	NEV	Yes (Dinosaur Point)
CA-MER-99 P-24-000199	Prehistoric village site with groundstone and flaked stone tool	Riddell	1962d	NEV	No
CA-MER-130 P-24-000220	Prehistoric midden deposit with “pitted boulder”	Olsen	1968b	E (code 1D)	No
CA-MER-134 P-24-000224	Prehistoric midden deposit with bedrock mortars	Payen and Olsen	1969c	E (code 1D)	No
CA-MER-135 P-24-000225	Prehistoric midden deposit with pestle fragment	Olsen and Pritchard	1970	E (code 1D)	No
CA-MER-138 P-24-000228	Prehistoric midden deposit	Olsen	1973	NEV	No

Resource Designation	Description	Author	Date	NRHP/CRHR	Intersects APE
CA-MER-96 P-24-000196	Prehistoric midden with groundstone pieces and possible house-pits	Olsen	1964g; 1968a	NEV	No
CA-MER-261H P-24-000351	Two historic period rock alignments and one rock pile with ceramic artifacts	Wulzen	2007b	NEV	No
CA-MER-433 P-24-001806	Prehistoric bedrock milling features and petroglyphs	Whatford	2004		No
CA-MER-437 P-24-001859	Two prehistoric milling stations	Wulzen	2003b, 2007c	NEV	Yes (Basalt Point)
CA-MER-451H P-24-001876	Historic period ranch complex	Wulzen	2008b	NEV	No
P-24-000078	Historic period fire watch tower	Thornton	1991	AE (code 4CM)	No
P-24-000489	San Luis Gonzaga Archaeological District comprised of five prehistoric midden sites (CA-MER-107, CA-MER-126 CA-MER-130, CA-MER-134, and CA-MER-135)	Olsen	1970	E (code 1S)	Yes (Dinosaur Point/ Dinosaur Point Road)
P-24-000643 CHL-829	California State Historical Landmark plaque commemorating Moraga's 1805 exploration of Pacheco Pass	Arbuckle	1979	NEV (NRHP); E (CRHR)	Yes (Aeration Facility)
P-24-001818	Historic period linear feature comprising a 2.5-mile long fence	Whatford	1996b	NEV	Yes (Dinosaur Point Road)
P-24-001819	Prehistoric bedrock milling station	Whatford	1996c	NEV	No
P-24-001820	Prehistoric bedrock milling station	Whatford	1996d	NEV	No
P-24-001821	Prehistoric rock cairn	Whatford	1996e	NEV	No
P-24-001822	Historic period linear features comprising road cuts and retaining walls associated with SR 152 and a stage road	Whatford	1996f	NEV	Yes (Dinosaur Point/ Dinosaur Point Road)
	Historic period linear feature consisting of a 3,455-foot long segment of the old Pacheco Pass Highway	Barnes	2009		
P-24-001823	Historic period linear feature comprising a 4 mile-long fence	Whatford	1996g	NEV	No
P-24-001824	Historic period windmill	Whatford	1996h	NEV	No
P-24-001827	Historic period linear resource comprising four rock cairn/ wooden post monuments	Whatford	1996i	NEV	No
P-24-001856	San Luis Gonzaga Rancho-Paula (Pacheco) Fatjo Ranch Historic District	Bissonnette	2007	NEV	Yes (Dinosaur Point/ Dinosaur Point Road)

[1] Note CA-MER-8, CA-MER-9 and CA-MER-56/H are not plotted on maps provided by the CCIC, however they appear in a 1960 report by A. Treganza (ME-000694) on file with the CCIC that notes their approximate locations and basic constituents.
NRHP/CRHR: AE – appears eligible; DNE – determined not eligible; E – eligible; NE – not eligible; NEV – not evaluated

4.2.2 Combination Alternative

As originally proposed, the Combination Alternative Project Area encompassed a 300-foot radius surrounding 21 groundwater production wells, 18 associated pipeline segments, and one recharge pond. Due to changes in engineering, 12 groundwater production wells and their associated pipeline segments were removed from consideration. Ultimately, the Project Area encompassed just eight groundwater production wells, three pipeline segments, and one recharge pond in seven discontinuous areas. Archival and records searches revealed that the final Project Area was intersected by 48 prior cultural resource studies and that 35 of those studies encompassed some portion of the Combination Alternative APE. Many comprised linear inventory surveys associated with modern infrastructural development for roads, sewage lines, and telecommunication routes (*see* Table 4-3 and Appendix A, Figures A-2a through A-2e).

Table 4-3. Previous Cultural Resource Studies Conducted within the Combination Alternative Project Area.

Study Number	Study Type	Author	Date	Results	Intersects APE
Final Project Area					
S-004173	Regional Overview	Carrell and Edwards	1975	Positive	Yes
S-004193	Inventory Survey	Edwards	1974	Negative	Yes
S-004730	Inventory Survey	Winter	1975	Negative	Yes
S-004772	Inventory Survey	Jackson et al.	1973	Positive	Yes
S-005195	Inventory Survey	Garaventa and Busby	1982	Positive	No
S-005234	Reconnaissance	Holman	1974	Negative	Yes
S-005901	Inventory Survey	Garaventa and Harmon	1983	Negative	No
S-006168	Inventory Survey	Cartier	1983	Negative	No
S-006617	Inventory Survey	Garaventa and Anastasio	1984	Negative	Yes
S-007199	Inventory Survey	Cartier	1985	Negative	Yes
S-007207	Inventory Survey	Flynn	1985	Negative	Yes
S-007619	Inventory Survey	Cartier et al.	1984	Positive	Yes
S-007844	Inventory Survey	Anastasio	1985	Negative	No
S-007901	Survey/Architectural Evaluation	Dietz	1986	Negative	Yes
S-008387	Inventory Survey	Chavez	1980	Positive	No
S-008883	Overview	Laffey	1986	Negative	Yes
S-008955	Inventory Survey	Cartier and Laffey	1986	Positive	Yes
S-009378	Historic study	Laffey	1987	Negative	Yes
S-009728	Inventory Survey	Archaeological Resource Management	1988	Negative	No
S-010578	Overview	Cartier and Laffey	1989	Positive	Yes
S-011642	Inventory Survey	Anastasio et al.	1988	Positive	Yes
S-011879	Inventory Survey	Garaventa et al.	1989	Positive	Yes

Study Number	Study Type	Author	Date	Results	Intersects APE
S-011927	Archival and Records Search	Holman	1987	Negative	Yes
S-013894	Inventory Survey	Garaventa et al.	1991	Positive	Yes
S-018541	Overview	Busby et al.	1996a	Positive	Yes
S-018975	Monitoring Report	Cartier and Morgan	1996	Positive	Yes
S-019072	Overview	Busby et al.	1996b	Positive	Yes
S-020186	Monitoring Report	Busby	1997a	Positive	Yes
S-020855	Inventory Survey	Laffey and Duval	1998	Negative	No
S-021162	Inventory Survey	Busby	1997b	Negative	Yes
S-021170	Inventory Survey	Corbett et al.	1997	Negative	Yes
S-021576	Overview	Hill et al.	1998	Positive	Yes
S-022179	Inventory Survey	Archaeological Resource Management	1999	Negative	No
S-023051	Inventory Survey	Basin Research Associates, Inc.	1998	Positive	Yes
S-023080	Monitoring Report	Busby	1999a	Positive	Yes
S-023105	Overview	Busby	1999b	Positive	Yes
S-023382	Inventory Survey	Basin Research Associates, Inc.	2000	Positive	Yes
S-024128	Inventory Survey	Archaeological Resource Management	2000	Negative	No
S-025552	Archival and Records Search	Busby	2002	Positive	Yes
S-027102	Inventory Survey	Archaeological Resource Management	2003	Negative	No
S-027196	Inventory Survey	Holman	2002	Negative	No
S-031898	Monitoring Report	Busby	2005	Positive	Yes
S-032563	Excavation/Study	Psota et al.	2006	Positive	No
S-033543	Archival and Records Search	US Department of Transportation	1981	Positive	Yes
S-033544	Mitigation	Basin Research Associates, Inc.	1984	Negative	Yes
S-034188	Inventory Survey	Holman	2006	Negative	Yes
S-036714	Inventory Survey	Basin Research Associates, Inc.	2009	Positive	Yes
S-037032	Inventory Survey	Ruby et al.	2010	Positive	No

Five cultural resources were previously recorded within the Combination Alternative Project Area as it was initially proposed. Due to engineering changes in the alternative, however, two resources (CA-SCL-186 and CA-SCL-187) were excluded from the Project Area. Of the three previously recorded cultural resources that remained, only one (CA-SCL-799H) intersected the final extents of the Combination Alternative APE (*see* Table 4-4). That resource, a modern and historic period surface debris scatter with a subsurface component,

was discovered along Hedding Street between Guadalupe Parkway and Spring Street in San Jose. The site was not formally evaluated but was found to contain domestic and building materials dating from the 1880s through the 1970s, with the majority of the site's constituents dating to the 1880s through the 1930s. The site was found to be heavily disturbed, though subsurface portions of the site were believed to be intact (Morgan et al. 1996). Figures A-2a through A-2e in Appendix A depict previously recorded cultural resources present within the Combination Alternative Project Area.

Table 4-4. Previously Recorded Cultural Resources within the Combination Alternative Project Area.

Resource Designation	Description	Author	Date	NRHP/CRHR	Intersects APE
CA-SCL-588H P-43-000583	Historic period subsurface feature comprising redwood fence posts surrounding a perimeter foundation with ceramics	Cartier	1984	NEV	No
CA-SCL-744/H P-43-000642	Historic period debris pit with bottles, saw cut bone, shell, fish, ceramics, metal car parts, battery parts, wood, and clock parts	Sidhu	1993	DNE (code 6Y)	No
CA-SCL-799H P-43-000966	Historic period surface debris scatter with subsurface lens of debris observed 2 meters below the ground surface consisting of domestic items (ca. 1880s-1970s)	Morgan et al.	1996	NEV	Yes (Hedding Street #1 and #2 Well Piping)

NRHP/CRHR: DNE – determined not eligible; NEV – not evaluated

4.2.3 Treatment Alternative

The current Treatment Alternative Project Area comprises a 300-foot radius surrounding the existing SCVWD Santa Teresa WTP, which was built in 1989. As originally conceived, the Treatment Alternative included a second facility, the Rinconada WTP, which was excluded from Project consideration in mid-2017. The Santa Teresa WTP was developed to serve Santa Clara Valley customers and has been heavily developed to accommodate plant facilities and infrastructure. An archival and records search revealed that the current Treatment Alternative Project Area was intersected by four prior cultural resource studies and that three of those studies encompassed some portion of the APE (*see* Table 4-5 and Appendix A, Figures A-3a through A-3b). One 2002 study (S-034611) in particular fully subsumed the Treatment Alternative APE. It included an archival and records search of a 0.5-mile buffer surrounding the Santa Teresa WTP and as well as a reconnaissance survey of the facility. Two other facilities, the Penitencia and Rinconada WTPs, also were examined. No cultural resources were documented as a result as a result of the study.

One cultural resource was previously recorded within the Treatment Alternative Project Area, though it did not intersect the APE. That resource (CA-SCL-377) is a prehistoric site located roughly 275 feet northwest of the Santa Teresa WTP. It includes one chert flake as well as possible midden soils and possible bedrock mortars that may or may not be cultural features (Whitlow and Harris 1978) (*see* Figure A-3b in Appendix A).

Table 4-5. Previous Cultural Resource Studies within the Treatment Alternative Project Area.

Study Number	Study Type	Author	Date	Results	Intersects APE
S-004574	Inventory Survey, Historic Study	Whitlow	1978a	Positive	Yes
S-004690	Resource Evaluation	Cartier	1979	Negative	Yes
S-026184	Inventory Survey and Evaluation	Cartier	2002	Negative	Yes
S-034611	Resource Evaluation	Cartier	2006	Negative	No

4.2.4 San Luis Reservoir Expansion Alternative

Archival and records searches revealed that 52 prior cultural resource studies have been carried out within the San Luis Reservoir Expansion Alternative Project Area and that 33 of those intersected some portion of the APE (*see* Table 4-6 and Appendix A, Figures A-4a through A-4g). Among the most extensive was an overview completed by the California Department of Parks and Recreation (2005) for the San Luis Reservoir Recreation Area EIS/EIR. Another was the Luis Reservoir Recreation Area Draft Resource Management Plan/General Plan and Draft EIS/EIR by Reclamation and the California Department of Parks and Recreation (2012). Particularly relevant to the SLLPIP was the draft "Built-Environment Inventory for the B.F. Sisk Dam Corrective Action Study, Merced County, California" (ICF 2013). It included an inventory of built environment resources within the San Luis Reservoir Expansion Alternative APE, including the B.F. Sisk Dam and San Luis Reservoir, the O'Neil Dam and Forebay, the William R. Gianelli Pumping-Generating Plant, and the San Luis Operation and Maintenance Center. The study was never finalized, but its author concluded that the dam, the reservoir, the pumping-generating plant, and the forebay were eligible for listing in the NRHP and CRHR under Criterion A/1 for their importance to the development of the CVP and SWP as well as state and federal partnerships regarding water infrastructure (ICF 2013).

More recently, JRP Historic Consulting re-examined the key elements of the B.F. Sisk Dam System during an architectural field inventory in support of the B.F. Sisk Dam Safety of Dams Modification Project. They recommended the B.F. Sisk Dam and San Luis Reservoir, the O'Neil Dam and Forebay, the William R. Gianelli Pumping-Generating Plant, and the San Luis Operation and Maintenance Center eligible for listing in the NRHP and CRHR under Criterion

A/1 as contributing elements to the "B.F. Sisk Dam/San Luis Reservoir Historic District" (JRP 2018). Elements of the district were recommended not eligible for individual listing in the NRHP or the CRHR, but taken together were found to be significant within the context of water resource development in California and an integral part of both the CVP and SWP (JRP 2018). Two ancillary facilities used in construction of the dam, the Basalt Hill Quarry (CA-MER-509H) and a rip-rap separation plant (CA-MER-492H), were recommended as non-contributing elements of the district.

Table 4-6. Previous Cultural Resource Studies Conducted within the Reservoir Expansion Alternative Project Area.

Study Number	Study Type	Author	Date	Results	Intersects APE
ME-000581	Inventory Survey	Adams	1988	Negative	Yes
ME-000602	Site-Specific	Follett	1983	Positive	Yes
ME-000603	Reconnaissance	Foster	1982	Negative	Yes
ME-000605	Inventory Survey	Foster	1985	Negative	No
ME-000618	Inventory Survey	Littlefield	1984	Negative	Yes
ME-000645	Sensitivity Study	Napton	1990	Positive	Yes
ME-000655	Excavation	Nissley	1975	Positive	Yes
ME-000657	Site-Specific	Olsen	1968c	Positive	No
ME-000666	Inventory Survey	Peak & Associates, Inc.	1979	Negative	Yes
ME-000683	Site-Specific	Riddell	1968	Positive	Yes
ME-000695	Overview	Varner	1975	Negative	No
ME-000699	Inventory Survey	Weber	1978	Negative	No
ME-000709	Reconnaissance	Wren	1987	Positive	No
ME-001462	Site-Specific	Olsen and Payen	1969	Positive	No
ME-001746/1747	Excavation	Schulz	1970a; 1970b	Positive	Yes
ME-001954	Reconnaissance	Thornton	1993	Positive	No
ME-001975	Sensitivity Study/EIR	Peak & Associates, Inc.	1991a	Negative	No
ME-001976	Inventory Survey	Peak & Associates, Inc.	1992	Negative	Yes
ME-003228	Excavation	Jensen	1976	Positive	Yes
ME-003345	Site-Specific	Stroppini	1975	Positive	Yes
ME-004287	Reconnaissance	Runnings and Haversat	2001	Negative	No
ME-004424	Inventory Survey	Napton	2001	Negative	No
ME-004578	Inventory Survey	Peak & Associates, Inc.	1991b	Indeterminate	No
ME-004688	Inventory Survey	Jensen	2002	Negative	No
ME-005221	Survey	Hector et al.	2003	Positive	No
ME-005378	Reconnaissance	Wren	2004	Negative	No

Study Number	Study Type	Author	Date	Results	Intersects APE
ME-005498/ 005499/005500	Inventory Survey	Leach-Palm, Mikkelsen, King, and Hatch	2004a; 2004b; 2004c	Positive	Yes
ME-005590	Inventory Survey	Wulzen	2004	Negative	Yes
ME-005758	Inventory Survey	Jones & Stokes	2003	Negative	No
ME-005777	Inventory Survey	Wulzen	2005	Negative	Yes
ME-005908	Reconnaissance	Bonner	2005	Positive	No
ME-005926	Inventory Survey	Maslonka & Associates	2005	Positive	No
ME-006017	Inventory Survey	Whatford	1996a	Positive	No
ME-006099	Master Plan	EDAW	2006	Positive	No
ME-006474	Inventory Survey	Wulzen	2008a	Positive	Yes
ME-006535	Inventory Survey	Wulzen	2007a	Negative	Yes
ME-006834	Geotechnical Testing	Fry	2008	Negative	Yes
ME-006836	Site-Specific	Zaugg	2008	Negative	Yes
ME-006882	Overview (EIS/EIR)	California Department of Parks and Recreation	2005	Positive	Yes
ME-006984	Reconnaissance	Chotkowski	2009a	Negative	Yes
ME-007007	Inventory Survey	Chotkowski	2009b	Negative	Yes
ME-007015	Inventory Survey	Wulzen	2003a	Negative	Yes
ME-007119	Overview	Romoli and Ruby	1963	Positive	Yes
ME-007120	Overview	Olsen	1974	Positive	Yes
ME-007269	Reconnaissance	Chotkowski	2010a	Negative	Yes
ME-007405	Management Plan	Chotkowski	2010b	Negative	Yes
ME-007933	Survey	Siskin et al.	2010	Positive	Yes
ME-008185	Reconnaissance	Wulzen	2009	Positive	Yes
ME-008283	Inventory Survey	Johnston and Brewer	2015	Positive	Yes
---	Built-Environment Inventory	ICF International	2013	Positive	Yes
---	Inventory Survey	Holm, Reese, Ballard, Streich, Kovak, Sanchez and Holson	2014	Positive	Yes
---	Built-Environment Inventory	JRP Historical Consulting	2018	Positive	Yes

Fifty cultural resources have been previously recorded within the San Luis Reservoir Expansion Alternative Project Area (*see* Table 4-7). Of those, 19 intersect the San Luis Reservoir Expansion Alternative APE. Fifteen (CA-MER-14, CA-MER-15, CA-MER-20, CA-MER-21, CA-MER-22, CA-MER-23, CA-MER-27, CA-MER-28, CA-MER-29, CA-MER-41, CA-MER-82, CA-MER-130, CA-MER-136, CA-MER-137, and CA-MER-437) comprise prehistoric archaeological sites; one is a prehistoric district (P-24-000489); two are historic period resources (CA-MER-451H and CA-MER-521H); and one encompasses the B.F. Sisk Dam System. Five of the 19 cultural resources

within the APE have been previously evaluated for listing in the NRHP and/or the CRHR. Two prehistoric sites, one a prehistoric midden deposit with a "pitted boulder" (CA-MER-130, Olsen 1968b) and the other a prehistoric midden deposit with pestle fragments (CA-MER-136), are listed in the NRHP and CRHR. CA-MER-130 is regarded as a contributing element to the San Luis Gonzaga Archaeological District (P-24-000489), a prehistoric district with five known midden deposits that is also listed in the NRHP and CRHR (*see* Section 4.2.1). A fourth resource, a historic period water tank and trough, was recommended not eligible for listing in the NRHP and CRHR (Holm et al. 2014). Finally, the B.F. Sisk Dam and its key features were recommended eligible for listing in the NRHP and CRHR as a part of the B.F. Sisk Dam/San Luis Reservoir Historic District (JRP 2018). Figures A-4a through A-4g in Appendix A show all previously recorded cultural resources within the San Luis Reservoir Expansion Alternative Project Area.

Table 4-7. Previously Recorded Cultural Resources within the San Luis Reservoir Expansion Alternative Project Area.

Resource Designation	Description	Author	Date	NRHP/CRHR	Intersects APE
B.F. Sisk Dam System	Historic period B.F. Sisk Dam and facilities	ICF International	2013	RE (NRHP/ CRHR)	Yes (Expanded Embankment, Downstream Stability Berms, Construction Staging Areas, and Reservoir Shoreline)
		JRP Historical Consulting	2018		
CA-MER-8[1] P-24-0001091	Prehistoric lithic scatter with one handstone	Treganza	1960	NEV	No
CA-MER-9[1] P-24-0001101	Prehistoric house-pits with lithic scatter and one mortar	Treganza	NA-b	NEV	No
CA-MER-14[2] P-24-000115	Prehistoric lithic scatter with groundstone, burials, and rock cairn; destroyed	Olsen	1962	NEV	Yes (Expanded dam embankment)
		Riddell	1962a		
		Glassow	1962, 1963		
CA-MER-15 P-24-000116	Prehistoric village site with bedrock mortars and flaked stone	Riddell	1962b	NEV	Yes (Reservoir Shoreline – South of Dinosaur Point Boat Ramp)
CA-MER-16 P-24-000117	Prehistoric village site with two burials	Riddell	1963	NEV	No
CA-MER-17 P-24-000118	Prehistoric house-pits and midden deposit	Olsen	1963	NEV	No
CA-MER-18 P-24-000119	Prehistoric small, dark, rocky deposit with flakes, a shell, and possibly a human bone	Olsen	1964a	NEV	No
CA-MER-19 P-24-000120	Prehistoric midden deposit with pestle and flaked stone	Olsen	1964b	NEV	No
CA-MER-20 P-24-000121	Prehistoric midden deposit with pestle	Olsen	1964c	NEV	Yes (Reservoir Shoreline – South Highway 152)

Resource Designation	Description	Author	Date	NRHP/CRHR	Intersects APE
CA-MER-21 P-24-000122	Prehistoric midden deposit with bedrock mortar	Olsen	1964d	NEV	Yes (Reservoir Shoreline – North of Dinosaur Point Boat Ramp)
CA-MER-22 P-24-000123	Prehistoric midden deposit	Olsen	1964e	NEV	Yes (Reservoir Shoreline – North of Dinosaur Point Boat Ramp)
CA-MER-23 P-24-000124	Prehistoric midden deposit with pestle fragment	Olsen	1964f	NEV	Yes (Reservoir Shoreline – North of Dinosaur Point Boat Ramp)
CA-MER-24 P-24-000125	Prehistoric village site with mortars and pestles	Riddell	1964	NEV	No
CA-MER-26 P-24-000127	Prehistoric Midden and small lithic scatter	Olsen	1965a	NEV	No
CA-MER-27 P-24-000128	Prehistoric midden deposit with flaked stone and groundstone	Olsen	1965b	NEV	Yes (Reservoir Shoreline – Near Dinosaur Point Boat Ramp)
CA-MER-28 P-24-000129	Prehistoric occupation deposit with flaked stone	Olsen	1965c	NEV	Yes (Reservoir Shoreline – South of Dinosaur Point Boat Ramp)
CA-MER-29 P-24-000130	Prehistoric Midden with silicate flakes and a scraper and mortar	Olsen	1965d	NEV	Yes (Reservoir Shoreline – East side of San Luis Creek Inlet)
CA-MER-31 P-24-000132	Prehistoric midden with two silicate scrapers	Olsen	1965e	NEV	No
CA-MER-32 P-24-000133	Prehistoric Midden with flakes and a hammerstone	Olsen	1965f	NEV	No
CA-MER-41 P-24-000142	Prehistoric midden deposit with fire affected rock fragments, flaked stone and groundstone	Olsen	1966a	NEV	Yes (Reservoir Shoreline – South of Dinosaur Point Boat Ramp)
CA-MER-42 P-24-000143	Prehistoric midden deposit with flaked stone	Olsen	1966b	NEV	No
CA-MER-56/H[1] P-24-0001571	Site of historic San Luis Ranch Adobe	Latta	1950	NEV	No
	Prehistoric site with lithic scatter, handstones, mortars, and burials	Treganza	1960		
CA-MER-82 P-24-000182	Prehistoric occupation deposit with flaked stone and fire affected rock	Olsen	1966c	NEV	Yes (Reservoir Shoreline – West side of San Luis Creek Inlet)
CA-MER-83 P-24-000183	Prehistoric midden deposit	Olsen	1966d	NEV	No
CA-MER-94 P-24-000194	Prehistoric village site with sandstone bowl and flaked stone	Riddell	1962c	NEV	No

Resource Designation	Description	Author	Date	NRHP/CRHR	Intersects APE
CA-MER-96 P-24-000196	Prehistoric midden with groundstone pieces and possible house-pits	Olsen	1964g, 1968a	NEV	No
CA-MER-99 P-24-000199	Prehistoric village site with groundstone and flaked stone tool	Riddell	1962d	NEV	No
CA-MER-130 P-24-000220	Prehistoric midden deposit with "pitted boulder"	Olsen	1968b	E (code 1D)	Yes (Reservoir Shoreline – North of Dinosaur Point Boat Ramp)
CA-MER-131 P-24-000221	Prehistoric midden site with one rimmed housepit	Payen and Olsen	1969a	NEV	No
CA-MER-132 P-24-000222	Prehistoric midden site with one small housepit	Payen and Olsen	1969b	NEV	No
CA-MER-134 P-24-000224	Prehistoric midden deposit with bedrock mortars	Payen and Olsen	1969	E (code 1D)	No
CA-MER-135 P-24-000225	Prehistoric midden deposit with pestle fragment	Olsen and Pritchard	1970	E (code 1D)	No
CA-MER-136 P-24-000226	Prehistoric midden deposit with pestle fragments	Olsen	1971a	E (code 1D)	Yes (Reservoir Shoreline – Cottonwood Bay)
CA-MER-137 P-24-000227	Prehistoric large occupation site on knoll with pestle fragments	Olsen	1971b	NEV	Yes (Reservoir Shoreline – Cottonwood Bay)
CA-MER-138 P-24-000228	Prehistoric midden deposit	Olsen	1973	NEV	No
CA-MER-261H P-24-000351	Two historic rock alignments and one rock pile with ceramic artifacts	Wulzen	2007b	NEV	No
CA-MER-433 P-24-001806	Prehistoric bedrock milling features and petroglyphs	Whatford	2004	NEV	No
CA-MER-437 P-24-001859	Two prehistoric milling stations	Wulzen	2003b, 2007c	NEV	Yes (Construction Impact Area – West of Goosehead Point)
CA-MER-451H P-24-001876	Ranch complex	Wulzen	2008b	NEV	Yes (Construction Staging Area – South of B.F. Sisk Dam)
CA-MER-477H P-24-001822	Historic linear features comprising road cuts and retaining walls associated with State Route 152 and a stage route	Whatford	1996f	NEV	No
	Historic linear feature consisting of a 3,455-foot long segment of the old Pacheco Pass Highway	Barnes	2009		
CA-MER-521H P-24-002173 SLTP-B-11	Elevated water tank and water trough	Fuerstenberg	2014	NE (NRHP)	Yes (Borrow Area 6 - South of O'Neill Forebay)
Harris Ranch vicinity	Harris Ranch vicinity per the 1955 USGS Pacheco Pass 7.5-minute topographic map	---	---	NEV	No

Resource Designation	Description	Author	Date	NRHP/CRHR	Intersects APE
P-24-000078	Historic Basalt Hill Fire Lookout Station	Thornton	1991	AE (code 4CM)	No
P-24-000489	San Luis Gonzaga Archaeological District comprised of five prehistoric midden sites (CA-MER-107, CA-MER-126 CA-MER-130, CA-MER-134, and CA-MER-135)	Olsen	1970	E (code 1S)	Yes (Reservoir Shoreline – Dinosaur Point Area; Cottonwood Bay Levee Modification and Levee Raise Areas)
P-24-000643 CHL-829	California State Historical Landmark # plaque commemorating Lt. G. Moraga's 1805 traversal of Pacheco pass	Arbuckle	1979	NEV (NRHP); E (CRHR)	No
P-24-001729	The site consists of a very light scatter of historic ironstone fragments	Peak and Gerry	1991	NEV	No
P-24-001823	Historic linear feature comprising a 4-mile long fence	Whatford	1996g	NEV	No
P-24-001856	San Luis Gonzaga Rancho-Paula (Pacheco) Fatjo Ranch Historic District	Bissonnette	2007	NEV	No
P-24-001931	California Aqueduct	Ambacher	2011	RE (NRHP)	No

[1] Note CA-MER-8, CA-MER-9 and CA-MER-56/H are not plotted on maps provided by the CCIC, however they appear in a 1960 report by A. Treganza (ME-000694) on file with the CCIC that notes their approximate locations and basic constituents.

[2] Note CA-MER-14 appears in a study (ME-07119) by Romoli and Ruby (1963) but is not mapped by the CCIC. NRHP/CRHR: AE – appears eligible; DNE – determined not eligible; E – eligible; NE – not eligible; NEV – not evaluated; RE recommended

4.3 Native American and Organizational Contact

Pacific Legacy first requested a search of the Sacred Lands Inventory maintained by the Native American Heritage Commission (NAHC) in support of the SLLPIP on November 30, 2012. A revised request was submitted to the NAHC on December 12, 2012. A partial response from the NAHC was received on December 19, 2012, which indicated that a search of the Sacred Lands Inventory did not result in the identification of Native American cultural resources in the Combination Alternative Project Area in Santa Clara County. The NAHC provided a list of Native American individuals who may have knowledge of or interest in cultural resources in Santa Clara County. Requests for contact and further information were sent via certified letter to Jakki Kehl (Ohlone/Costanoan), Jean-Marie Feyling (Amah/Mutsun Tribal Band), Katherine Erolinda Pérez (Northern Valley Yokuts Tribe), Ann Marie Sayers (Chairperson, Indian Canyon Mutsun Band of Costanoan), Valentin Lopez (Chairperson, Amah Mutsun Tribal Band), Rosemary Cambra (Chairperson, Muwekma Ohlone Indian Tribe of the San Francisco Bay Area), Edward Ketchum (Amah Mutsun Tribal Band), Andrew Galvan (The Ohlone Indian Tribe), Irene Zweirlein (Chairperson, Amah/Mutsun Tribal Band), and Ramona Garibay (Representative, Trina Marine Ruano Family).

At the suggestion of Ms. Pilas-Treadway, Pacific Legacy resubmitted its request to the NAHC on January 10, 2013 for Merced County. A response was received on January 11, 2013, indicating that no Native American cultural resources had been identified through a search of the Sacred Lands Inventory within a 0.5-mile radius surrounding the San Felipe Intake Alternative APE. The NAHC provided a list of Native American individuals who may have knowledge of or interest in cultural resources in Merced County. Requests for contact and further information were sent via certified letter to Valentin Lopez (Chairperson, Amah Mutsun Tribal Band), Lorrie Planas (Choinumni Tribe), Katherine Erolinda Pérez (Northern Valley Yokuts Tribe), Les James (Spiritual Leader, Southern Sierra Miwuk Nation), Edward Ketchum (Amah Mutsun Tribal Band), and Anthony Brochini (Chairperson, Southern Sierra Miwuk Nation).

As a part of the environmental review process, Reclamation will engage in consultation with Native American tribal representatives as well as other potential stakeholders regarding the SLLPIP action alternatives. In compliance with CEQA and Assembly Bill 52, the SCVWD also will consult with Native American tribal representatives regarding the Project. Recently, both Reclamation and the SCVWD have conducted outreach to the Native American community on behalf of other proposed projects that overlap the SLLPIP. These include the Pacheco Reservoir Expansion Project and geotechnical studies supporting the B.F. Sisk Dam Safety of Dams Modification Project. Documentation provided by the SCVWD for the Pacheco Reservoir Expansion Project is included in the cultural resources technical report for the New Pacheco Reservoir Alternative (Pacific Legacy 2018) while documentation provided by Reclamation for the B.F. Sisk Dam Safety of Dams Modification Project is provided in a forthcoming cultural resources technical report (Pacific Legacy 2018b). Pacific Legacy's correspondence with the NAHC from 2012 and 2013 is included in Appendix D.

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Chapter 5
Survey and Recording Methodology

5.1 Inventory Survey Methods

Pacific Legacy personnel conducted an inventory survey of the APE for the Lower San Felipe Intake Alternative, the Combination Alternative, and the San Luis Reservoir Expansion Alternative in 2012 and 2016. The Lower San Felipe Intake Alternative APE was examined over the course of 12 days beginning on November 13, 2012 and ending December 6, 2012. An inventory survey of the Combination Alternative APE was completed on September 25, 2012. The San Luis Reservoir Expansion Alternative APE was examined over the course of 34 days beginning on June 22, 2016 and ending August 11, 2016. The full extents of the Treatment Alternative APE were subject to an inventory survey in 2002 (Cartier 2002). Because the existing Santa Teresa WTP that makes up the Treatment Alternative APE will not be expanded beyond its current footprint, and because it has not been substantially altered or upgraded since 2002, it was not subject to re-examination in 2012 or 2016.

Qualified personnel from Pacific Legacy familiar with the prehistoric and historic period archaeology of California carried out inventory surveys of all accessible areas within the APE for the three action alternatives noted above. Personnel were divided into teams of two to six professional archaeologists, each led by a field director or crew chief. Pedestrian surveys were performed using systematic transects in which team members were spaced no more than 12-15 meters apart. No artifacts were collected and no subsurface testing or excavation was undertaken. Within areas of particularly dense vegetation or poor surface visibility, field personnel conducted judgmental surface scrapes to expose the ground surface. The main objective of the inventory surveys was to identify previously recorded cultural resources, discover previously undocumented resources, and to note the potential of surveyed areas to contain buried cultural materials.

All previously recorded and newly identified prehistoric and historic period cultural resources were documented using global positioning system (GPS) receivers with sub-meter accuracy (e.g., Trimble GeoXT or GeoXH). A standardized data dictionary was used with each unit to ensure cross-compatibility. All location and attribute data collected via GPS receiver were compiled into a geospatial database to aid in record and report production and to facilitate future management.

Prior to the start of the inventory surveys, personnel were supplied with records for previously recorded cultural resources as well as copies of relevant historic period maps. Personnel also received information regarding the identification and anticipated age range of prehistoric and historic period cultural resources within the APE for each action alternative as well manuals regarding landforms, soil types, and floral and faunal resources to ensure that standardized recording nomenclature was used.

During inventory survey, every effort was made to relocate and document previously recorded sites and isolated finds in accessible areas. Personnel were provided with location information on GPS receivers and on field inventory maps of the APE for each action alternative. They were also provided with information on potential resources noted but not formally recorded through prior cultural resource studies and through information obtained from historic period map research. If a resource could not be located, field personnel examined nearby locations based on the resource description and using maps from the original records. For those previously recorded cultural resources that were relocated, field personnel noted the condition of the resource, documented any materials not previously observed, created new sketch and location maps as necessary, and updated other pertinent information on Department of Parks and Recreation (DPR) Forms 523.

When a cultural resource was newly discovered during inventory survey, personnel conducted a careful inspection of the vicinity, assigned the resource a temporary number, plotted its location using a GPS receiver and topographic maps, and documented its nature and extents. All resources were fully documented at the time of their discovery. Modern, structures, objects, or materials were only recorded if they represented a modification, intrusion, or disturbance to a prehistoric or historic period cultural resource. Resources that were indistinguishable as historic period or modern were fully recorded by field personnel and subject to further investigation through archival research. For instance, several road alignments were not immediately distinguishable as historic period travel routes but were documented in the field and examined using historic period topographic maps and aerial photographs.

Generally, recording efforts were limited to the APE for a given action alternative. There were several instances, however, in which cultural resources, particularly linear features, extended beyond the APE or encompassed areas not accessible to pedestrian survey (e.g., inundated areas, areas of extreme slope, etc.). In the case of certain road alignments (e.g., CA-MER-519H), accessible segments were recorded in the field but also were documented digitally with the aid of georeferenced true color orthophotographs. Given its great size and scale, similar methods were used to record the Basalt Hill Quarry (CA-MER-509H).

5.2 Vegetation, Terrain and Other Access Limitations

The Lower San Felipe Intake Alternative APE and the San Luis Reservoir Expansion Alternative APE fall almost entirely within the San Luis Reservoir State Park and are largely undeveloped except for roads and facilities associated with the maintenance of the B.F. Sisk Dam and San Luis Reservoir. The vast majority of the San Luis Reservoir vicinity is covered with dense, knee-high to waist-high grasses that severely limit (5%) visibility away from the shoreline. Relatively few woodland areas are present, and are limited mostly to riparian corridors bordering existing drainages. Wave action and lake currents have eroded a series of step-like benches parallel with the active reservoir shoreline. This has limited vegetation growth along the shoreline, which does offer better (25-50%) average ground surface visibility. Wave action has likely eroded, displaced, or buried many cultural materials that were present along the active shoreline, particularly those exposed to the prevalent northeast-southeast winds, which can average 25 miles per hour in the month of May (Windfinder.com). The terrain in the eastern portion of the reservoir area, particularly near the O'Neill Forebay, is generally flat and open with a gentle (1-2°) north-facing or east-facing slope. In contrast, the southern reservoir shoreline and the Basalt Hill area are dissected rolling foothills and narrow valleys and canyons with slopes that exceed 30° in some areas.

Counter to the San Luis Reservoir vicinity, the Combination Alternative APE was dominated by areas of urban infrastructural and private residential development. Few areas of native vegetation remained extant, but mostly occurred along riparian corridors (e.g., Mossdale #1 and #2 and pipeline area). Most proposed well locations and pipeline alignments followed existing utility routes or were located proximate to them and lay beneath paved areas (e.g., asphalt roads, concrete lined curbs, gravel lots) or modern landscaping (e.g., parks or recreational lands, residential landscaping).

Certain areas within APE for the Combination Alternative and the San Luis Reservoir Expansion Alternative could not be examined due to a lack of access permissions. The northernmost portion of the San Luis Reservoir Expansion Alternative APE was one such area. The reservoir shoreline encompassing Cottonwood Bay just north of SR 152 could not be safely accessed from the highway, nor could it be accessed from private roads without landowner permissions that were unavailable during the 2016 inventory survey. Limited portions of the Combination Alternative APE also lay on private property (e.g., single-family residences, an apartment complex) and could not be examined fully. In general, however, access permissions presented little barrier to the inventory surveys conducted in 2012 and 2016.

5.3 Cultural Resource Documentation

All cultural resources encountered during field inventory were documented on DPR Forms 523 and on supplemental records in keeping with procedures identified in the *Instructions for Recording Historical Resources* (California Office of Historic Preservation 1995). At a minimum, resource documentation was completed on DPR Form 523(a) (a Primary form) and DPR Form 523(j) (a 1:24,000-scale map depicting the cultural resource location). Sites were defined as three or more artifacts discovered within 30 meters of each other. Isolated finds were defined as a single artifact, two artifacts located less than 30 meters apart, or as isolated discrete features within the landscape (e.g., a historic period well head or trough or a prehistoric lithic flake and tested cobble).

Isolated finds were recorded via GPS receiver, photographed, and briefly described. Prehistoric sites and historic period resources were recorded via GPS receiver, photographed, described, documented on a sketch map drawn to an appropriate scale, and supplemented with additional forms as necessary. Sketch maps were prepared that depicted the resource boundary, its constituent elements, and its relationship to other resources or natural features in the vicinity. As appropriate, some cultural resource sketch maps were rendered against true color orthophotographs to depict the surrounding environment more clearly and to provide a better sense of scale (e.g., the Basalt Hill Quarry/CA-MER-509H). Datum locations, chosen for durability and the potential to remain unaffected by future impacts, were marked temporarily and recorded via GPS receiver. These receivers were used to record location and attribute data; they were downloaded and corrected using GPS Pathfinder Office software and converted to GIS coverages for use with ESRI ArcGIS software. All sites were photographed to capture their landscape setting, internal features, and diagnostic artifacts; all photographs were logged using image numbers that included information on photograph orientation, content, and date.

In addition to the standard DPR Forms 523, additional data sheets were included as necessary to document each cultural resource. Diagnostic and unusual, rare, or unique artifacts were assigned artifact numbers and recorded via GPS receivers and on site sketch maps. The potential for buried cultural deposits was noted through inspection of natural or artificial exposures of soil stratigraphy (e.g., vertical soil exposures, areas of bioturbation, etc.). Daily field notes documenting inventory efforts were kept on standardized forms and archived at the Berkeley office of Pacific Legacy. DPR Forms 523 were regularly checked for completeness and consistency during inventory survey. Copies of new and updated records for cultural resources recorded in 2012 and 2016 were submitted to the CCIC and received permanent designations through the CHRIS (*see* Section 4.1), and these permanent number assignments have been used throughout this document.

Chapter 6
Inventory Survey Results

6.1 Lower San Felipe Intake Alternative

6.1.1 Inventory Survey Coverage

Pacific Legacy personnel conducted an inventory survey of the Lower San Felipe Intake Alternative APE over the course of 12 days beginning on November 13, 2012 and ending December 6, 2012. All accessible areas within the 2,097.5-acre APE were examined using a survey interval of no more than 12-15 meters, and all previously recorded and newly identified cultural resources were documented as they were encountered. The alternative circumscribes six main potential impact areas: an aeration facility, the Basalt Point use area, Dinosaur Point, Dinosaur Point Road, an intake area, and Gate Shaft Island. Conditions and findings for each area are presented below. Very steep portions of the APE were not surveyed due to safety concerns. Approximately 510 acres within the Dinosaur Point area were surveyed; 320 acres within the Basalt Point use area were examined; and roughly 21 acres on Gate Shaft Island were inventoried (*see* Table 6-1). Almost all of the dredging area was inundated at the time of survey, and only 2 acres within the 972-acre area were accessible. Much of the aeration facility was very steep or was paved, so less than 1 acre of the 13-acre area was surveyed.

Table 6-1. Lower San Felipe Intake Alternative Inventory Survey Coverage.

Potential Impact Area	Area Surveyed (Full Coverage)	Area Unsurveyed (Terrain/Access)	Total Area
Aeration Facility	1	12	13
Basalt Point Use Area	320	102	422
Dinosaur Point	510	110	620
Dinosaur Point Road	31.5	7	38.5
Intake Area	2	972	974
Gate Shaft Island	21	9	30
Total	855.5	1,212	2,097.5

6.1.2 Inventory Survey Results

Twenty-four cultural resources were encountered during the inventory survey of the Lower San Felipe Intake Alternative APE (*see* Table 6-2). Six previously recorded districts, archaeological sites, or built environment resources were relocated. Records for three of those resources (CA-MER-26, CA-MER-94, and

CA-MER-477H) were updated. No new documentation was generated for the remaining three resources; two represent arbitrarily defined district boundaries (P-24-000489 and P-24-001856) while the third consists of a commemorative plaque (P-24-000643, CHL-829). One resource was previously recorded as a prehistoric site with two milling stations (CA-MER-437), but was found to be non-cultural and was documented accordingly. Twelve archaeological sites or built environment resources (CA-MER-484H, CA-MER-485H, CA-MER-486H, CA-MER-487H, CA-MER-488H, CA-MER-489H, CA-MER-490H, CA-MER-491H, CA-MER-492H, CA-MER-493H, CA-MER-494H, and CA-MER-495H) were newly identified within the Lower San Felipe Intake Alternative APE in addition to six isolated finds (P-24-001973, P-24-001981, P-24-001982, P-24-001983, P-24-001990, and P-24-001991).

Table

6-2. Previously Recorded and Newly Identified Cultural Resources within the Lower San Felipe Intake Alternative APE.

Resource Designation	Description	Author	Date	APE Location
Previously Recorded Cultural Resources				
CA-MER-26/H P-24-000127 (updated)	Multi-component site featuring a prehistoric midden with lithic scatters and a historic period earthen dam with stock pond	Ledebuhr et al.	2012	Dinosaur Point
CA-MER-94 P-24-000194 (updated)	Prehistoric midden and lithic scatter	Elliott and Atwater et al.	2012	Dinosaur Point
CA-MER-477H[1] P-24-001822 (updated)	Fourteen historic period road segments	Elliott, Ledebuhr, Fittinghoff, Atwater	2012c	Dinosaur Point; Dinosaur Point Road
P-24-000489[1] (not updated) Listed in the NRHP/ CRHR	San Luis Gonzaga Archaeological District comprised of five prehistoric midden sites (CA-MER-107, CA-MER-126 CA-MER-130, CA-MER-134, and CA-MER-135)	Olsen	1970	Dinosaur Point; Dinosaur Point Road
P-24-000643 CHL-829 (not updated) Listed in the CRHR	California State Historical Landmark plaque commemorating Moraga's 1805 exploration of Pacheco Pass	Arbuckle	1979	Aeration Facility
P-24-001856 (not updated)	San Luis Gonzaga Rancho-Paula (Pacheco) Fatjo Ranch Historic District	Bissonnette		oad

Resource Designation	Description	Author	Date	APE Location
Newly Discovered Archaeological Sites or Built Environment Resources				
CA-MER-484H[1] P-24-001974 PL-SLLP-A-001	Historic period transmission poles and debris scatter	Trout and Atwater et al.	2012a	Dinosaur Point
CA-MER-485H P-24-001975 PL-SLLP-A-003	Historic period debris scatter	Elliott and Fittinghoff et al.	2012a	Dinosaur Point
CA-MER-486H P-24-001976 PL-SLLP-A-004	Historic period earthworks dam	Elliott and Fittinghoff et al.	2012b	Dinosaur Point
CA-MER-487H P-24-001977 PL-SLLP-A-005	Historic period road segment	Trout, Elliott, Atwater et al.	2012	Dinosaur Point
CA-MER-488H P-24-001978 PL-SLLP-A-009	Historic period road segment	Trout and Atwater et al.	2012b	Dinosaur Point
CA-MER-489H[1] P-24-001979 PL-SLLP-A-013	Historic period road segment	Elliott and Trout et al.	2012	Dinosaur Point
CA-MER-490H P-24-001980 PL-SLLP-A-019	Historic period debris concentration	Elliott and Fittinghoff et al.	2012c	Dinosaur Point Road
CA-MER-491H[1] P-24-001985 PL-SLLP-A-010	Historic period road segment	Trout and Atwater et al.	2012c	Basalt Point Use Area
CA-MER-492H[1] P-24-001986 PL-SLLP-A-011	Historic period industrial site used in construction of the B.F. Sisk Dam	Elliott, Ledebuhr, Fittingoff, Atwater	2012a	Basalt Point Use Area
CA-MER-493H[1] P-24-001987 PL-SLLP-A-014	Historic period road segment	Elliott, Ledebuhr, Atwater, Fittingoff	2012a	Basalt Point Use Area
CA-MER-494H[1] P-24-001988 PL-SLLP-A-015	Historic period road segment	Elliott, Ledebuhr, Fittingoff, Atwater	2012b	Basalt Point Use Area
CA-MER-495H[1] P-24-001989 PL-SLLP-A-016	Historic period road segment	Elliott, Ledebuhr, Atwater, Fittinghoff	2012b	Basalt Point Use Area
Newly Discovered Isolated Finds				
P-24-001973 PL-SLLP-B-ISO-001	Isolated historic period bottle base	Elliott and Fittingoff	2012	Dinosaur Point Road
P-24-001981 PL-SLLP-A-ISO-002	Isolated historic period bronze statue remnant	Trout and Atwater et al.	2012d	Dinosaur Point
P-24-001982 PL-SLLP-A-ISO-003	Isolated historic period vehicle remnants	Trout, Elliott, Ledebuhr et al.	2012	Dinosaur Point
P-24-001983 PL-SLLP-A-ISO-008	Decorative fencing used as bridge	Elliott and Trout	2012	Dinosaur Point
P-24-001990[1] PL-SLLP-A-ISO-010	Isolated prehistoric utilized core	Elliott, Ledebuhr, Atwater, Fittinghoff	2012c	Basalt Point Use Area

Resource Designation	Description	Author	Date	APE Location
P-24-001991[1] PL-SLLP-A-ISO-011	Isolated prehistoric biface fragment	Elliott, Ledebuhr, Atwater, Fittinghoff	2012d	Basalt Point Use Area

Note: Author and Date reflect most recent recording
[1] Resource also occurs within the San Luis Reservoir Expansion Alternative APE

One resource was found within the aeration facility, seven within the Basalt Point use area, 11 within the Dinosaur Point area, two within the Dinosaur Point Road area, and three within both the Dinosaur Point and Dinosaur Point Road areas. All are depicted in Figures B-1a through B-1d of Appendix B. Four previously recorded cultural resources that were believed to intersect the APE could not be relocated during the 2012 inventory survey (*see* Table 6-3).

Table 6-3. Previously Recorded Cultural Resources Not Relocated during Inventory Survey of the Lower San Felipe Intake Alternative APE.

Resource Designation	Description	Author	Date	APE Location
Archaeological Sites or Built Environment Resources				
CA-MER-8 P-24-000109	Prehistoric lithic scatter with one handstone	Treganza	1960	Intake Area
CA-MER-17 P-24-000118	Prehistoric house-pits and midden deposit	Olsen	1963	Basalt Point Use Area
CA-MER-27 P-24-000128	Prehistoric midden deposit with flaked stone and groundstone	Olsen	1965b	Dinosaur Point
P-24-001818	Historic period linear feature comprising a 2.5-mile long fence	Whatford	1996b	Dinosaur Point Road

Note: Author and Date reflect when resource was last located

Aeration Facility

The aeration facility comprises 13 acres that are dominated by a graded hilltop and steep hillslope (*see* Appendix B, Figure B-1b). The hilltop features a parking lot and visitor center, which is situated next to CHL-829 (P-24-000643), a plaque commemorating Gabriel Moraga's 1805 exploration of Pacheco Pass. Because much of the aeration facility was subsumed by modern disturbance or slopes exceeding 40º, less than 1 acre was subject to inventory survey.

Basalt Point Use Area

The Basalt Point use area encompasses 422 acres along Basalt Road beginning just east of Willow Point and proceeding west to the Basalt Point boat ramp and reservoir shoreline (*see* Appendix B, Figure B-1d). It includes roughly 25 acres that were inundated during the 2012 inventory survey as well as 42 acres that are typically inundated but were exposed. Surface visibility within that 42-acre area was very high (90-100%), as it featured little vegetation; visibility

throughout the remainder of the Basalt Point use area was poor (10-20%) due to dense non-native grasses that covered the flat valleys and low hills of the inland areas. Areas featuring slopes in excess of 30º were not subject to survey for safety reasons, and areas along the northwestern shoreline that had eroded away to bedrock also were omitted. A total of 320 acres were subject to inventory survey within the Basalt Point use area.

During inventory survey, five historic period resources were newly identified and two prehistoric isolated finds were discovered. One site (CA-MER-437) previously recorded as a prehistoric bedrock milling location was determined to be non-cultural in 2012. CA-MER-17, another previously known site within the Basalt Point use area, could not be relocated as its position was inundated at the time of inventory survey. The five newly discovered resources included four historic period road segments (CA-MER-491H, CA-MER-493H, CA-MER-494H, and CA-MER-495H) and one historic period industrial site (CA-MER-492H). Two of the road segments (CA-MER-494H and CA-MER-495H) were large and well constructed; both included substantial hill cuts and earthen causeways. The largest site discovered within the Basalt Point use area was CA-MER-492H, a historic period industrial resource that marked the receiving end of a riprap separation plant or production facility. It lies at the base of a long grade that once featured a conveyor belt that transported rock from the Basalt Hill Quarry (CA-MER-509H) downslope to CA-MER-492H for transport and construction of the B.F. Sisk Dam. The two isolated prehistoric artifacts (P-24-001990 and P-24-001991) were discovered along a historic period road segment (CA-MER-493H) and were likely not *in situ*.

Dinosaur Point

The Dinosaur Point area consists of 620 acres to the north and south of the eastern end of Dinosaur Point Road and encompasses the existing Pacheco Pumping Plant (*see* Appendix B, Figure B-1a). It includes approximately 20 acres that were inundated at the time of the 2012 inventory survey; it also includes 80 acres that are typically inundated but were exposed during the 2012 inventory survey due to low water levels. Surface visibility within that 80-acre area was very high (90-100%), though visibility throughout the remainder of the Dinosaur Point area was generally poor (10-20%) due to dense ground cover. Exposed portions of the Dinosaur Point area included one major valley, several smaller valleys, and a number of ridges and steep drainages covered in low grasses, oak woodlands, and patches of sparse chaparral. Areas featuring slopes in excess of 30º were not subject to inventory survey for safety reasons. Approximately 510 acres were surveyed within the Dinosaur Point area; roughly 205 of those acres lay to the north of Dinosaur Point Road, while 305 acres lay to the south.

Two previously known sites were relocated within the Dinosaur Point area, including a prehistoric village site (CA-MER-94) and a prehistoric midden site with a lithic scatters that was also found to contain a historic period earthen dam and impound pond (CA-MER-26/H). The location of a third previously known

site, a prehistoric midden deposit (CA-MER-27), was found to be covered by imported fill material, likely associated with the Pacheco Pumping Plant. Its location could not be confirmed. A historic period road (CA_MER-477H) that had been recorded outside of the Dinosaur Point area was found to intersect it. The resource represents portions of three different historic period road alignments, including the 1920s-era and 1940s-era alignments of SR 152. The San Luis Gonzaga Archaeological District (P-24-000489) and the San Luis Gonzaga Rancho Historic District (P-24-001856) also intersected the Dinosaur Point area but were not re-recorded in 2012.

Six newly discovered historic period sites or built environment resources were documented during the inventory survey, including a historic period utility pole alignment (CA-MER-484H), a historic period debris concentration (CA-MER-485H), an earthworks dam (CA-MER-486H), and three historic period road alignments (CA-MER-487H, CA-MER-488H, and CA-MER-489H). Three historic period isolated finds (P-24-001981, P-24-001982, and P-24-001983) also were discovered (*see* Table 6-2).

Dinosaur Point Road

Dinosaur Point Road consists of a 3.28-mile long paved road segment that stretches between SR 152 and the San Luis Reservoir; approximately 0.77 miles of the road intersect the Dinosaur Point area (*see* Appendix B, Figure B-1a). Dinosaur Point Road follows the north side of a ridgeline; it is cut into the hill slope in several areas and is significantly built up in others. A 15-meter wide buffer was surveyed on either side of the road, however due to the nature of the terrain two 0.5-mile long segments could not be accessed along the north side of the road and two 0.6-mile long segments could not be accessed along the south side of the road. Thus, approximately 7 acres of the 38.5-acre Dinosaur Point Road corridor were not subject to inventory survey. Due to ground cover that was dominated by non-native grasses, surface visibility was generally poor (15-30%).

The route followed by the modern Dinosaur Point Road has been used to cross the Diablo Range through Pacheco Pass for more than a century. It was the route of the Pacheco Pass Stage Road, which was part of the Andrew Firebaugh Toll Road and the Butterfield Overland Mail route. Prior to the construction of SR 152 in 1923, this stage road was the only one that crossed Pacheco Pass. In the early 1940s, the highway was rebuilt and re-graded. Portions of these roads were previously recorded (CA_MER-477H) and were relocated during the 2012 inventory survey; additional segments were recorded and added to an updated resource record. Eight concrete posts used by the California Highway Commission to mark highway right-of-way (ROW) between 1914 and 1934 also were located and added to the record for CA-MER-477H. In addition to previously known resource CA-MER-477H, one newly discovered site (CA-MER-490H) was documented during the inventory survey of Dinosaur Point Road: a historic period debris scatter of cans, glass, and ceramics that was deposited between a historic period roadbed and Dinosaur Point Road in an area

of light chaparral. An isolated historic period bottle base (P-24-001973) also was found. A previously recorded historic period fenceline (P-24-001818) believed to intersect the Dinosaur Point Road area was found to lie outside the Lower San Felipe Intake Alternative APE and so was not re-recorded. Resource records for the San Luis Gonzaga Archaeological District (P-24-000489) and the San Luis Gonzaga Rancho Historic District (P-24-001856) were not updated.

Intake or Dredging Area

The intake or dredging area encompasses approximately 974 acres surrounding the proposed tunnel or pipeline intake segments; it lies within the north-central portion of San Luis Reservoir and is typically inundated year-round. Approximately 2 acres of the intake area are located along the eastern edge of Gate Shaft Island (*see* Appendix B, Figures B-1a and B-1b). Those areas remained accessible and were subject to inventory survey in 2012, though the remaining 972 acres were fully inundated and remained inaccessible.

No cultural resources were identified within the intake or dredging area, though one resource (CA-MER-8) is believed to intersect it. That resource was discovered during a 1960 reconnaissance survey conducted in advance of construction for the B.F. Sisk Dam. Although it was never formally recorded and does not appear on basemaps maintained by the CCIC, CA-MER-8 was depicted in an early reconnaissance report and was described as a lithic scatter with one handstone (Treganza 1960: 6). The location of CA-MER-8 could not be confirmed, as it was fully inundated during the 2012 inventory survey and is likely to remain so during construction of the Lower San Felipe Intake Alternative.

Gate Shaft Island

The Gate Shaft Island area consists of 30 acres centered on Gate Shaft Island, which is located within the San Luis Reservoir approximately 1 mile southeast of SR 152 (*see* Appendix B, Figure B-1a). During the 2012 inventory survey, the island was pedestrian-accessible due to low water levels. Surface visibility was very good (60-70%), though much of the soil below the typical waterline had eroded to bedrock. Approximately 9 acres within the Gate Shaft Island area remained inundated and could not be surveyed, but the remaining 21 acres were examined. No cultural resources were identified.

6.2. Combination Alternative

6.2.1. Survey Coverage

All accessible areas within public or SCVWD ROW were examined within the Combination Alternative APE on September 25, 2012 by Pacific Legacy personnel. As originally proposed, the APE encompassed a 100-foot radius surrounding 21 groundwater production wells, 18 associated pipeline segments, and one recharge pond. Subsequent to archival and records searches and the

inventory survey, 12 groundwater production wells and their associated pipeline segments were removed from consideration due to changes in engineering. The final Combination Alternative APE included just eight groundwater production wells, three pipeline segments, and one recharge pond spanning seven discontinuous areas. Two proposed well sites (Campbell and San Thomas) were not surveyed as no ground disturbance was anticipated at either location. The proposed Saratoga Avenue area (3.66 acres) was not surveyed as landowner permissions to access the property could not be obtained. Approximately 107.9 acres were subject to inventory or reconnaissance survey, including 23.4 acres that remained part of the final APE and 85.2 acres that were subsequently excluded (*see* Table 6-4).

6.2.2 Survey Results

No previously recorded or newly identified cultural resources were encountered within the Combination Alternative APE during the 2012 inventory survey. One historic period archaeological site (CA-SCL-799H) was documented within the APE along West Hedding Street and excavated in 1996 during the replacement and extension of the Hedding Street Bridge. That resource was recorded as a surface debris scatter (ca. 1880s-1930s) with a subsurface component observed at a depth of 2 meters below the ground surface and centered within the Hedding Street ROW. The site was severely impacted by flood control modifications, utility trenching, and grading activities (Morgan et al. 1996). No surface manifestations of the site were noted in 2012, however it was anticipated that ground disturbing activities associated with well piping within the vicinity of Hedding #1 and Hedding #2 could result in the discovery of subsurface materials associated with the resource. CA-SCL-799H has not been evaluated for listing in the NRHP or the CRHR.

Ground surface visibility throughout much (70%) of the Combination Alternative APE was poor (20-30%), as many of the proposed well sites and pipelines were covered by paved roads, curbs, landscaping, or other infrastructural development. Areas that remained undeveloped, such as those surrounding proposed groundwater wells Viceroy #1 and Viceroy #2 in Penitencia Creek County Park; North King northwest of North King Road; Julian, Old Julian, and St. John near the Guadalupe River Trail; and Oak Canyon #1A, Oak Canyon #1B, and Captancillos north of Captancillos Drive and Oak Canyon Place, were generally dominated by dense vegetation or ground cover and offered similarly limited (30-40%) ground surface visibility. Unless otherwise stated, all areas within the final and abandoned portions of the Combination Alternative APE were subject to archival and records searches and to inventory survey.

Table 6-4. Combination Alternative Inventory Survey Coverage.

Potential Impact Area[1]	Area Surveyed (Full Coverage)	Area Unsurveyed (Terrain/Access)	Total Area
Potential Impact Area (2017)			
Mossdale #1 (with pipeline)	11	0	11
North King	0.7	0	0.7
Hedding #1 and #2 (with pipeline)	9.6	0	9.6
Julian	0.7	0	0.7
Old Julian #1 and #2	0.7	0	0.7
St. John	0.7	0	0.7
Campbell	0	0.7	0.7
San Thomas	0	0.7	0.7
Saratoga Avenue	0	3.7	3.7
Subtotal	*23.4*	*5.1*	*28.5*
Areas Removed from the Project (2012)			
Noble (with pipeline)	6.35	0	6.35
Viceroy #1 and #2 (with pipeline)	10.7	0	10.7
Mossdale #2 (with pipeline) (falls within Mossdale #1 and pipeline area)	0	0	0
Winchester #1 and Winchester #2 (with pipeline)	2.7	0	2.7
MC, Oak Canyon #1A, Oak Canyon #1B, and Winfield (with pipeline)	60.8	0	60.8
AC (with pipeline)	1.4	0	1.4
Captancillos	2.5	0	2.5

Potential Impact Area[1]	Area Surveyed (Full Coverage)	Area Unsurveyed (Terrain/Access)	Total Area
Subtotal	*85.2*	*0*	*85.2*
Total	107.9	5.1	113

[1] Note that the 100-foot APE buffer areas for some locations overlapped/were continuous and are lumped for area calculations

The Final Combination Alternative APE

The final Combination Alternative APE included the following areas and proposed groundwater wells (*see* Appendix B, Figures B-2a through B-2e): North Jackson Avenue from south of Berryessa Road to north of Mossdale Way to west of Toiyabe Way (Mossdale #1); northwest of North King Road and southeast of Commodore Drive (North King); West Hedding Street southwest of Guadalupe Parkway and southeast along Spring Street (Hedding #1 and Hedding #2); near the Guadalupe River Trail north of West Julian Street (Julian) and north (Old Julian) and south of West St John Street (St. John); east of the San Tomas Expressway and south of Latimar Circle (Campbell); east of the San Tomas Expressway and north of Sobrante Drive (San Thomas); and west of Saratoga (Saratoga Avenue). The conditions within each area at the time of the 2012 inventory survey are described below.

Mossdale #1

The Mossdale #1 Well Site lay in an open area bounded by North Jackson Avenue to the west and Mossdale Way to the south and east (*see* Appendix B, Figure B-2a). The well site was sited just east of a small drainage. Two pieces of rusted farm equipment were noted just north of the 100-foot APE buffer, which was fully examined. Ground visibility was poor (20%), with much of the area covered by trees and duff.

North King

The North King Well Site lay within a small open area in a drainage between two large housing developments bounded by North King Road to the west (*see* Appendix B, Figure B-2a). Portions of the 100-foot APE buffer encompassed a modern housing development. The open area was very disturbed, with a raised berm along the northern portion of the survey area. Ground visibility was good (60-80%), and the area was moderately (50%) exposed.

Hedding #1

The Hedding #1 Well Site lay in a park-like setting just north of an employment office and southeast of the San Jose Airport (*see* Appendix B, Figure B-2b). It was bounded by West Hedding Street to the southeast, Ruff Drive to the southwest, Interstate 880 to the northwest, and SR 87 to the northeast. Surface visibility was poor (0-10%), with much of the area obscured by tall grasses. A portion of the survey area was subsumed by an office complex, while another portion of the survey area crossed the Guadalupe River Trail. That area was mostly (70%) exposed and sloped gently (0-3º) to the east.

Hedding #2

The Hedding #2 Well Site is located southeast of the San Jose Airport (*see* Appendix B, Figure B-2b). It is bounded by West Hedding Street to the northwest, Ruff Drive to the southwest, Interstate 880 to the northwest, and SR 87 to the northeast. Surface visibility was poor (0-20%) as much of the area was obscured by tall grasses. A portion of the area was subsumed by an office complex while another portion encompassed a segment of the Guadalupe River Trail. As with the Hedding #1 Well Site, much (75%) of the area was exposed and sloped gently (0-3º) to the east.

Old Julian

The Old Julian Well Site lay in an open area bounded by a railroad to the north, the Guadalupe River to the East, West Julian Street to the south, and a large commercial shopping complex to the west (*see* Appendix B, Figure B-2b). Roughly 33% of the area was covered by pavement and was heavily developed. The rest of the area was characterized by a riparian zone along the Guadalupe River Trail, which sloped gently (3º) to the east. Ground surface visibility was generally good (50-80%) and much (85%) of the area was exposed.

Julian

The Julian Well Site was located in a gated area in an empty lot (*see* Appendix B, Figure B-2b). It was bounded by West Julian Street to the north, North Almaden Boulevard to the east, and West Saint John Street to the south. Part of the 100-foot APE buffer area had been developed, but the western half of the area lay within a public park. The proposed well location was found to be heavily disturbed, subsumed by modern debris, and located near a modern, broken concrete foundation.

St. John

The St. John Well Site lay within a park bounded by West St. John Street to the north, SR 87 to the east, West Santa Clara Street to the south, and the Guadalupe River to the west (*see* Appendix B, Figure B-2b). Most of the area had been developed or landscaped with a grass field, trails, and tennis courts. The area was almost fully exposed (95%), offered poor ground surface visibility (0-15%), and sloped generally (0-3º) towards the west.

Campbell

The Campbell Well site comprised an existing SCVWD facility bounded by San Tomas Expressway to the west, Latimar Circle to the north, Llewllyn Avenue to the east, and West Campbell to the south *(see* Appendix B, Figure B-2d). The area was not surveyed as no ground disturbing activities were proposed at the well location; instead, the existing facility was simply scheduled for reactivation.

San Thomas

The San Thomas Well site comprised an existing SCVWD facility bounded by San Tomas Expressway to the east, a concrete-lined drainage to the west, and

Sobrante Drive to the south (*see* Appendix B, Figure B-2d). The area was not surveyed as no ground disturbing activities were proposed at the well location; instead, the existing facility was to have been reactivated.

Saratoga Avenue

The Saratoga Avenue Recharge Area was located on privately owned land bounded by Saratoga Avenue to the east and Vineyard Lane to the southwest (*see* Appendix B, Figure B-2c). The recharge area was not examined, as permission to access the parcel could not be obtained from the landowner at the time of the 2012 inventory survey.

Abandoned Locations within the Combination Alternative

Several proposed groundwater wells and pipeline segments were abandoned after the 2012 inventory survey was completed, including Grossmont Drive to south of Noble Avenue (Noble); Summerdale Drive to south of Penitencia Creek Road north of Stonecrest Way (Viceroy #1 and Viceroy #2); west of Toiyabe Way (Mossdale #2); north of SR 85, east of Winchester Boulevard, and west of the Los Gatos Creek Trail (Winchester #1 and Winchester #2); Coleman Road from Oak Canyon Place to Winfield Boulevard turning north on Winfield Blvd between Coleman Road the Guadalupe Park Trail (MC, Oak Canyon #1A, Oak Canyon #1B, and Winfield); north of Oak Canyon Place and west of Coleman Road (AC); and north of Captancillos Drive and south of Guadalupe Creek Trail (Captancillos). No cultural resources were encountered in any of these areas, which are described below.

Noble

The Noble Well Site was located approximately 0.5 miles northeast of the proposed Viceroy #1 well pad. It lay within an open area with two ponds bounded by Noble Avenue to the north and east, Penitencia Creek Road to the south, and Mira Vista Circle to the west (*see* Appendix B, Figure B-2a). The area had been graded but featured patches of dense, dry grasses. Ground surface visibility was generally good (80-100%) but limited (0-20%) by vegetation in certain areas. The well site is fully exposed and slopes gently (<2º) to the south.

Viceroy #1

The Viceroy #1 Well Site lay in an open area bounded by Penitencia Creek Road to the north, Stonecrest Way to the south and east, and Viceroy Way to the west (*see* Appendix B, Figure B-2a). The entire survey area was found to be disturbed when it was examined in 2012. There was a man-made berm running parallel to Stonecrest Way, and ground surface visibility was very limited (0-20%).

Viceroy #2

The Viceroy #2 Well Site was in an open area bounded by Penitencia Creek Road to the north, Stonecrest Way to the south, and Viceroy Way to the east (*see* Appendix B, Figure B-2a). This well site lay within the northeast corner of Penitencia Creek County Park, and the entire 100-foot APE buffer appeared to

have been disturbed. There was a man-made berm running parallel to Stonecrest Way, and ground surface visibility was very limited (0-20%).

Mossdale #2

The Mossdale #2 Well Site is in an open area bounded by North Jackson Avenue to the west and Mossdale Way to the south and east (*see* Appendix B, Figure B-2a). The well site lies just east of a small drainage. The area offers poor (20%) ground surface visibility, as much of the area is covered by trees and leaf liter. The well site slopes gently to the northwest.

Winchester #1

The Winchester #1 Well Site was in an open, disturbed area bounded by Winchester Boulevard to the west, Winchester Circle to the north, and SR 85 to the south (*see* Appendix B, Figure B-2d). The well site lay within a graded lot covered by gravels. Surface visibility was extremely poor (0-10%). The area was almost fully exposed (95%) and sloped gently (<2º) to the north.

Winchester #2

The Winchester #2 Well Site was in an open, disturbed area bounded by Winchester Boulevard to the west, Winchester Circle to the north, and SR 85 to the south (*see* Appendix B, Figure B-2d). The well site lay in a graded lot covered by gravels that offered extremely poor (0-10%) ground surface visibility. The area was almost fully exposed (95%) and sloped gently (<2º) to the north.

Winfield

The Winfield Well Site lay within a developed area bounded by Winfield Way to the east, an unnamed road to the south, and Lake Almaden to the west (*see* Appendix B, Figure B-2e). The area had been developed with a shopping center, apartment complexes, and roads. Ground surface visibility was extremely limited (0-10%). The area was largely exposed (90%) and sloped gently (<2º) to the west.

AC

The AC Well Site was bounded by Lake Almaden to the north and Coleman Road to the south (*see* Appendix B, Figure B-2e). A large apartment complex was located immediately east of the well site. The area outside of the apartment complex and north of Coleman Road was open and flat but obscured by low, dry grasses that offered poor to fair (20-30%) ground surface visibility. The area was mostly (90%) exposed and sloped gently (<2º) to the north. Modern debris was noted throughout the area.

MC

The MC Well Site lay within an open area bounded by Guadalupe Creek to the north, Coleman Avenue to the south, and Meridian Avenue to the west (*see* Appendix B, Figure B-2e). The well site was in a fenced area with low, dry

grasses that limited (20-30%) ground surface visibility. The ground surface sloped gently (2º) to the north and was mostly exposed (90%).

Oak Canyon #1A

The Oak Canyon #1A Well Site is in a large open area underneath power lines that is bounded by Coleman Avenue to the east and Guadalupe Creek to the north (*see* Appendix B, Figure B-2e). The well site was fully exposed but subsumed by tall grasses that severely limited (0-10%) ground surface visibility. The surrounding area sloped slightly (1-2º) to the north.

Oak Canyon #1B

The Oak Canyon #1B Well Site lay within an open area bounded by Coleman Avenue to the east and Guadalupe Creek to the north (*see* Appendix B, Figure B-2e). The well site was positioned beneath a series of power lines but was fully exposed. The area featured a slight (1-2º) northern aspect and was covered by tall grasses that almost fully obscured (0-10%) ground surface visibility.

Captancillos

The Captancillos Well Site was in a large open area underneath power lines that was bounded by Coleman Avenue to the south and Guadalupe Creek to the north (*see* Appendix B, Figure B-2e). The area was subsumed by tall grasses that severely limited (10%) ground surface visibility. The site had been previously disturbed by the construction of underground utilities.

6.3 Treatment Alternative

6.3.1 Inventory Survey Coverage

In 2002, Archaeological Resource Management undertook a cultural resources study for the Santa Teresa, Rinconada, and Penitencia WTPs in advance of SCVWD improvement projects at each facility (Cartier 2002). The study was conducted to comply with NEPA and CEQA requirements and included the inventory survey of all accessible areas within the three WTPs. Survey boundaries were defined by existing fence lines surrounding each property, which fully enveloped the current 11.8-acre Treatment Alternative APE. Although each WTP was dominated by existing plant facilities, particular attention was paid to areas of exposed soils (e.g., rodent burrows, inclines, or earthen banks) that might reveal cultural materials. The study's author noted that full coverage survey was achieved for all "open land surfaces" (Cartier 2002: 7) (*see* Table 6-5 and Appendix B, Figures B-3a and B-3b). No prehistoric or historic period cultural materials were observed. Because the 2002 inventory survey encompassed the Santa Teresa and Rinconada WTPs in their entirety and used methods comparable to those used by Pacific Legacy for the other action alternatives, the Treatment Alternative APE was not re-examined.

Table 6-5. Treatment Alternative Inventory Survey Coverage

Potential Impact Area	Area Surveyed (Full Coverage)	Area Unsurveyed (Terrain/Access)	Total Area
Potential Impact Area (2018)			
Santa Teresa Water Treatment Plant	11.8	0	11.8
Areas Removed from the Project (2018)			
Rinconada Water Treatment Plant	6.5	0	6.5
Total	*18.3*	*0*	*18.3*

6.3.2 Survey Results

Ground surface visibility throughout the Treatment Alternative APE was poor (20-30%), as much of the area was covered by existing infrastructure. Exposed soils, where noted, comprised medium brown silty loam with sandstone gravels and cobbles. Although chert cobbles were noted in the Rinconada WTP, they were absent at the Santa Teresa WTP. Each of the facilities examined in 2002 were found to be highly disturbed by prior development (Cartier 2002).

No previously recorded or newly identified cultural resources were encountered within the Treatment Alternative APE during the 2002 inventory survey. As noted above, the Santa Teresa WTP was built in 1989 (*see* Section 4.2). All of the infrastructural elements within the facility are less than 50 years old and thus would not typically be regarded as elements of the historic period built environment. As described in the 2002 study by Archaeological Resource Management, none of the infrastructural elements at the Santa Teresa WTP facility appeared distinctive or exceptional in construction or design.

6.4. San Luis Reservoir Expansion Alternative

6.4.1. Survey Coverage

Pacific Legacy personnel conducted an inventory survey of the San Luis Reservoir Expansion Alternative APE over the course of 34 days beginning on June 22, 2016 and ending August 11, 2016. All accessible areas within the APE were examined using a survey interval of no more than 12-15 meters, and all previously recorded and newly identified cultural resources were documented as appropriate. A portion of the reservoir shoreline and a potential construction staging area within the San Luis Reservoir Expansion Alternative APE overlapped the Dinosaur Point and Basalt Point areas within the Lower San Felipe Intake Alternative APE. Areas of overlap subject to inventory survey in 2012 generally were not revisited in 2016 unless resources were found to span both alternatives (e.g., historic period roads) and recording efforts necessitated some level of re-examination.

The Reservoir Expansion Alternative encompasses nine major potential impact areas: the Basalt Hill borrow area, Borrow Area 6, the Cottonwood Bay levee modification and levee raise areas, the Dinosaur Point boat launch modification area, downstream stability berm and fill impact areas, haul roads, a Highway 152 impact area, potential construction staging areas, and the reservoir shoreline (*see* Table 6-6). Several of these areas overlapped. For instance, the Cottonwood Bay levee modification and levee raise areas, the Dinosaur Point boat launch modification area, and Highway 152 impact area are all located along the reservoir shoreline. Similarly, the proposed haul roads overlap the Basalt Hill borrow area, Borrow Area 6, and each of the potential construction staging areas.

Cumulatively, 3,888
acres were subject to inventory survey within the Reservoir Expansion Alternative APE in 2012 or 2016. Due to safety or accessibility issues, areas of extreme terrain within the Basalt Hill borrow area, a roughly 3.4-mile long stretch of the reservoir shoreline fronting the B.F. Sisk Dam, and a 4.4-mile stretch of reservoir shoreline as it encompasses Cottonwood Bay were not examined (*see* Table 6-6). The Cottonwood Bay area could not be safely accessed from SR 152, and access permissions to the area through private property could not be obtained during the 2016 field season. Portions of the potential construction staging area west of the dam were inundated during the 2016 inventory survey and were not accessible. Most of the fill impact and stability berm areas could not be accessed as they are located along or immediately adjacent to the dam. A portion of Borrow Area 6 and a potential construction staging area were examined by Pacific Legacy personnel in 2013 as a part of the San Luis Transmission Line Project for the Western Area Power Authority (Holm et al. 2014). These areas were slated for avoidance in 2016 but were essentially re-examined as a part of larger, block survey areas.

In 2018, changes to the design and extents of the Reservoir Expansion Alternative removed approximately 251 acres from the APE and added 799 acres. Roughly 157 acres removed from the APE were subject to full coverage inventory survey in 2016. These alterations were concentrated around the Basalt Hill borrow area, potential construction staging areas, haul roads, and fill impact areas or stability berms. A recent inventory survey conducted in support of a proposed solar array east of the dam encompassed 195 acres within the expanded APE (Johnston and Brewer 2015). The study relied on methods directly comparable to those used by Pacific Legacy personnel in 2012 and 2016, and coverage totals for that effort are included as previously surveyed areas in Table 6-6. Conditions specific to each of the main potential impact areas within the San Luis Reservoir Expansion Alternative APE are discussed below, along with a summary of findings for each.

Table 6-6. San Luis Reservoir Expansion Alternative Inventory Survey Coverage

Potential Impact Area	Area Surveyed (Full Coverage)	Area Unsurveyed (Terrain/Access/ Recently Added)	Previously Surveyed	Total Area
Potential Impact Area (2018)				
Basalt Hill Borrow Area	183	309	0	492
Borrow Area 6	662	12	195	869
Expanded Embankment, Fill Impact/Stability Berm, and Haul Road Areas	38	303	0	341
Potential Construction Staging Areas	1,968	248	0	2,216
Cottonwood Bay Levee Modification and Levee Raise, Dinosaur Point Boat Launch Modification, Highway 152 Impact, and Reservoir Shoreline Areas	1,037	67	0	1,104
Total	3,888	939	195	5,022

6.4.2 Survey Results

Thirty-seven cultural resources intersect the San Luis Reservoir Expansion Alternative APE (*see* Table 6-7), including 28 newly discovered and nine previously recorded districts, archaeological sites, built environment resources, or isolated finds. Records for seven previously recorded resources were updated by Pacific Legacy personnel in 2012 or 2016. They included five prehistoric sites (CA-MER-15, CA-MER-28, CA-MER-82, CA-MER-83, and CA-MER-130), most with midden, lithics, and groundstone; one historic period water tank and trough (CA-MER-521H); and one historic period road (CA-MER-477H). Two of these resources, a prehistoric site with midden, lithics, and groundstone (CA-MER-83) and a historic period road (CA-MER-477H), were previously reported outside of the APE but were found to intersect it (*see* Tables 4-7 and 6-7). Two additional resources were noted but not re-recorded in 2012 or 2016. These included the San Luis Gonzaga Archaeological District (P-24-000489), which lacks any physical boundary distinguishable through inventory survey, and the B.F. Sisk Dam System. The B.F. Sisk Dam and two of its key features, the San Luis Reservoir and the San Luis Operation and Maintenance Center, lie within the San Luis Reservoir Expansion Alternative APE while other associated facilities (i.e., the O'Neill Dam and Forebay and the Gianelli Pumping-Generating Plant) lie outside of the APE. On behalf of Reclamation and the California Department of Water Resources, ICF International (2013) recorded and evaluated these structures in support of the B.F. Sisk Dam Corrective Action Study. JRP Historical Consulting (2018) completed an in-

depth revision to that study, which included an architectural field survey and the evaluation of the dam and its key features as elements of a historic period district.

Eleven previously recorded resources in the San Luis Reservoir Expansion Alternative APE were not relocated. Seven were prehistoric archaeological sites originally noted along the reservoir shoreline (CA-MER-20, CA-MER-21, CA-MER-22, CA-MER-23, CA-MER-27, CA-MER-29, and CA-MER-41) that may have been mis-plotted during prior recording efforts, impacted geomorphic processes, or subject to modern disturbance. One prehistoric site (CA-MER-14) lay within the dam footprint and was presumed destroyed. Two prehistoric sites (CA-MER-136 and CA-MER-137) lay along the Cottonwood Bay shoreline, which was inaccessible during the 2016 inventory survey. One historic period ranch complex (CA-MER-451H) lay within an area that was added to the San Luis Reservoir Expansion Alternative APE after the 2016 inventory survey was completed. Finally, one previously recorded archaeological site (CA-MER-437) was determined to be non-cultural by Pacific Legacy archaeologists in 2012 and 2016.

Resources newly discovered within the San Luis Reservoir Expansion Alternative APE in 2012 or 2016 included a series of historic period transmission poles with a debris scatter (CA-MER-484H); two industrial sites (CA-MER-492H and CA-MER-509H) associated with construction of the B.F. Sisk Dam; seven historic period road segments (CA-MER-489H, CA-MER-491H, CA-MER-493H, CA-MER-494H, CA-MER-495H, CA-MER-513H, and CA-MER-519H); a concrete equipment pad (CA-MER-510H); a water tank on railroad ties (CA-MER-511H); a helicopter pad (CA-MER-512H); a ditch segment (CA-MER-514H); three earthen dams with impound ponds (CA-MER-515H, CA-MER-516H, and CA-MER-518H); a prehistoric midden site with lithics and groundstone (CA-MER-517); and a series of survey markers and monitoring wells (CA-MER-520H) associated with the construction and maintenance of the B.F. Sisk Dam. Three prehistoric (P-24-001990, P-24-001991, and P-24-002168) and six historic period (P-24-002166, P-24-002167, P-24-002169, P-24-002170, P-24-002171, and P-24-002172) isolated finds also were discovered within the APE 2012 or in 2016 (*see* Table 6-7). All of these resources are depicted in Figures B-4a through B-4g of Appendix B.

Two resources were identified within the Basalt Hill borrow area, five within Borrow Area 6, one within the Cottonwood Bay levee modification and levee raise areas, one within the Dinosaur Point boat launch modification area, two within the downstream stability berms/fill impact areas, two within the haul road impact areas, ten within the potential construction staging areas, and 19 along the reservoir shoreline. Several resources (e.g., CA-MER-477H, CA-MER-494H, and CA-MER-520H) spanned more than one proposed impact area.

Table 6-7. Previously Recorded and Newly Identified Cultural Resources within the Reservoir Expansion Alternative APE

Site Number	Description	Author	Date	APE Location
Previously Recorded Archaeological Sites or Built Environment Resources				
B.F. Sisk Dam System (not updated)	Historic period B.F. Sisk Dam and facilities	JRP Historical Consulting	2018	Downstream Stability Berms/Fill Impact Areas; Expanded Embankment; Reservoir Shoreline – Fronting the B.F. Sisk Dam
CA-MER-15 P-24-000116 (updated)	Prehistoric pictographs, bedrock mortars, cupules, cleared areas midden soil, lithic scatter	Greenberg, O'Neill, Sprague, Walton et al.	2016	Reservoir Shoreline – South of Dinosaur Point Boat Ramp
CA-MER-28 P-24-000129 (updated)	Prehistoric occupation site with lithic scatter	Greenberg, O'Neill, Sprague, Varkel et al.	2016a	Reservoir Shoreline – South of Dinosaur Point Boat Ramp
CA-MER-82 P-24-000182 (updated)	Prehistoric lithic scatter with groundstone	Greenberg, Sprague, and Wiant	2016b	Reservoir Shoreline – West side of San Luis Creek Inlet
CA-MER-83 P-24-000183 (updated)	Prehistoric midden soil with lithic scatter and groundstone	O'Neill and Walton	2016a	Reservoir Shoreline – South of Dinosaur Point Boat Ramp
CA-MER-130 P-24-000220 (updated)	Prehistoric midden soil with two bedrock mortar features with five mortars and groundstone	O'Neill and Walton et al.	2016	Reservoir Shoreline – North of Dinosaur Point Boat Ramp (not previously inundated)*
CA-MER-477H P-24-001822[1] (updated 2012)	Fourteen historic period road segments	Elliott, Ledebuhr, Fittinghoff, Atwater	2012c	Dinosaur Point Boat Launch Modification Area; Reservoir Shoreline – Dinosaur Point Area
CA-MER-521H P-24-002173 SLTP-B-11 (updated)	Historic water tank and trough	Greenberg, O'Neill, Sprague, Trout, and Wiant	2016a	Borrow Area 6 - South of O'Neill Forebay
P-24-000489[1] (not updated) Listed in the NRHP/CRHR	San Luis Gonzaga Archaeological District comprised of five prehistoric midden sites (CA-MER-107, CA-MER-126 CA-MER-130, CA-MER-134, and CA-MER-135)	Olsen	1970	Cottonwood Bay Levee Modification and Levee Raise Areas; Reservoir Shoreline – Dinosaur Point Area
Newly Discovered Archaeological Sites or Built Environment Resources				
CA-MER-484H[1] P-24-001974 PL-SLLP-A-001 (not updated)	Historic period transmission poles and debris scatter	Trout and Atwater et al.	2012a	Reservoir Shoreline – Dinosaur Point Area (not previously inundated)*
CA-MER-489H[1] P-24-001979 PL-SLLP-A-013 (not updated)	Historic period road segment	Elliott and Trout et al.	2012	Reservoir Shoreline – Dinosaur Point Area

Site Number	Description	Author	Date	APE Location
CA-MER-491H[1] P-24-001985 PL-SLLP-A-010 (not updated)	Historic period road segment	Trout and Atwater et al.	2012c	Potential Construction Staging Area – West of Goosehead Point
CA-MER-492H[1] P-24-001986 (not updated)	Historic period industrial site used in construction of the B.F. Sisk Dam	Elliott, Ledebuhr, Fittingoff, Atwater	2012a	Potential Construction Staging Area – West of Goosehead Point
CA-MER-493H[1] P-24-001987 PL-SLLP-A-014 (updated)	Historic period road segment	Greenberg and Beckett	2016b	Potential Construction Staging Area – West of Goosehead Point
CA-MER-494H[1] P-24-001988 PL-SLLP-A-015 (updated)	Historic period road segment	Greenberg and Beckett	2016c	Basalt Hill Borrow Area; Potential Construction Staging Area – West of Goosehead Point; Haul Road Area
CA-MER-495H[1] P-24-001989 PL-SLLP-A-016 (updated)	Historic period road segment	Greenberg and Beckett	2016d	Potential Construction Staging Area – West of Goosehead Point
CA-MER-509H P-24-002154 PL-SLLPIP-16-01	Historic period Basalt Hill Quarry, part of the industrial complex used in construction of B.F. Sisk Dam system	Greenberg, Juelch, Beckett	2016	Basalt Hill Borrow Area; Haul Road Area
CA-MER-510H P-24-002155 PL-SLLPIP-16-02	Historic concrete equipment pad near O'Neill Forebay	Greenberg, O'Neill, Sprague, and Trout	2016	Borrow Area 6 - South of O'Neill Forebay
CA-MER-511H P-24-002156 PL-SLLPIP-16-03	Historic metal water tank on railroad ties in a corral area near O'Neill Forebay	Greenberg, O'Neill, Sprague, Trout, and Wiant	2016b	Borrow Area 6 - South of O'Neill Forebay
CA-MER-512H P-24-002157 PL-SLLPIP-16-05	Historic helicopter pad located east of the BF Sisk Dam	Greenberg, O'Neill, Sprague, Trout, and Wiant	2016c	Potential construction staging areas – block east of B.F. Sisk Dam
CA-MER-513H P-24-002158 PL-SLLPIP-16-06	Historic asphalt road segment	Greenberg, Sprague, and Wiant	2016c	Potential construction staging areas – block east of B.F. Sisk Dam
CA-MER-514H P-24-002159 PL-SLLPIP-16-07		**erg, O'Neill, Sprague, Trout, and Wiant**	**2016d**	**Potential construction staging areas – block east of B.F. Sisk Dam**
CA-MER-515H P-24-002160 PL-SLLPIP-16-09	Historic period earthen dam with impound pond	O'Neill and Walton	2016b	Reservoire
CA-MER-516	Historic period earthen dam with impound pond	Sprague and Wiant	2016	Reservoir Shoreline – South of SR 152
6-11	**Prehistne**	**Greenberg, O'Neill, Sprague, Varkel et al.**	**2016b**	**Reservoir Shoreline – South of Dinosaur Point Boat Ramp**
CA-MER-518H P-24-002163 PL-SLLPIP-16-12	Historic period earthen dam with impound pond			servoir Shoreline – South side of San Luis Creeet

Site Number	Description	Author	Date	APE Location
CA-MER-519H P-24-002164 PL-SLLPIP-16-13	Historic period dirt road segments	Greenberg, Sprague, and Wiant	2016e	Reservoir Shoreline – San Luis Creek Inlet
CA-MER-520H P-24-002165 PL-SLLPIP-16-14	Historic period survey markers and monitoring wells associated with construction and maintenance of the B.F. Sisk Dam	Greenberg, O'Neill, Sprague, Trout, and Wiant	2016e	Downstream Stability Berms/Fill Impact Areas; Potential Construction Staging Areas
Newly Discovered Isolated Finds				
P-24-001990[1] PL-SLLP-A-ISO-010 (not updated 2016)	Isolated prehistoric utilized core	Elliott, Ledebuhr, Atwater, Fittingoff	2012c	Construction Impact Area – West of Goosehead Point
P-24-001991[1] PL-SLLP-A-ISO-011 (not updated 2016)	Isolated prehistoric biface fragment	Elliott, Ledebuhr, Atwater, Fittingoff	2012d	Construction Impact Area – West of Goosehead Point
P-24-002166 PL-SLLPIP-ISO-16-01	Isolated historic well head	Greenberg, O'Neill, Sprague, Trout, and Wiant	2016f	Borrow Area 6 - South of O'Neill Forebay
P-24-002167 PL-SLLPIP-ISO-16-02	Isolated historic metal fuel can	Greenberg	2016	Potential construction staging areas – block east of B.F. Sisk Dam
P-24-002168 PL-SLLPIP-ISO-16-05	Isolated prehistoric tested chert cobble and flake	Greenberg, Sprague, and Wiant	2016f	Reservoir Shoreline – East side of San Luis Creek Inlet
P-24-002169 PL-SLLPIP-ISO-16-06	Isolated historic water trough	O'Neill and Sprague	2016	Reservoir Shoreline – South of Dinosaur Point Boat Ramp
P-24-002170 PL-SLLPIP-ISO-16-07	Isolated historic galvanized water trough	Greenberg, Sprague, and Wiant	2016g	Reservoir Shoreline – South of Dinosaur Point Boat Ramp
P-24-002171 PL-SLLPIP-ISO-16-08	Isolated historic soda bottle	Greenberg, Sprague, and Wiant	2016h	Reservoir Shoreline – North of Dinosaur Point Boat Ramp
P-24-002172 PL-SLLPIP-ISO-16-09	Historic concrete pad foundations near O'Neill Forebay	O'Neill and Sprague et al.	2016	Borrow Area 6 - South of O'Neill Forebay

Note: Author and Date reflect most recent recording. [1]Resource also occurs within the Lower San Felipe Intake Alternative APE.
* Indicates resource above the current reservoir pool level that could be newly affected by the action alternative

Table 6-8. Previously Recorded Cultural Resources Not Relocated during Inventory Survey of the San Luis Reservoir Expansion Alternative APE.

Site Number	Description	Author	Date	APE Location
Archaeological Sites or Built Environment Resources				
CA-MER-14* P-24-000115	Prehistoric lithic scatter with groundstone, burials, and rock cairn; destroyed	Riddell and Olsen	1962	Expanded dam embankment
CA-MER-20 P-24-000121 (updated)	Prehistoric midden deposit with pestle	Olsen	1964c	Reservoir Shoreline – South of SR 152

Site Number	Description	Author	Date	APE Location
CA-MER-21 P-24-000122 (updated)	Prehistoric midden deposit with bedrock mortar	Olsen	1964d	Reservoir Shoreline – North of Dinosaur Point Boat Ramp
CA-MER-22 P-24-000123 (updated)	Prehistoric midden deposit	Olsen	1964e	Reservoir Shoreline – North of Dinosaur Point Boat Ramp
CA-MER-23 P-24-000124 (updated)	Prehistoric midden deposit with pestle fragment	Olsen	1964f	Reservoir Shoreline – North of Dinosaur Point Boat Ramp
CA-MER-27 P-24-000128 (not updated)	Prehistoric midden deposit with flaked stone and groundstone; reported covered by imported fill in 2012	Olsen	1965b	Reservoir Shoreline – Near Dinosaur Point Boat Ramp
CA-MER-29 P-24-000130 (updated)	Prehistoric Midden with silicate flakes and a scraper and mortar	Olsen	1965d	Reservoir Shoreline – East side of San Luis Creek Inlet
CA-MER-41 P-24-000142 (updated)	Prehistoric midden deposit with fire-affected rock fragments, flaked stone and groundstone	Olsen	1966a	Reservoir Shoreline – South of Dinosaur Point Boat Ramp
CA-MER-136 P-24-000226 (not updated)	Prehistoric midden deposit with pestle fragments	Olsen	1971a	Reservoir Shoreline – Cottonwood Bay (location not previously inundated)*
CA-MER-137 P-24-000227 (not updated)	Prehistoric large occupation site on knoll with pestle fragments	Olsen	1971b	Reservoir Shoreline – Cottonwood Bay
CA-MER-451H P-24-001876	Historic period ranch complex	Wulzen	2008b	Construction Staging Area – South of B.F. Sisk Dam

Note: Author and Date reflect when resource was last located

* Indicates mapped resource location above the current reservoir pool level that could be newly affected by the action alternative

Basalt Hill Borrow Area

The APE for the Basalt Hill Borrow Area spans approximately 492 acres on the western shoulder of Basalt Hill, a prominent peak that flanks the southern reservoir shoreline. An existing haul road extends northeast from the borrow area to a potential construction staging area and then to Borrow Area 6 while another haul road spans the borrow area and a potential construction staging area just west of the dam. The Basalt Hill Borrow Area ranges in elevation from roughly 700 feet along its western margin to 1,707 feet at the summit near the eastern side of the borrow area. Approximately 183 acres were subject to inventory survey within the borrow area while a visual reconnaissance was conducted for areas of unsafe or extreme terrain surrounding Basalt Hill. Approximately 87.5 acres within the Basalt Hill Borrow Area were identified as a part of the APE following the 2016 investigation and so were not examined.

Two historic period resources were relocated or newly recorded within the Basalt Hill Borrow Area in 2012 or 2016. The most prominent was the Basalt Hill Quarry (CA-MER-509H), which was documented within a 150-acre area made up of a series of terraces that incorporated the improved areas of the mine on the northern shoulder of Basalt Hill. When it was recorded, the quarried area

was covered by sparse grasses while the more heavily disturbed areas were marked by invasive weeds. The quarry area as a whole offered fair to good (50-80°) ground surface visibility, though the slopes surrounding the quarry area offered very limited (5-10°) ground surface visibility in areas subsumed by dense, knee-high grasses. Two natural springs were noted on the northern slope of Basalt Hill, but no cultural materials were observed in either location. An improved dirt road (CA-MER-494H) extending northeast from the Basalt Hill Quarry identified for use under the Lower San Felipe Intake Alternative was first recorded as a historic period resource in 2012. An additional segment of the road was recorded in 2016 as it extended west towards the quarry.

Borrow Area 6

Borrow Area 6 consists of approximately 869 acres south of the O'Neill Forebay, east of SR 33, and north of SR 152 (*see* Appendix B, Figure B-4d). Roughly 857 acres were subject to inventory survey while 12 acres were identified as a part of the San Luis Reservoir Expansion Alternative after inventories had been completed and so were not examined. Borrow Area 6 is relatively flat with a slight (1-2°) slope to the north and is crossed by several shallow, unnamed drainages. During the 2016 inventory survey, vegetation throughout the borrow area consisted of thick knee-high to waist-high grasses that offered very limited (0-10°) ground surface visibility.

The record for one previously recorded historic period resource was updated and four newly identified historic period resources were recorded in 2016. One resource (CA-MER-521H) was first recorded by Pacific Legacy personnel in 2014, though the site record and accompanying report have not yet been filed with the CCIC pending permission from the Western Area Power Authority (Holm et al. 2014). It was documented as a livestock watering locale with an elevated cylindrical water tank and a circular trough surrounded by fencing. In 2016, the resource appeared as described in the original 2014 cultural resource record. Two newly identified sites included a concrete equipment pad and a large boulder from the Basalt Hill Quarry that were found near the northwest corner of Borrow Area 6 (CA-MER-510H) and a corral complex with a large welded water tank, a loading chute, a livestock access gate, fencing, and two circular metal water troughs (CA-MER-511H). Two isolated finds also were discovered and included a pair of concrete pad foundations (P-24-002172) and a 6-inch diameter iron well head (P-24-002166) along an access road leading to the corral complex.

Potential Construction Staging Areas

Three potential construction staging areas totaling 2,216 acres were examined in 2012 and 2016 (*see* Appendix B, Figures B-4d and B-4f). Two were located to the east of the B.F. Sisk Dam while the third was located along the southern margin of the San Luis Reservoir on the northern flanks of Basalt Hill to the west of the dam. A portion of that third construction staging area was inundated at the time of the 2016 inventory survey, and approximately 21 acres remained inaccessible. A further 227 acres within the same construction staging area were

identified as a part of the San Luis Reservoir Expansion APE subsequent to the 2016 inventory survey and were not investigated. The remaining 1,968 acres were subject to intensive pedestrian inventory survey.

The terrain within the construction staging areas varied greatly. The southern third of the construction staging area to the west of the dam was marked by heavily vegetated hills and slopes while the northern portion of the staging area was characterized by largely denuded, gentle slopes where inundation, wave action, and recent recreational activities had altered the landscape. Mechanical impacts along the reservoir shoreline in the northern portion of the staging area were evident in the form of a series of shallow, stepped, cut terraces. Human activities, particularly recreational fishing, also left behind hundreds of rock features, including fishing rod supports that appeared as cairns or rock piles, rock alignments in linear or semi-circular shapes, and other rock accumulations. None of these features was identified as prehistoric, and all were presumed to post-date the filling of the San Luis Reservoir. During the 2012 and 2016 inventory surveys, eight resources were identified within the construction staging area to the west of the B.F. Sisk Dam. These included segments of four historic period roads (CA-MER-491H, CA-MER-493H, CA-MER-494H, and CA-MER-495H) that were first documented in 2012. Two (CA-MER-493H and CA-MER-495H) were updated in 2016 to include additional segments (*see* Table 6-2). The northern portion of a historic period industrial resource that was used to support construction of the B.F. Sisk Dam (CA-MER-492H) and two isolated prehistoric finds (P-24-001990 and P-24-001991) also were encountered within the potential construction staging area.

The two potential construction staging areas just east of the B.F. Sisk Dam were examined in 2016. One was a smaller northern block of roughly 113 acres and the other was a much larger block to the south encompassing approximately 1,102 acres. The northern staging area spans a narrow stretch of land at the northern end of the B.F. Sisk Dam just southwest of SR 152 that extends from the north side of the inlet to the O'Neill Forebay to just south of Romero Overlook. The landform includes level to slightly east-facing flats with two prominent hills. Elevations range from 240 feet at the O'Neill Forebay to over 600 feet at the northern end of the area. In 2016, the vegetation was mostly high grass with spotty juniper, which yielded very poor (0-10°) ground surface visibility. The larger, southern construction staging area is marked by fairly level terrain and elevations of approximately 300 feet in the northern portion of the block that becomes increasingly steep to the southeast where elevations exceed 600 feet. As with the northern construction staging area, the area to the south was characterized by thick, high grasses that offered very limited (0-10°) ground surface visibility. Sixteen features associated with CA-MER-520H, all historic period survey markers or observation wells, were recorded in the construction staging areas to the east of the dam. Four additional historic period resources were encountered in the southern block in addition to the CA-MER-520H features. These included a helicopter landing pad (CA-MER-512H), an

asphalt road segment (CA-MER-513H), an excavated earthen irrigation ditch (CA-MER-514H), and an isolated metal can (P-24-002167).

Cottonwood Bay Levee Modification and Levee Raise, Dinosaur Point Boat Launch Modification, and Highway 152 Impact Areas

The Cottonwood Bay levee modification and levee raise areas comprise two areas: a 9.4-acre linear tract in the northern portion of the San Luis Reservoir south of SR 152 where Cottonwood Creek would empty into the reservoir and a 14.1-acre area within Dinosaur Point south of Dinosaur Point Road (*see* Appendix B, Figure B-4a). The Cottonwood Bay levee modification area is characterized by imported fill and riprap to form the levee supporting SR 152. Only sparse invasive plants are present. The levee raise area was subsumed by the 2012 inventory survey for the Lower San Felipe Intake Alternative APE and was not re-examined in 2016. No previously recorded or newly identified cultural resources were encountered in either area, though the arbitrarily defined extents of the San Luis Gonzaga Archaeological District (P-24-000489) intersect the levee raise area.

The 15.4-acre Dinosaur Point boat launch modification area was subsumed (*see* Appendix B, Figure B-4c) by the 2012 inventory survey for the San Felipe Intake Alternative APE and was not re-examined in 2016. A series of 14 historic period road segments (CA-MER-477H) were noted within the area extending west outside of the APE.

The Highway 152 Impact Area is adjacent to an existing paved parking area on the southwestern side of SR 152 to the north of the Romero Overlook and to the south of a turn east of Cottonwood Creek. It is a relatively flat, west-facing bench cut by a west-flowing drainage that supports trees and bushes along its banks. The remaining area is covered in dense grasses. No previously recorded or newly identified cultural resources were noted in the Highway 152 impact area, which overlaps the area examined along the reservoir shoreline.

Expanded Embankment, Downstream Fill Impact, and Haul Road Areas

The proposed expanded embankment areas and downstream stability berm or fill impact areas largely overlap. They also intersect the two potential construction staging areas east of the B.F. Sisk Dam. The haul roads intersect the potential construction staging areas, Borrow Area 6, and the Basalt Hill Borrow Area. Collectively, these areas total 341 acres (Appendix B, Figure B-4a, B-4d, and B-4f). Approximately 38 acres were accessible to inventory survey in 2016 while the remaining portions of these areas were inaccessible due to terrain or safety considerations. Eleven features associated with CA-MER-520H were detected in areas that could be safely accessed. All of these features consisted of brass Reclamation elevation markers or observation wells used for measuring ground water levels and potential dam seepage.

Accessible portions of the expanded embankment areas and downstream stability berm or fill impact areas appeared largely disturbed by previous dam

and facility construction. Vegetation consisted mostly of dense knee-high grasses, thistle, and a few areas with sparse tree cover, yielding very poor (0-10°) ground surface visibility. Areas surveyed along one proposed haul route began at the northwest corner of Borrow Area 6 near the O'Neill Forebay, crossed SR 152 at the inlet to the O'Neill Forebay, and proceeded south along the eastern side of the B.F. Sisk Dam before turning west towards the Basalt Hill Quarry (CA-MER-509H). Another haul route that was added to the alternative after the 2016 inventory links a potential construction staging area to the west of the dam with the Basalt Hill Borrow Area to the south. The haul routes range in elevation from roughly 240 feet to more than 1,200 feet and pass through rugged, variable terrain. Segments of one of the existing haul routes were recorded as a historic period resource (CA-MER-494H) in 2012, and an additional segment of the same road was recorded in 2016 as it intersected the Basalt Hill Quarry.

Reservoir Shoreline

The reservoir shoreline spans roughly 65.1 miles around the circumference of the reservoir from the 560-foot elevation contour downslope for roughly 50 meters, with the lower extents varying based on terrain steepness (*see* Appendix B, Figures B-4a through B-4f). Approximately 47.3 linear miles of the reservoir shoreline were subject to inventory survey in 2016. Areas that were not examined included the western face of the B.F. Sisk Dam and the Cottonwood Bay shoreline north of SR 152. An area near Dinosaur Point that was a part of the 2012 inventory survey of the Lower San Felipe Intake Alternative APE was not re-examined in 2016. The reservoir shoreline crosses each of the potential construction staging areas, with the greatest overlap occurring within the potential construction staging areas west of the dam. Since the shoreline is below the reservoir high waterline, the majority of the area is relatively flat and clear of vegetation, with ground surface visibility ranging from 30-75° along the wave-eroded margins of the San Luis Reservoir.

Eight districts, archaeological sites, or built environment resources were previously recorded along the reservoir shoreline and noted within the San Luis Reservoir Expansion Alternative APE in 2012 or 2016. Resource records updated during inventory survey included those for a prehistoric site with petroglyphs, milling features, cleared areas, midden, and lithic tools (CA-MER-15); two prehistoric midden sites with lithic and artifact scatters (CA-MER-28 and CA-MER-83); a prehistoric lithic scatter with groundstone (CA-MER-82); a midden deposit with associated bedrock milling features and groundstone (CA-MER-130); and a historic period road (CA-MER-477H) (*see* Table 6-7). The arbitrarily defined San Luis Gonzaga Archaeological District (P-24-000489) and the B.F. Sisk Dam System also intersected the reservoir shoreline. As noted above, they were not re-recorded in 2012 or 2016.

Seven archaeological sites or built environment resources and four isolated finds were newly identified along the reservoir shoreline, including a series of historic period transmission poles with a debris scatter (CA-MER-484H); three

earthen dams with impound ponds (CA-MER-515H, CA-MER-516H, and CA-MER-518H); a prehistoric lithic and groundstone artifact scatter (CA-MER-517); and two historic period roads (CA-MER-489H and CA-MER-519H) (*see* Table 6-7). The four isolated finds included a prehistoric chert cobble and flake (P-24-002168), two isolated water troughs (P-24-002169 and P-24-002170), and one isolated bottle (P-24-002171).

Nine previously recorded prehistoric sites (CA-MER-20, CA-MER-21, CA-MER-22, CA-MER-23, CA-MER-27, CA-MER-29, and CA-MER-41) that lay within areas examined in 2012 or 2016 could not be relocated along the reservoir shoreline, and updated site records were generated accordingly. It is possible that these sites were mis-plotted during initial recording, mis-plotted later by the CCIC, impacted by wave action, geomorphic processes, and/or human activities. Three additional resources associated with the reservoir shoreline could not be relocated. One prehistoric site (CA-MER-27) lay within an area that was found to be covered by imported fill, and no traces of the site were observed. Two other prehistoric sites (CA-MER-136 and CA-MER-137) were previously reported in areas that could not be examined in 2016 (*see* Table 6-8).

All of the previously recorded or newly discovered cultural resources along the reservoir shoreline within the San Luis Reservoir Expansion Alternative APE may be subject to impacts if the maximum pool level of the reservoir is increased. These potential impacts have been studied in other lake and reservoir settings (Lenihan et al. 1981:18), and can include *mechanical impacts* from persistent wave action and nearshore currents that shape, abrade, erode, cover, and reveal shoreline topography and cultural resources as well as *biochemical impacts* to site soils and contextual relationships that can lead to the differential preservation of archaeological materials. These mechanical and biochemical impacts would be in addition to any direct effects to cultural resources that might result from construction activities associated with implementing the action alternative. In particular, it is anticipated that two archaeological sites (CA-MER-130 and CA-MER-484H) that were relocated in 2016 will be newly affected by an increase in the maximum pool level of the San Luis Reservoir. One previously recorded site (CA-MER-136) that could not be examined also is mapped on existing site records as being above the current reservoir pool level. Additional inventory survey and/or subsurface testing would be required to determine if and how these resources would be affected by the expansion of the reservoir.

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Chapter 7 Cultural Resource Evaluations, Conclusions, and Recommendations

The cultural resources investigation for the SLLPIP revealed that 24 cultural resources are present with the Lower San Felipe Intake Alternative APE, none is evident within the APE for the former Combination Alternative or the Treatment Alternative, and 37 lie within the San Luis Reservoir Expansion Alternative APE. These totals do not include cultural resources that were previously recorded but not relocated. Due to the spatial overlap between the Lower San Felipe Intake Alternative APE and the San Luis Reservoir Expansion Alternative APE, 11 cultural resources were found to intersect both, including the San Luis Gonzaga Archaeological District (P-24-000489), eight archaeological sites or built environment resources (CA-MER-477H, CA-MER-484H, CA-MER-489H, CA-MER-491H, CA-MER-492H, CA-MER-493H, CA-MER-494H, and CA-MER-495H), and two isolated finds (P-24-001990 and P-24-001991) (*see* Tables 6-2 and 6-7).

Inventory surveys completed for each action alternative fulfilled three main objectives that will assist Reclamation and the SCVWD in managing cultural resources. First, a nearly complete inventory of cultural resources within the APE for each action alternative was achieved, limited only by topographic constraints or access permissions. Second, inventory surveys provided for the recording of highly accurate cultural resource boundaries that may be used to locate, manage, and potentially avoid cultural resources within the APE of each action alternative. Finally, inventory surveys provided important baseline data in the form of detailed records for previously recorded and newly identified archaeological sites and built environment resources that can be used to evaluate and manage these resources for the SLLPIP and future projects.

In the sections that follow, data collected during inventory surveys for the SLLPIP will be used in conjunction with resource-specific documentary research to offer NRHP/CRHR eligibility recommendations for archaeological sites and built environment resources within the APE for the Lower San Felipe Intake Alternative and the San Luis Reservoir Expansion Alternative. These evaluations are prefaced by a brief discussion of the criteria and methods that were used in assessing eligibility, the research themes and questions that were explored when examining prehistoric and historic period resources, and the resource types and attributes that were used to classify archaeological sites and built environment resources within the SLLPIP vicinity. Evaluations were based surface evidence, natural subsurface exposures (e.g., bioturbation, drainage profiles, hillslope erosion exposures, etc.), and archival research as appropriate. No subsurface excavation was undertaken during inventory surveys for the SLLPIP.

7.1 Cultural Resource Evaluation Criteria and Methods

Criteria for formally evaluating cultural resources under the NRHP and the CRHR were introduced in Sections 1.4.1 and 1.4.2. Using those criteria, evaluations will be based on an approach that assesses the integrity or condition of cultural resources and their significance in relation to the four criteria outlined under 36 CFR Part 60.4 and under Section 15064.5 of state CEQA *Guidelines*.

Assessments of integrity are based upon the integrity of location, design, setting, materials, workmanship, feeling, and association for each resource examined. Integrity of location refers to whether a resource has been displaced from its original position. It may apply to standing structures or infrastructural elements, or it may apply to archaeological sites or cultural resource deposits that have been moved or displaced from where they originated. Cultural resources that lack integrity of location will generally have lost their depositional or historic context and would be expected to provide little significant information important to the study of prehistory or history. Integrity of setting, feeling, and association are particularly relevant when assessing historic period buildings, structures, objects, and sites for which the physical setting and its degree of preservation are important (e.g., a historic period irrigation ditch that is part of a larger intact site or district, a canal or aqueduct that remains in use and has not been substantially altered, or a historic period farmstead that retains its rural agricultural setting). In contrast, archaeological sites, particularly prehistoric cultural deposits, can be significant if undisturbed even if they are encountered in a developed setting incongruent with the context of their original deposition. Integrity of design, materials, and workmanship may be pertinent to prehistoric sites or historic period resources, though integrity of design and workmanship are most often examined with reference to historic period built environment resources.

In order to evaluate prehistoric or historic period cultural resources for their potential eligibility for listing in the NRHP/CRHR, it is necessary examine them with reference to a historic context. Information regarding the natural environment and cultural history of the SLLPIP vicinity was included in Sections 2.0 and 3.0, while Section 4.2 outlined many of the most common types of cultural resources that have been previously documented within each action alternative Project Area. Research themes and questions relevant to the specific resource types likely to be encountered in each alternative Project Area are offered below in Sections 7.2 and 7.3. Contextual information specific to individual cultural resources is presented in Section 7.4. This information was developed largely through an examination of archival documents and records and was particularly critical to the evaluation of historic period sites and structures within the APE for the Lower San Felipe Intake Alternative and the San Luis Reservoir Expansion Alternative. A variety of sources, many available online, were consulted including previous site records; historic period topographic maps; federal land patents; GLO survey plats and mineral survey

plats; federal manuscript and agricultural census records; mining bulletins and journals; historical newspapers and photographs; and local county histories, tax documents, and voter registers. Online materials were accessed through the following locations:

- *USGS* (http://nationalmap.gov/) for topographic maps;
- *BLM* (http://www.glorecords.blm.gov/) for land patent data and cadastral survey maps;
- *USGS, The National Map: Historic Topographic Map Collection* (http://nationalmap.gov/historical/);
- *Historic Map Works* (http://www.historicmapworks.com/Browse/United_States/California/);
- *David Rumsey Map Collection* (http://www.davidrumsey.com/) for historical maps;
- *Library of Congress: American Memory Map Collection* (http://memory.loc.gov/ammem/gmdhtml/gmdgeogindex1.html) for historical maps;
- *UC Berkeley Map collection* (http://sunsite.berkeley.edu/histopo/) for historical topographic maps;
- *University of Alabama Historical Maps of California* (http://alabamamaps.ua.edu/historicalmaps/us_states/california/index_Before1875.html) for maps;
- *The Meriam Library Special Collections at California State University, Chico* (http://cricket.csuchico.edu/spcfotos2/photos6.html) for historical photographs and maps;
- *Historic Aerial photographs by NETR Online* (http://www.historicaerial photographs.com/) for historic aerial photographs,
- *UC Santa Barbara Library, Map and Imagery Laboratory* (http://www.library.ucsb.edu/mil/airs) for aerial photographs,
- *California Digital Newspaper Collection*, UC Riverside (http://cdnc.ucr.edu);
- *Online Archive of California* (http://www.oac.cdlib.org/);
- *USGS Publications Warehouse* (http://pubs.er.usgs.gov/browse/usgs-publications) for water supply papers and well data;
- *Ancestry.com* (http://www.ancesty.com) for federal census data, county voter registers and tax data bases, California newspaper collection, local newspapers, city/town directories, military records, and vital statistics; and,
- Google books for county histories and other government publications.

The aim in constructing resource-specific contexts was to identify potential associations with events that made a significant contribution to the broad patterns of our history (NRHP Criterion A/CRHR Criterion 1) and to identify potential associations with one or more individuals who were significant to our past (NRHP Criterion B/CRHR Criterion 2). The distinctive physical characteristics—the construction, style, or artistic values (NRHP Criterion C/CRHR Criterion 3) of cultural resources—were most evident through their material aspects, but were also considered in light of their historic context. Finally, resource specific contexts were used to evaluate the potential of sites or structures to yield information important to the study of prehistory or history (NRHP Criterion D/CRHR Criterion 4).

7.2 Potential Research Themes and Questions for Evaluating Prehistoric and Historic Period Cultural Resources

A series of research themes and questions that might be addressed during the evaluation of cultural resources within the San Luis Reservoir vicinity, specifically within the Lower San Felipe Intake Alternative and San Luis Reservoir Expansion Alternative Project areas, are presented below. Research themes and questions that are more pertinent to the Combination Alternative and Treatment Alternative Project areas are not presented, as inventory surveys of the Combination Alternative APE and Treatment Alternative APE revealed no cultural resources requiring evaluation for NRHP eligibility. Should previously unidentified cultural resources be encountered in the Combination Alternative APE or the Treatment Alternative APE as a part of the SLLPIP, research themes and questions similar to those below would be applicable.

Most of the themes and questions presented below are relevant to both prehistoric and historic period resources, though the manner in which they are addressed will vary greatly based on the specific resource type under assessment.

- *Chronology* is a fundamental research theme central to the study of both prehistoric and historic period cultural resources. A focus on chronology allows researchers to examine sites and/or structures as representative of (or anomalous within) a particular time and place, relate sites and/or structures to one another and to broader regional landscapes or patterns in prehistory or history, and better understand change through time as expressed through a given resource. Questions relating to chronology might include the following:
  - Does the resource contain dateable or temporally sensitive materials such as charcoal, other organic remains, obsidian, diagnostic projectile point types, or dateable historic period glass, metal, or ceramic artifacts?

  - Does the historic period structure exhibit details in its fabrication or construction that would render it dateable?

  - What do dateable materials or structures reveal about when the site was used, how it was related to other sites in the vicinity, and how use or occupation of the resource may have changed through time?

- *Economy* comprises another key research theme that is relevant to the study of prehistoric and historic period cultural resources. For historic period resources, the theme of economy has much to do with how products or materials were produced, sold, purchased, and consumed. For prehistoric sites, the theme of economy is closely related to subsistence, though it also may relate to how raw materials or finished goods were obtained or traded. The theme of economy is closely aligned to other research themes such as settlement or community organization, technology, trade and exchange, and cultural identity. Questions relating to economy or economic subsistence might include the following:

  - Does the resource contain evidence of the subsistence economy such as macrofloral or faunal remains? Do those materials represent seasonally or more permanently available foods? If seasonal materials are represented, what might they reveal about when or how a given site was used (e.g., temporary versus long-term habitation)? Is there evidence of food storage present?

  - Are non-local resources represented, perhaps indicating trade or exchange?

  - What do the floral or faunal remains reveal about the use of technology at the site?

  - Within historic period resources, is there evidence that food was grown for household consumption and/or grown as an economic commodity? Is there evidence for the consumption of non-local or mass produced goods?

- *Settlement or Community Organization* refers to how people occupied the landscape—how they moved through space, where they established their settlements or communities, how those settlements or communities were structured and organized, and how those settlements or communities were related to others within the same region or territory. Questions relating to settlement or community organization might include the following:

  - How is space structured within the boundaries of the resource? Is there evidence for different activity areas? What might that reveal about aspects of cultural identity such as gender, race, or ethnicity?

  - How does a particular resource relate to the larger settlement landscape or community? What cultural or environmental factors might have influenced the choice of one locale versus another?

  - Was a given resource area used temporarily or permanently? On a seasonal or year-round basis?

  - What might the resource reveal about social or economic structures at the local or regional level?

- *Technology* refers to the tools or methods that are used during the course of daily activities such as procuring or processing foods, building dwellings or other structures, and manufacturing utilitarian or non-utilitarian items. Questions relating to technology might include the following:

  - What kinds of tools were being used or manufactured by the people accessing or inhabiting the resource area?

  - Do they shed light on how the resource area was used or what activities may have been carried out there?

  - Do the artifacts present represent finished or unfinished items and what might that reveal about trade, exchange, and/or commerce?

  - What does the technology represented at a given resource location reveal about cultural chronology, the economy, and/or trade and exchange?

- *Trade and Economic Exchange* relate to how finished goods and raw materials were obtained through direct or indirect interactions between social groups. At prehistoric sites, it is possible to discover marine shell from the coast at sites within the San Joaquin Valley interior or non-local lithic materials procured from other regions. At historic period sites, it is even more common to find goods or materials of non-local manufacture that were acquired through commercial activity. Questions relating to trade and exchange might include the following:

  - Does the site contain non-local materials or goods? How and from whom were those materials obtained?

  - What do those items reveal about the spatial extent and stability of trade networks? What might those items reveal about technology,

community organization, cultural identity, or the priorities and values of a given site's occupants?

- How do non-local materials at a resource location relate to the broader cultural landscape and environmental region?

- *Cultural History and Identity* pertain to the ways in which groups developed and formed shared identities based on social organization, political affiliation, religious practices, and/or gender, race, and ethnicity. Questions relating to cultural history and identity might include the following:

Does the resource area contain materials that can be linked to a particular social group that may shed light on the cultural history or identity of its inhabitants?

- What do those materials or the ways in which they were structured, used, or organized reveal about gender, race, or ethnic identity?

- Are particular ethnographic or linguistic groups represented?

- For late prehistoric or historic period resources, how do the materials or remains within a given site support or refute other lines of evidence such as oral history or documentary records?

The research themes and questions above are not exhaustive, but provide a basic framework for examining cultural resources within the San Luis Reservoir vicinity and for evaluating the potential NRHP/CRHR eligibility of those resources within the APE for the Lower San Felipe Intake Alternative and the San Luis Reservoir Expansion Alternative.

7.3 Site Types and Attributes

An integral part of conducting cultural resource evaluations includes defining and documenting the site types represented by a given group of cultural resources. This was noted in Section 6.0 when discussing the types of cultural resources that were encountered during the inventory surveys. Defining and documenting general site types is important because it can guide the construction of contexts for historic period sites and structures or suggest fruitful research themes or questions for prehistoric sites. A brief outline of site types and attributes representative of those typically found within the San Luis Reservoir vicinity is presented below. Several of these site types were encountered during inventory surveys while others were noted during archival and records searches of the Lower San Felipe Intake Alternative and San Luis Reservoir Expansion Alternative Project areas.

7.3.1 Prehistoric Site Types and Attributes

Typical prehistoric site types might include permanent or temporary habitation sites or activity-specific sites such as lithic scatters or food processing areas.

- *Permanent habitation sites* comprise residential sites that were occupied on a permanent or nearly permanent basis. Such sites are often distinguished by their size and by evidence for long-term occupation and material deposition. Permanent habitation sites frequently contain stratified midden deposits or mounds. Midden deposits consist of black or very dark, organic-rich soils that accumulate through intensive or long-term and repeated deposition. Permanent habitation sites might also be expected to feature evidence of house-pit depressions or the remains of other habitation structures. House-pit depressions are typically round, measure between 2-20 meters in diameter, and feature a low berm around their periphery. Given the effects of environmental forces and modern development, house-pit depressions are rarely encountered in the archaeological record but can provide valuable information about daily activities and the use of space in prehistory. The presence of bedrock milling features may also be indicative of long-term habitation. Frequently encountered in the foothills and in areas with bedrock outcrops, bedrock milling features contain mortars or slicks—rounded, cup-like depressions or shallower, elongated depressions that were formed by and used for grinding hard seeds such as acorns and other materials. Although many bedrock milling features have been associated with long-term habitation, they also frequently occur in isolation or independent of other archaeological deposits. The evaluation of a site's physical setting or context is critical in examining such features. In addition to midden soils, house-pit depressions, and bedrock milling features, the archaeological assemblage at permanent habitation sites might be expected to include an array of groundstone and lithic tools as well as floral and faunal remains.

- *Temporary or seasonal habitation sites* include those that were occupied for a short duration or those that were occupied repeatedly, though on a seasonal or short-term basis. Typically smaller than permanent habitation sites, temporary or seasonal habitation sites usually lack accumulated midden deposits or formal house-pit depressions. An array of activities may be evident at temporary or seasonal habitation sites, though materials would be expected to be less diverse than encountered at permanent habitation sites. Bedrock milling features, groundstone, lithic tools, and floral and faunal remains may all be present at temporary or seasonal habitation sites, though the assemblage would likely be less varied, and materials would be expected to be fewer in number when contrasted with permanent habitation sites.

- *Activity-specific sites* include those that were used for one purpose or for a very limited range of purposes. Lithic scatters, lithic quarry areas, or food processing locales are all examples of such sites. Typically used once or for a short duration, these sites are often characterized by limited assemblages that represent the narrow range of activities that would have occurred there.

7.3.2 Historic Period Site Types and Attributes

Historic period site types that have been encountered or might be anticipated within the APE for the Lower San Felipe Intake Alternative and San Luis Reservoir Expansion Alternative would include intact or remnant farmstead or ranch sites, agricultural sites, transportation infrastructure, water conveyance features, prospect pits or mining sites, foundations or structure pads, and debris scatters or deposits. Historic period site types are usually based on functional categories, and such sites are typically easy to distinguish based on their physical attributes. Cultural constituents often encountered at historic period sites include pits, privies, fences, ditches, water features, other structural elements, and domestic or industrial debris.

- *Farmstead or ranch sites* frequently include a residence and one or more outbuildings or structures clearly associated with ranching or agricultural activity (e.g., barn, corral, livestock watering locale, and/or shed). They may feature associated historic period debris deposits or scatters and may contain pits, privies, fences, ditches, and livestock watering locales marked by troughs, windmills, and/or water pumps.

- *Agricultural sites* typically include features that are functionally related to the cultivation, production, and harvesting of crops. Such sites are often distinguished by irrigation ditches and canals, fencelines, modified or landscaped hedgerows or tree lines, and berms or mounded soil areas meant to aid water retention or abatement.

- *Transportation infrastructure* consists of historic period features such as paved or unpaved roads and railroad lines or grades. Railroad lines or grades generally feature a relatively level grade, typically on a constructed berm that may or may not include rails, ties, or spikes. Former railroad lines are often dismantled and repurposed as roads and can be difficult to distinguish in the form of berms that have been converted into unpaved roads. Roads are usually easier to distinguish and are sometimes associated with bridges, culverts, and/or secondary debris deposits or scatters left casually or deliberately by passing vehicles.

- *Water conveyance features* include infrastructural elements such as canals, ditches, dams, and dykes and are generally easy to distinguish in form and function, though they can be hard to discern or differentiate when encountered as a part of a larger water conveyance system. For instance, an agricultural canal and ditch system may contain hundreds of elements that have been added, removed, or transformed through time, and it can be difficult to distinguish the precise date or period when certain elements were altered.

- *Foundations or structure pads* include the material remains of a building's base and are generally constructed of stone, concrete, or wood. Structure pads are areas that have been leveled, typically for the placement of small, less permanent structures, and do not contain foundation elements.

- *Prospect pits or mining sites* typically comprise excavated pits or quarry areas made to test for or extract rocks, gravels, minerals or metals. Spoils piles, or areas of mounded soils or stones removed from prospect pits, are often found in conjunction with them.

- *Debris scatters or deposits* are typically composed of domestic and/or industrial materials that have been scattered or deposited in the area in which they were used (i.e., a primary deposit) or in an area unassociated with their use (i.e., a secondary deposit). A farmstead or ranch site for instance might feature one or more primary debris scatters containing domestic items such as glass, metal, and ceramics and might contain debris associated with ranching or farming activities such as barbed wire, fencepost remnants, and horseshoes. A historic period road might feature a secondary scatter of domestic or industrial items representing one or more roadside discard events.

7.4 Cultural Resource Evaluations

Not all of the cultural resources encountered during the SLLPIP inventory surveys will be eligible for listing in the NRHP and/or the CRHR, and not all will require protection, avoidance, or mitigation per Section 106 of the NHPA or CEQA. Until all appropriate consultation efforts have been completed, however, Reclamation and the SCVWD will avoid impacts to cultural resources that have not been previously evaluated for listing in the NRHP and/or the CRHR.

7.4.1 Lower San Felipe Intake Alternative

Preliminary NRHP and CRHR evaluations are offered below for three cultural resources that were previously recorded and relocated within the Lower San Felipe Intake Alternative APE in 2012. These include one multi-component site (CA-MER-26/H) comprised of prehistoric midden and a historic period earthen dam and impound pond, one large prehistoric site (CA-MER-94) that was excavated in 1966-1967, and one historic period built environment resource made up of a series of road segments (CA-MER-477H). Three other previously recorded cultural resources within the Lower San Felipe Intake Alternative APE are listed in the NRHP and the CRHR (P-24-000489), listed in the CRHR (CHL-829, P-24-000643), or were found to contain no surface expression within the APE that might be evaluated (P-24-001856) (*see* Table 6-2). One previously recorded resource (CA-MER-437) was found to be non-cultural during the 2012 field inventory and is not evaluated below.

Twelve archaeological sites or built environment resources that were newly identified within the Lower San Felipe Intake Alternative APE also are evaluated below. These resources include a historic period utility pole alignment (CA-MER-484H), two historic period debris scatters (CA-MER-485H and CA-MER-490H), a historic period earthen dam (CA-MER-486H), seven historic period road segments (CA-MER-487H, CA-MER-488H, CA-MER-489H, CA-MER-491H, CA-MER-493H, CA-MER-494H, and CA-MER-495H), and an industrial resource that was a part of the larger Basalt Hill Quarry (CA-MER-509H) and separation plant complex built in 1963 to process basalt into riprap for construction of the B.F. Sisk Dam (CA-MER-492H) (*see* Table 6-2). The six isolated finds that were newly discovered within the Lower San Felipe Intake Alternative APE are not evaluated.

Of the 15 archaeological sites or built environment resources discussed below, one prehistoric resource (CA-MER-94) is recommended eligible for listing in the NRHP/CRHR based on findings from prior excavations. An evaluation for one resource (CA-MER-26/H, prehistoric component) remains pending further investigation. One historic period industrial site (CA-MER-492H) is recommended not eligible for individual listing in the NRHP/CRHR; it is also regarded as a non-contributing element of the recently defined B.F. Sisk Dam/San Luis Reservoir Historic District (JRP 2018). Twelve other resources are recommended not eligible for listing in the NRHP and the CRHR, either as individual resources (CA-MER-484H; CA-MER-485H; CA-MER-486H; CA-MER-487H; CA-MER-488H; CA-MER-489H; CA-MER-490H; CA-MER-491H; CA-MER-493H; CA-MER-494H; and CA-MER-495H; P-24-001822) or as elements of a larger complex.

Previously Recorded Cultural Resources

CA-MER-26/H ***P-24-000127***	***Description*** CA-MER-26/H was originally recorded in 1965 by W.H. Olsen who described the site as prehistoric midden

Prehistoric Component Pending Evaluation for Listing in the NRHP/CRHR under Criterion D/4

Historic Period Component Recommended Not Eligible for Listing in the NRHP/CRHR

Appendix A, Figure A-1a; Appendix B, Figure B-1a

Lower San Felipe Intake Alternative APE (Dinosaur Point)

deposits eroding from either side of a drainage (Olsen 1965a). As recorded during the 2012 inventory survey, CA-MER-26 comprises a multi-component site that measures 100 meters N/S by 40 meters E/W. It contains three prehistoric features: a low-density lithic concentration (Feature A); two midden deposits and a lithic concentration (Feature B); and a midden deposit (Feature C). These features are situated to either side of a historic period impound pond created by a large earthen dam, with Features A and B located to the north and Feature C located to the south of the pond.

Feature A lies on a bank to the north of the dam and measures 12 meters N/S by 6 meters E/W. The lithic concentration consists of five pieces of cryptocrystalline (CCS) angular shatter (1-3 centimeters diameter), two obsidian tertiary flakes (1-centimeter diameter), and one piece of quartz angular shatter (1-centimeter diameter). The Feature B midden deposits are visible in the eroding bank above the pond and drainage and are separated by an alluvial deposit. Taken together, the scatters measure 55 meters N/S by 5 meters E/W and contain a lithic concentration consisting of one chalcedony core tool (5-x-6-x-3 centimeters), one obsidian and two basalt tertiary flakes (1-centimeter diameter), and approximately 15 pieces of angular and non-angular CCS shatter (1-2 centimeters diameter). Feature C consists of a midden deposit measuring 18 meters NE/SE by 10 meters NW/SE on a steep bank south of the historic period impound pond.

The historic period component of CA-MER-26/H consists of an east-west trending earthen dam that forms a small pond to the south of Dinosaur Point Road. The dam was constructed before the reservoir inundated the area in 1967, and it lies below the high waterline. The dam stands approximately 12 feet high on the downslope (northeast) side and 3 feet above the waterline for the pond on the up-slope (southwest) side. It spans 6 feet in width at the top, approximately 40 feet in width at the base, and measures 110 feet in length. No historic period artifacts or cultural materials associated with the dam or impound pond were noted, though a historic period road (CA-MER-489H) is located immediately to the south.

Sedges, reeds, and small willows edge the historic period stock pond, while low, invasive grasses and cockleburs

cover the dam and the surrounding site area. The spillway lies on the southeast side of the dam and runs through a series of bedrock outcrops. The site is situated at the confluence of a major and a minor unnamed drainage that was once a tributary of San Luis Creek and now flows directly into the San Luis Reservoir. CA-MER-26/H lies approximately 60 feet below the average waterline and is often fully submerged beneath the reservoir. Soils are a light tan-brown sandy silt. The resource area is fully exposed, offers excellent (80-90%) ground surface visibility, and is marked by a variable slope of 10-20°. The site has been impacted by periodic inundation but otherwise remains in fair condition.

Archival Research Summary – Historic Period Component

CA-MER-26/H is located in Township 10 South, Range 7 East in the unsectioned San Luis Gonzaga Land Grant. The resource area was patented on May 16, 1871 to Juan Pérez Pacheco (Doc #PLC 234, BLM # CACAAA 094227) (BLM 2016). An 1879 GLO plat map shows only the area not covered by the land grant. A later 1909 GLO sketch map of the diseño of Rancho San Luis Gonzaga depicts a stage route through the rancho but no features near the resource location. The 1920 Pacheco Pass 15-minute USGS topographic map[4] does not portray the site's historic period component but does depict the early SR 152 alignment to the north of its location (USGS 1920). The 1940 Pacheco Pass 15-minute USGS topographic map[5] also shows the road as well as an early telegraph alignment, but no earthen dam, impound pond, or other similar features (USGS 1940a). CA-MER-26/H first appears on the 1955 Pacheco Pass 7.5-minute USGS topographic map[6], which shows the pond or possibly the dam at the approximate site location (USGS 1955). Thus, based on historic period map evidence, CA-MER-26/H was likely constructed by 1953. A 1946 aerial photograph shows what appears to be a pond and possible earthen dam at the site location with possible outbuildings or structures located to the north (Fairchild Aerial Surveys 1946).

[4] The 1920 Pacheco Pass 15-minute USGS topographic map was surveyed in 1916 and 1918.
[5] The 1940 Pacheco Pass 15-minute USGS topographic map was revised through aerial photography in 1939.
[6] The 1955 Pacheco Pass 7.5-minute USGS topographic map was surveyed in 1955; aerial photographs were taken in 1953.

Francisco Pérez Pacheco, who inherited the San Luis Gonzaga Rancho upon the death of his son Juan, had one daughter, Lola. She married Mariano Malarin, and they in turn had two daughters; one married Dr. Ramon Roca, while the other married Dr. Luis Fatjo. The Fatjos and their children inherited the Merced portion of the rancho. In 1949, Paula Fatjo, the great-great granddaughter of Francisco Pérez Pacheco, moved to the rancho and remodeled the original 1843 adobe that once stood on the property (Pierce 1977: 107). San Luis Gonzaga was an operating cattle ranch during Paula Fatjo's tenure, though she also bred and boarded Arabian horses (Pierce 1977: 107-111). The historic period component of CA-MER-26/H may have been used during Fatjo's time, though the site appears to have been constructed prior to her receipt of the property. While it is likely that the earthen dam and impound pond supported ranching and/or farming, the features could have been erected any time after Juan Pérez Pacheco was first granted the land and before 1946 (Hoover et al. 1990: 200).

NRHP/CRHR Evaluation – Prehistoric Component

The prehistoric component of CA-MER-26/H consists of three features, including a low-density lithic concentration, two midden deposits with a lithic concentration, and a third midden deposit. These features are separated and have likely been disturbed by a historic period stock pond and earthen dam that was likely constructed by 1946. The prehistoric component of the site may represent a short-term or permanent habitation site (*see* Section 7.3.1). Although the site features midden deposits, the paucity of artifacts present coupled with the lack of groundstone or bedrock mortars, habitation areas, fire-affected rock, or other markers of long-term habitation signal that it has likely been disturbed or was not used over a long duration. The resource is evaluated under the themes of *Economy* and *Settlement* (*see* Section 7.2).

A search of the Sacred Lands Inventory by the NAHC did not reveal any information about the CA-MER-26/H vicinity, and the resource does not appear to have been associated with any significant events in local or regional Native American history. The prehistoric component of the site is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

No definitive association with one or more individuals could be established for CA-MER-26/H, and a literature review did not identify any prominent individuals who may have been associated with the site during the ethnographic period. The site's prehistoric component is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

CA-MER-26/H does not contain structurally or artistically unique features and does not exemplify distinctive characteristics of a type, period, or method of construction. The prehistoric component of the site is thus recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

Given that CA-MER-26/H includes midden soils and multiple features, it may have the potential to yield subsurface materials and/or vertical stratigraphy. The data potential of the site (e.g., its depth, integrity, age, and artifact diversity) thus has not been fully explored. Subsurface testing at CA-MER-26/H may reveal information regarding its potential to address important research questions about chronology, settlement, economy, and technology in northern San Joaquin Valley prehistory (*see* Section 7.2). Based on the limited data acquired during inventory survey, an informed recommendation regarding the eligibility of the site's prehistoric component for listing in the NRHP/CRHR under Criterion D/4 cannot be offered. If construction activities associated with the Lower San Felipe Intake Alternative may affect the site, subsurface testing is recommended to determine if CA-MER-26/H offers the potential to address important research questions such as those outlined in Section 7.2.

NRHP/CRHR Evaluation – Historic Period Component
The historic period component of CA-MER-26/H consists of an earthen dam and impound pond that appear to have been constructed by 1946 (Fairchild Aerial Surveys 1946). It lies to the south of SR 152 within the San Luis Gonzaga Rancho, along a drainage, and adjacent to a historic period road (CA-MER-489H) (Fairchild Aerial Surveys 1946; USGS 1955). The historic period component of CA-MER-26/H appears to pre-date Paula Fatjo's arrival at the ranch in 1949, though the property may have been leased to other unknown ranchers or farmers who built the dam and impound pond. Although the resource was likely used for

ranching or farming, it could not be tied to a specific time period or function and could not be linked to events of local or regional importance. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

The historic period site component could not be clearly associated with one or more historically significant individuals. It is therefore recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

The historic period site component consists of an earthen dam and impound pond—features that are very common throughout the San Joaquin Valley. The features are not unusual or distinctive in terms of engineering, architecture, or construction. The historic period site component of CA-MER-26/H is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

CA-MER-26/H includes no historic period artifacts or stratified vertical deposits. It does not offer sufficient research potential to address important research questions regarding ranching, agriculture, or other major research themes. CA-MER-26/H is recommended not eligible for listing in the NRHP/CRHR under Criterion D/4.

Overall, the historic period component of CA-MER-26/H retains integrity of location, design, materials, and workmanship. Its integrity of setting, feeling, and association have been somewhat compromised, however, by the lack of any clear functional or temporal association for the resource, its inundation following the construction of the B.F. Sisk Dam and San Luis Reservoir, and the construction of a boat ramp and Dinosaur Point Road, which are visible to the north. The historic period component of CA-MER-26/H retains poor integrity. It is recommended not eligible for listing in the NRHP/CRHR.

CA-MER-94
P-24-000194

Description

CA-MER-94 was originally recorded by F.A. Riddell in 1962 as a small prehistoric village site with a sandstone bowl mortar and lithics (Riddell 1962c). In 1966 and 1967, W.H. Olsen and L.A. Payen revisited CA-MER-94 and conducted extensive excavations at what they dubbed the “Grayson Site.” As recorded by Olsen and Payen, the site spanned an area measuring 240 meters N/S by 180

Recommended Eligible for Listing in the NRHP/CRHR under Criteria A/1 and D/4

Appendix A, Figure A-1a; Appendix B, Figure B-1a

Lower San Felipe Intake Alternative APE (Dinosaur Point)

meters E/W on a low stream terrace remnant with the long axis paralleling the drainage. Excavations were conducted by hand, though a bulldozer was also used in several areas in 1967 to expose more deeply buried deposits. Those investigations revealed midden to a depth of 1.8 meters as well as 41 burials; four round, hard-packed house floors (Feature 1, 2, 6, and 7); bedrock mortars; groundstone artifacts such as handstones, pestles, mortars, hammerstones, "perforated flat cobbles," and milling stones; chert, jasper, chalcedony, and quartz flaked stone tools and debitage, including 14 projectile point types, bifaces, "knives," drills, cores, and an atlatl spur; *Olivella* and *Haliotis* shell beads and other shell ornaments; stone beads and polished stone artifacts such as incised stone rings, a perforated "gorget," stone pendants, and one charmstone; worked bone artifacts such as beads, incised fragments, a whistle, drilled animal teeth, and bone or antler awls and tools; and baked clay artifacts (Olsen and Payen 1969: 5-39). In addition to the house floors, four additional features were found: four large, flat stone slabs at a depth of 1.1 meters (Features 3 and 4); a concentration of flat, perforated cobbles at a depth of 2.0-2.3 meters (Feature 5); and a large sandstone bedrock mortar with four mortars (Feature 8) that lay exposed but below the average drainage waterline (Olsen and Payen 1969: 35-36).

Based on their findings, Olsen and Payen determined that the site contained protohistoric or Panoche complex materials within the upper 40-50 centimeters of the deposit, "essentially homogenous" Middle Period or Pacheco Complex A and B materials to a depth of 1.8 meters, and limited Positas Complex materials at the base of the deposit (Olsen and Payen 1969: 38). Radiocarbon dates obtained for CA-MER-94 ranged from approximately 645 ± 90 BP to 450 BP (AD 1305 to 1500). One date of 2,400 ± 100 BP (450 BC) was derived from the base of the deposit, but Olsen and Payen (1969: 41) believed it to be erroneous.

When CA-MER-94 was revisited in 2012, the site's midden deposit was found to span an area measuring 57 meters E/W by 62 meters N/S with traces of the excavated trenches apparent in the northwest portion of the site and the spoils visible along the northeast and southwest edges. Considerable rodent disturbance had brought a number of artifacts to the surface, including one CCS edge-modified

flake and several pieces of shatter as well as groundstone fragments such as a handstone fragment, a milling slab fragment, and a nearly complete pestle. The bedrock mortars noted by Olsen and Payen in 1966 were not relocated.

CA-MER-94 is located at the base of a steep-sided valley just before it opens to the San Luis Reservoir. The site is bordered to the south and east by a small drainage, and it sits on a small, flat rise or bench of light tan-brown sandy silt. The site area is characterized by sparse, non-native grasses and cockleburs that afford good (70-80%) ground surface visibility. The site is fully exposed but is bounded by slopes of 10-20° except as it fronts the drainage. There are areas of exposed sedimentary bedrock around the site, as well as round to sub-angular sedimentary cobbles and boulders. Olsen and Payen (1969: 1) noted that "several springs, near which are sites, are located in the upper end of the flat. One of these [CA-MER-26/H], now dammed up for use as a stock reservoir, is only about 100 meters upstream from 4-Mer-S94."

NRHP/CRHR Evaluation

CA-MER-94 is an extensive site that was excavated in 1966-1967. It revealed 41 burials, four hard-packed house floors, bedrock mortars, diverse groundstone artifacts, flaked stone tools and debitage, shell beads and ornaments, worked bone adornments and tools, stone ornaments and implements, four additional intact features, and a well developed, stratified midden deposit to a depth of 1.8 meters below the ground surface. Those cultural constituents and features indicate that CA-MER-94 likely functioned as a permanent habitation site (*see* Section 7.3.1). Permanent habitation sites typically feature accumulated midden deposits, indicating long-term occupation; diverse, numerous cultural constituents; and defined house-pits or living areas. The resource is evaluated under the themes of *Economy, Settlement,* and *Cultural History and Identity* (*see* Section 7.2), particularly as they relate to prehistoric settlement practices, foodways, and group identity.

A search of the Sacred Lands Inventory by the NAHC did not reveal any information about the site locale, and the resource is not known to have been associated with any significant events in local or regional Native American history. The presence of Native American remains at the

site, however, suggests that CA-MER-94 is a culturally sensitive location that may have significance to the descendent Native American community. The presence of human remains suggests repeated and habitual use of the site as a part of the prehistoric ritual and social landscape. As expressed through ritualized interment over time, CA-MER-94 represents a significant place that was invested with meaning by its inhabitants—a place that embodied wider social practices and observances that would have been more important than many other locations that hosted more ephemeral activities. Despite the excavations conducted by Olsen and Payen in 1966-1967, much of CA-MER-94 remains unexcavated, and it may be assumed that the site contains additional, potentially intact human remains. CA-MER-94 is recommended eligible for inclusion in the NRHP/CRHR under Criterion A/1 for its significance in prehistory at the local or regional level.

No definitive association with one or more individuals could be established for CA-MER-94, and no prominent individuals were identified who may have been associated with the site during the ethnographic period. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

Despite the presence of several hard-packed floors or housepits at CA-MER-94, the site did not reveal structurally or artistically unique features and did not exemplify distinctive characteristics of a type, period, or method of construction. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

The potential for CA-MER-94 to reveal subsurface components and vertical stratigraphy was proven through excavations conducted by Olsen and Payen in 1966-1967. The data potential of the site (e.g., its depth, integrity, age, and artifact diversity) has been previously tested but has not been exhausted. Further subsurface excavations at CA-MER-94 and a re-examination of previously collected materials may reveal additional information that could be used to address important research questions about chronology, settlement, economy, and technology in northern San Joaquin Valley prehistory (*see* Section 7.2). Given the quantity and diversity of materials excavated in 1966-1967 and the analytic advancements in archaeology that have been achieved in the past 50 years, particularly

with respect to absolute and relative dating methods, CA-MER-94 offers significant further data potential. CA-MER-94 is thus recommended eligible for listing in the NRHP/CRHR under Criterion D/4.

CA-MER-94 retains integrity of location, but its integrity of setting, feeling, and association have been somewhat compromised by the development of the San Luis Reservoir, which dramatically altered the surrounding landscape. The site has also been disturbed by alluvial erosion, prior archaeological excavations and, to a lesser extent, rodent activity—all of which have likely led to the horizontal dispersion and vertical mixing of soils at the site. Despite these impacts, CA-MER-94 appears to retain sufficient integrity to convey its significance. The resource is recommended eligible for listing in the NRHP/CRHR under Criteria A/1 and D/4.

CA-MER-477H
P-24-001822

Recommended Not Eligible for Listing in the NRHP/CRHR

Appendix A, Figure A-1a; Appendix B, Figure B-1a

Lower San Felipe Intake Alternative APE (Dinosaur Point; Dinosaur Point Road)

San Luis Reservoir Expansion Alternative APE (Dinosaur Point Boat Launch Modification Area; Reservoir Shoreline)

Description

CA-MER-477H was first recorded by J.C. Whatford in 1996 as three segments (Features A, B, and C) of three separate road alignments. Feature A is located on a contour below the paved access road to Dinosaur Point. Feature B is a road cut situated on a contour above the paved access road to Dinosaur Point that includes the remains of an asphalt surface and occasional dry-laid stone retaining walls. Feature C comprises the road cut along which the paved Dinosaur Point access road is oriented (Whatford 1996a). The modern four-lane alignment of SR 152 is located roughly 0.3 miles to the northwest of Feature C.

During the 2012 field inventory, the three road segments originally recorded as CA-MER-477H by Whatford were relocated along with 11 additional road segments. All of these segments comprise three separate road alignments that together span 3.5 miles E/W on the western side of San Luis Reservoir. Features A, B, and C, originally noted by Whatford in 1996, were re-designated Segments A, B, and C in 2012, while the remaining segments were designated Segments D through N. All represent travel routes that spanned Pacheco Pass before 1967. They begin in the wide valley at the top of Pacheco Pass near the modern alignment of SR 152 and cross the summit of the pass before following a ridgeline down into the former San Luis Valley. The features consist primarily of roadbeds cut into the hillsides, with some segments

exhibiting asphalt paving and built-up roadbeds and causeways. A series of "C" blocks—concrete posts with a "C" stamped into one side—were noted along one of the road alignments and designated as Features 1 through 5. Posts of this type were used to delineate highway ROW between 1914 and 1934 (Windmiller 2007).

The three historic period road alignments include the 1920s-era route of SR 152. Construction of the route was completed in 1923, and it is represented by Segments B, D, E, F, G, H, I, J, and K as well as Features 1 through 5. Segments C and L represent two discontinuous portions of the improved 1940s-era route of SR 152. Finally, Segments A, M, and N represent the earliest alignment, which may mark the route of the 1856 Andrew Firebaugh Toll Road, the Pacheco Pass Stage Road, and/or a portion of the Butterfield Overland Mail route.

The main disturbances to CA-MER-477H include the construction and maintenance of Dinosaur Point Road and a pumping plant access road. Inundation of the reservoir has affected road Segments L, K, and M, and erosion has affected most of the resource segments. CA-MER-477H generally follows the course of a northwest-southeast trending ridgeline, first on the north side and then crossing to the south, with the exception of Segments M and N that continue on the north side. The resource passes through three vegetation communities: low to medium density chaparral with Manzanita, California sagebrush, coyote bush, chamise, and blue oaks; oak savanna blue oaks and non-native grasses; and open non-native grassland with cockleburs and other herbaceous plants. The resource descends below the reservoir's high-water mark in several locations, which are marked only by sparse grasses and cockleburs.

Archival Research Summary

CA-MER-477H is located in Township 9 and 10 South, Range 7 East and in Township 10 South, Range 8 East in the unsectioned San Luis Gonzaga Land Grant. The land grant was patented to Juan Pérez Pacheco on May 16, 1871 (Doc #PLC 234, BLM # CACAAA 094227) (BLM 2016). An 1879 GLO plat map depicts only the area not covered by the land grant. A 1909 GLO sketch map of the diseño of Rancho San Luis Gonzaga shows a stage route through the rancho, but it is unclear if the stage route depicted corresponds to one or more of the CA-MER-

477H road alignments (BLM 2016). The 1920 Pacheco Pass 15-minute USGS topographic map depicts Segments B, D, E, F, G, H, I, J, and K (USGS 1920). The 1940 Pacheco Pass 15-minute USGS topographic map shows Segments C and L. The 1955 Pacheco Pass 7.5-minute map portrays the San Luis Reservoir while the "Boat Ramp" road appears to represent portions of the 1940s-era alignment of SR 152. Two segments of the 1920s-era alignment of SR 152 are also shown (USGS 1955). A 1946 aerial photograph of the resource area shows numerous braided road alignments to the west of the reservoir near Dinosaur Point (Fairchild Aerial Surveys 1946). The 1920s-era SR 152 alignment is clearly visible, as is the later 1940s-era route. Several road segments that may represent the 19th century stage road are also visible. Two of the 1920s segments of SR 152 (Segments B and N) are most clearly discernible, as is one of the 1940s segments (Segment C).

Based on aerial photograph and historic period map evidence, CA-MER-477H represents the remains of three separate roads that traversed Pacheco Pass prior to 1967. One is the original 1920s-era route of SR 152, which was the first paved road over the pass and the one that included the distinctive "C" blocks. A second is the improved 1940s-era SR 152, a portion of which was repaved as Dinosaur Point Road after the flooding of the San Luis Reservoir in 1967 (Beck and Haase 1974: 52; Hoover 1990: 199; Whatford 1996: 1-2). Finally, the 1856 Andrew Firebaugh Toll Road, which later became the Pacheco Pass Stage Road and part of the Butterfield Overland Mail route, may be represented. Its correlation with early historic period maps is more tenuous, however, and it lacks associated features, such as the later 1920s-era "C" blocks that might support its link with a specific period and function.

NRHP/CRHR Evaluation

CA-MER-477H comprises 14 segments of three separate historic period road alignments that spanned Pacheco Pass. Each of the three alignments is evaluated under the historic context of *Transportation Development* in the American Period (*see* Section 3.3.3). Pacheco Pass is a part of a historically significant transportation corridor that was used by Native Americans as well as Spanish, Mexican, and American explorers, soldiers, and settlers. A commemorative plaque marking Gabriel Moraga's 1805

exploration of Pacheco Pass has been designated as CHL-829 (P-24-000643) and installed at the Romero Overlook on the northeastern edge of San Luis Reservoir.

Segments A, M, and N of CA-MER-477H may represent portions of the 1856 Andrew Firebaugh Toll Road that later became the Pacheco Pass Stage Road and part of the Butterfield Overland Mail route. Given the imprecision of the 1909 GLO map of the diseño of Rancho San Luis Gonzaga, the braided nature of the roads that cross the area, and the lack of associated materials that might confirm the age of the three recorded alignments, however, it is not possible to definitively link the road segments to the 19th century toll, stage, or mail route. Segments B, D, E, F, G, H, I, J, and K, which represent the 1920s-era alignment of SR 152, can be more securely linked to early historic period topographic maps (USGS 1920, 1955), as can the two segments (Segments C and L) that represent the improved 1940s-era alignment (USGS 1955).

Mere association with historical events or trends is not enough to qualify a resource for listing in the NRHP/CRHR under Criterion A/1. The resources' association with particular historical events or trends must be considered important as well. For instance, a historic period commercial building must be shown to have been significant in commercial history. Similarly, the three road alignments that make up CA-MER-477H may be considered potentially eligible for listing in the NRHP/CRHR under Criterion A/1 if they played a significant role in local or regional transportation development or history. As noted above, Segments A, M, and N of CA-MER-477H cannot be securely linked to their use as a part of the Andrew Firebaugh Toll Road, the Pacheco Pass Stage Road, or the Butterfield Overland Mail Route. Segments B, D, E, F, G, H, I, J, and K, which represent the 1920s-era alignment of SR 152, and Segments C and L, which represent the 1940s-era one, can be more firmly linked to a specific period through historical map and aerial photographic evidence. As remnant road alignments that played a significant role 1920s and 1940s-era transportation in Central California, 11 of the 14 road segments may be regarded as potentially eligible for listing in the NRHP/CRHR under Criterion A/1.

None of the road alignments that make up CA-MER-477H could be definitively linked with one or more historically significant individuals. The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

CA-MER-477H comprises 14 segments of three separate road alignments that could not be clearly linked to any other buildings, structures, or sites within the vicinity. The road segments are not structurally unique and do not exemplify distinctive characteristics of a type, period, or method of construction. The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

As a series of isolated road segments, there is little potential to encounter subsurface components or vertical stratigraphy along CA-MER-477H. As a physical entity, the resource offers little potential to address important research questions about *Transportation Development* in the American Period (*see* Section 3.3.3). Thus, CA-MER-477H is recommended not eligible for listing in the NRHP/CRHR under Criterion D/4.

The overall condition of CA-MER-477H in 2012 was described as fair, with impacts from construction and maintenance of the Dinosaur Point Road and a pumping plant access road, reservoir inundation, and erosion. Generally, the road segments retain integrity location and materials, though vegetation growth has diminished their aspect of workmanship and materials. Integrity of design has been diminished by modern construction and development, while the aspect of setting has been impacted by later road, pumping station, and boat ramp construction and by the San Luis Reservoir. Aspects of association and feeling also have been impacted by access road, reservoir, and boat ramp construction, which resulted in the re-routing of SR 152 in its current alignment. Some of the CA-MER-477H road segments have lost any clear historic period association. For instance, Segment G is described as being potentially "mistaken for a wide shoulder" (Elliot et al. 2012c). The integrity of CA-MER-477H is poor to fair.

The potential 19th century road alignment of CA-MER-477H could not be securely linked to a specific time period or function and may represent portions of a toll

road, stage road, and/or overland mail route. The 1920s and 1940s-era alignments of CA-MER-477H can be more securely fixed in time and space. Both served an important role in historic period transportation development, however both lack sufficient integrity to convey their significance in local or regional history. Portions of these alignments have been paved, inundated, and/or severely eroded. The recorded road segments are discontinuous and frequently limited in scale. Overall, the resource retains poor integrity. CA-MER-477H is recommended not eligible for listing in the NRHP/CRHR.

Newly Identified Cultural Resources

CA-MER-484H
P-24-001974
PL-SLLP-A-001

Recommended Not Eligible for Listing in the NRHP/CRHR

Appendix B, Figure B-1d

Lower San Felipe Intake Alternative (Dinosaur Point)

Description

CA-MER-484H is a historic period utility pole alignment or telegraph line set into a series of drainages, ridge tops, and slopes. The resource consists of 15 pole bases, three fallen poles, several wood crossbeams, and a large number of glass insulators. The alignment is depicted on the 1940 Pacheco Pass 15-minute USGS topographic map (USGS 1940), but absent from earlier or later maps. It is aligned almost due east-west at a bearing of 178° for approximately 1,680 feet and terminates as it reaches a modern road. The posts are placed between 120-130 feet apart with the exception of the westernmost three posts that are placed 65 feet apart. All poles have been cut close to the ground surface. Pole Location 1 consists of a single cut pole on the flat surface of a finger ridge. It measures 7¼ inches in diameter and is made of treated wood; it is cut at 4½ inches above the ground surface. A northeast-southwest trenching dirt road that eventually connects with Dinosaur Point Road lies approximately 60 feet to the west of the poles. A modern power pole is located 111 feet to the south, which marks the point from which a modern power line continues southward. Modern trash lies scattered across the ridge top close to the dirt road. Historic period glass insulators and fragments were noted at four pole locations, but no other historic period artifacts were noted.

CA-MER-484H is located on the northwestern side of San Luis Reservoir to the west of a boat ramp and to the north of the 1920s-era alignment of SR 152. Steep-sided, flat-topped finger ridges surround CA-MER-484H. Vegetation along the utility pole alignment includes dry grasses, blue oaks, and seasonal shrubs. Ground surface

visibility ranges from 20-35%, and the alignment is roughly 30% exposed.

Archival Research Summary

CA-MER-484H is located in Township 10 South, Range 7 East in the unsectioned San Luis Gonzaga Land Grant. The site area was patented on May 16, 1871 to Juan Pérez Pacheco (Doc #PLC 234, BLM # CACAAA 094227). An 1879 GLO plat map shows only the area not covered by the land grant. A later 1909 GLO sketch map of the diseño of Rancho San Luis Gonzaga depicts a stage route through the rancho but no utilities or similar features. The 1920 Pacheco Pass 15-minute USGS topographic map does not portray the utility pole alignment but does depict a road to the north of its location. The utility pole alignment appears on the 1940 Pacheco Pass 15-minute USGS topographic map, but is missing from the later 1955 Pacheco Pass 7.5-minute USGS topographic map (USGS 1940, 1955). Thus, based on historic period map evidence, CA-MER-484H was constructed and removed within a span of less than 37 years. Based on marks noted on the glass insulators, the site was likely constructed between 1921 and 1939 (Meier 2016; Whitten 2016a, 2016b).

NRHP/CRHR Evaluation

CA-MER-484H, which comprises 15 cut pole bases, three fallen poles, and several glass insulators, represents the fragment of a larger utility pole alignment that was likely constructed between 1921 and 1939. The first telegraph line across Pacheco Pass was built in 1859 (Mountain-charlie1850.org 2016), and there is no evidence that CA-MER-484H was connected with that early alignment. CA-MER-484H was not the first utility alignment to bridge Pacheco Pass, nor did it appear to be a historically significant one tied to events of local or regional importance. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

This utility pole alignment could not be linked to one or more individuals, historically significant or otherwise. CA-MER-484H is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

The site features 15 cut telegraph poles and 3 fallen poles. These features and the alignment they were once a part of are not unusual or distinctive in terms of engineering,

architecture, or artistry. CA-MER-484H is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

CA-MER-484H includes approximately 25 scattered glass insulator fragments representing five insulators that were associated with several of the utility poles. Two manufacturing marks were noted on these insulator fragments that indicated the alignment was likely constructed between 1921 and 1939 (Meier 2016; Whitten 2016a, 2016b). No other artifacts or features were recorded in conjunction with the utility pole alignment. The resource does not offer sufficient research potential to contribute to our knowledge of communications, the economy, technology, or other potential research themes and questions. CA-MER-484H is recommended not eligible for listing in the NRHP/CRHR under Criterion D/4.

The utility pole alignment retains integrity of location and materials. Its integrity of design, materials, and workmanship has been diminished by the removal of the poles, wires, and insulators that would have been integral to its function and appearance. Aspects of setting and feeling have been diminished by the construction of the boat ramp, Dinosaur Point Road, and the San Luis Reservoir, which truncates the utility pole alignment. Association and feeling are also diminished by the lack of any clear association with a specific utility company, which may have provided further context for the resource prior to the rerouting of SR 152. The remnant alignment no longer carries any clear historic period association and, overall, it has poor integrity. CA-MER-484H is recommended not eligible for listing in the NRHP/CRHR.

CA-MER-485H
P-24-001975
PL-SLLP-A-003

Recommended Not Eligible for Listing in the NRHP/CRHR

Description

CA-MER-485H is a historic period debris scatter that lies within in a seasonal drainage below a sharp curve just north of Dinosaur Point Road. The scatter is spread across an area measuring 100 feet N/S by 25 feet E/W and includes ten exposed or partially buried items. Among these items are several eroding gas cans, drainage pipes, and a 2-foot diameter metal drum containing glass bottle fragments and metal canisters. One glass fragment features an Illinois “I [in a circle]” maker’s mark that post-dates 1954 (Toulouse 1972). The debris scatter

Appendix B, Figure B-1d

extends along the drainage to the north, which skirts the north-facing slope of a low ridgeline.

Lower San Felipe Intake Alternative (Dinosaur Point)

The site area is characterized by non-native grasses, blue oaks, and small canyon scrub oaks that allow moderate ground surface visibility. The drainage slopes slightly (5°) to the north and feeds into the San Luis Reservoir, which lies 300 feet distant. CA-MER-485H is in fair condition, though items within the debris scatter have likely been displaced and/or partially buried by alluvial and colluvial erosion.

Archival Research Summary

CA-MER-485H is located in Township 10 South, Range 7 East in the unsectioned San Luis Gonzaga Land Grant. The site area was patented on May 16, 1871 to Juan Pérez Pacheco (Doc #PLC 234, BLM # CACAAA 094227). An 1879 GLO plat map depicts only the area not covered by the land grant. A 1909 GLO sketch map of Rancho San Luis Gonzaga shows a stage route through the rancho as well as two alternate stage routes (BLM 2016), though it is unclear if either of those two alternate routes correspond to the SR 152 alignment depicted in the later 1920 Pacheco Pass 15-minute USGS topographic map and the 1940 Pacheco Pass 15-minute USGS topographic map that passes to the south of the site location (USGS 1920, 1940). A 1946 aerial photograph corresponds with these earlier topographic maps (Fairchild Aerial Surveys 1946). The 1955 Pacheco Pass 7.5-minute USGS topographic map shows the San Luis Reservoir as well as a boat ramp to the north of Dinosaur Point Road, which is shown as an unimproved dirt road just south of the site location (USGS 1955).

Based on the map evidence and the single artifact bearing a maker's mark noted among the site's constituents, CA-MER-485H may post-date 1954. The debris scatter does not appear to be related to the 1920s-era road during its original period of use. The site may represent discard associated with mid-20th century ranching or recreational activities; it may also represent opportunistic discard from the abandoned 1920s-era road located upslope or from the 1940s-era road. No structures were noted in proximity to the debris scatter on any historic period map, and CA-MER-485H does not appear to have been associated with any other recorded site.

NRHP/CRHR Evaluation

CA-MER-485H is a historic period debris scatter made up of metal cans, drainage pipes, and a small metal drum containing glass bottle fragments and metal canisters. A single diagnostic artifact indicates that the debris scatter may post-date 1954 (Toulouse 1972). The site appears to represent the opportunistic discard of materials from a convenient roadside location. CA-MER-485H could not be linked to any other historic period sites in the vicinity through map evidence or field inventory, thus it could not be linked to a particular historic context. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

This historic period debris scatter could not be linked to one or more individuals, historically significant or otherwise. CA-MER-485H is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

As a historic period debris scatter, CA-MER-485H contains no engineered, designed, or artistic features. The site is thus recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

CA-MER-485H includes ten exposed or partially buried historic period artifacts, only one of which bears a diagnostic maker's mark. Although the site may retain some level of vertical stratigraphy, it likely retains little horizontal stratigraphy given its location within a drainage and its exposure to alluvial and colluvial erosion. The exposed artifact assemblage lacks any functional association with a particular historic context, and the assemblage does not retain a sufficient quantity or diversity of materials to address important research themes relating to transportation, ranching, recreation or other American Period developments (*see* Section 3.3.3). Thus, the site is recommended not eligible for listing in the NRHP/CRHR under Criterion D/4.

CA-MER-485H retains integrity of location and setting, though its position in a drainage suggests that artifacts have been transported downslope or partially buried through alluvial and colluvial erosion. The aspect of design implies an intentional site layout, which is typically lacking in historic period debris scatters. Aspects of materials and workmanship are not relevant, since there are no built features or structural remains

present. Integrity of feeling and association are diminished by the lack of any clear functional association for the site. CA-MER-485H thus retains little integrity. CA-MER-485H has poor overall integrity and is recommended not eligible for listing in the NRHP/CRHR.

CA-MER-486H
P-24-001976
PL-SLLP-A-004

Recommended Not Eligible for Listing in the NRHP/CRHR

Appendix B, Figure B-1a

Lower San Felipe Intake Alternative (Dinosaur Point)

Description

CA-MER-486H is a historic period earthen dam that was likely constructed to support cattle ranching. The resource measures 8 feet in width at the top, 20 feet in width at the base, and approximately 60 feet in length. The dam stands roughly 3 feet high on its western side (upslope) and 8 feet high on its eastern side (downslope). No artifacts or other features were found in association with the dam. A spillway is located at the northern end of the dam, which has contributed to the erosion of the feature. No artifacts or other features were found at CA-MER-486H, and the next closest resource is a historic period dirt road (CA-MER-487H) approximately 450 feet to the west.

CA-MER-486H is located in a dry drainage with seasonal grasses and a very large, old cotton wood tree just below the dam. Above the dam are sedges and marsh plants. The drainage is steep, with an approximate 20° slope to either side. The resource area is roughly 70-80% exposed and features moderate ground surface visibility, obscured mostly by dense, low grasses.

Archival Research Summary

CA-MER-486H is located in the unsectioned San Luis Gonzaga Land Grant in Township 10 South, Range 7 East. The resource area was patented on May 16, 1871 to Juan Pérez Pacheco (Doc #PLC 234, BLM # CACAAA 094227) (BLM 2016). An 1879 GLO plat map depicts only the area not covered by the land grant. A 1909 GLO sketch map of the diseño of Rancho San Luis Gonzaga shows a stage route through the rancho as well as two alternate stage routes, but does not depict the earthen dam (BLM 2016). The 1920 Pacheco Pass 15-minute USGS topographic map shows the resource location to the south of the SR 152 alignment while the 1940 Pacheco Pass 15-minute USGS topographic map depicts the road alignment to the north of the resource location (USGS 1920, 1940). Neither map depicts the earthen dam. CA-MER-486H is also not depicted on the 1955 Pacheco Pass 7.5-minute USGS topographic map (USGS 1955). A 1946 aerial photograph of the resource location shows what

may be the earthen dam, though given the scale of the image its presence could not be confirmed (Fairchild Aerial Surveys 1946).

NRHP/CRHR Evaluation

CA-MER-486H is a historic period earthen dam with no other associated features, structures, or surface artifacts. The resource could not be linked to a specific time period or to other historic period resources in the vicinity, though a dirt road (CA-MER-487H) roughly 450 feet to the west was likely established by 1946 and may have been associated with CA-MER-486H. Although the resource was likely associated with ranching or farming activities, it could not be linked to particular historic period events, significant or otherwise. CA-MER-486H is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

The resource could not be linked to one or more historically significant individuals. CA-MER-486H is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

As a historic period earthen dam, CA-MER-486H consists of a single engineered feature. That feature is not unique and does not exemplify distinctive characteristics of a type, period, or method of construction. The resource does not embody innovative construction techniques, or represent the work of a master. Therefore, CA-MER-486H is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

CA-MER-486H has been impacted by erosion and appears to retain integrity of location, design, materials, workmanship, and feeling. The resource's integrity of setting and association may have been impacted by the development and inundation of the San Luis Reservoir and by the lack of any clear or current link between the dam and the activities or function for which it was intended. Overall, CA-MER-486H possesses fair integrity and is recommended not eligible for listing in the NRHP/CRHR.

CA-MER-487H
P-24-001977
PL-SLLP-A-005

Description

CA-MER-487H consists of a dirt road segment that appears to have been cut into the north side of an east-west trending seasonal drainage embankment. The road

Recommended Not Eligible for Listing in the NRHP/CRHR

Appendix B, Figure B-1a

segment measures approximately 475 feet in length and 9 feet in width and it extends west outside of the Lower San Felipe Intake Alternative APE. The eastern portion of the road has been obscured by erosion and plant growth but may join an earthworks dam (CA-MER-486H) located approximately 450 feet to the east. No artifacts or other features were found in direct association with the road.

Lower San Felipe Intake Alternative (Dinosaur Point)

The area surrounding the dirt road segment is characterized by sparse blue oaks, live oaks, buckeye, chamise, coyote bush, California sagebrush, and non-native grasses. Ground surface visibility to either side of the road is fair (40%), the road is fully exposed, and slope varies between 2-6° with a northwestern aspect. Although the road remains in fair condition, it does not appear to have been recently used or actively maintained.

Archival Research Summary

CA-MER-487H is located in Township 10 South, Range 7 East in the unsectioned San Luis Gonzaga Land Grant. The land grant was patented on May 16, 1871 to Juan Pérez Pacheco (Doc #PLC 234, BLM # CACAAA 094227) (BLM 2016). An 1879 GLO plat map depicts only the area not covered by the land grant. A 1909 GLO sketch map of the diseño of Rancho San Luis Gonzaga shows a stage route through the rancho, but it is unclear if the stage route may have corresponded to the CA-MER-487H dirt road segment (BLM 2016). The 1920 and 1940 Pacheco Pass 15-minute USGS topographic maps do not depict the dirt road segment (USGS 1920, 1940). CA-MER-487H is also absent from the 1955 and 1972[7] Pacheco Pass 7.5-minute USGS topographic maps (USGS 1955, 1972). A 1946 aerial photograph of the area, however, shows the road as an ephemeral alternative route to the SR 152 alignment shown on the 1920 Pacheco Pass 15-minute USGS topographic map (Fairchild Aerial Surveys 1946; USGS 1920).

Based on aerial photograph evidence, CA-MER-487H appears to have been established prior to 1946 and may have been roughly contemporaneous with the 1920s-era alignment of SR 152. No other structures were noted proximate to the road segment on any historic period

[7] The 1972 Pacheco pass 7.5-minute USGS topographic map was revised from aerial photographs taken in 1971.

map, and it does not appear to have been directly associated with any other known resources.

NRHP/CRHR Evaluation

CA-MER-487H is a historic period road segment that was likely constructed prior to 1946. It is evaluated under the historic context of *Transportation Development* in the American Period (*see* Section 3.3.3). Although the construction date of CA-MER-487H and its period of use remain unknown, it may correspond to 1920s-1930s era transportation development (Fairchild Aerial Surveys 1946). The road appears only on a 1946 aerial photograph and could not be securely linked to any other buildings, structures, or sites within the vicinity, though it may have been associated with an earthen dam roughly 450 feet to the east. The road segment and surrounding area were not noted in a history of Merced County (Tinkham 1923), and CA-MER-487H does not appear to have been linked to any significant local or regional events or developments. The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

No links could be established between CA-MER-487H and any individuals significant in local, regional, or state history. Thus, the resource is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

CA-MER-487H comprises an isolated road segment that could not be chronologically or geographically linked to any other buildings, structures, or sites within the vicinity. The road segment is not structurally unique and does not exemplify distinctive characteristics of a type, period, or method of construction. CA-MER-487H is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

As an isolated road segment, there is little potential to encounter a subsurface component or vertical stratigraphy at CA-MER-487H. CA-MER-487H offers limited potential to address important research questions about *Transportation Development* in the American Period (*see* Section 3.3.3). Thus, the resource is recommended not eligible for listing in the NRHP/CRHR under Criterion D/4.

CA-MER-487H does not appear to be maintained or in active use. It remains in fair condition despite apparent

impacts from erosion and retains integrity of location, design, feeling, materials, and workmanship. It lacks integrity of association, however because it could not be linked to a particular time, event, individual, or purpose and could not be clearly associated with any neighboring buildings, structures, or sites. It lacks integrity of setting as the original alignment of SR 152 has been rerouted and the construction of the San Luis Reservoir has greatly altered the resource vicinity. CA-MER-487H does not meet any of the eligibility criteria for listing in the NRHP/CRHR despite possessing fair overall integrity. It is recommended not eligible for listing in the NRHP/CRHR.

CA-MER-488H
P-24-001978
PL-SLLP-A-009

Recommended Not Eligible for Listing in the NRHP/CRHR

Appendix B, Figure B-1a

Lower San Felipe Intake Alternative (Dinosaur Point)

Description

CA-MER-488H consists of a historic period dirt road segment that is cut into the south slope of an east-west trending finger ridge. The road segment, obscured by vegetation in some areas, measures approximately 2,500 feet in length and 20 feet in width. It extends west outside of the Lower San Felipe Intake Alternative APE. No artifacts or other features were found in association with the road segment, and the closest known resource consists of a distinct historic period road segment (CA-MER-487H) roughly 950 feet to the northeast.

The resource area is characterized by steep-sided, flat-topped finger ridges with dry grasses and sparse live and blue oaks. The road segment is almost fully exposed (95%), though ground surface visibility is somewhat limited (20%). The road remains in fair condition, though it does not appear to have been recently used or actively maintained and has been impacted by erosion.

Archival Research Summary

CA-MER-488H is located in Township 10 South, Range 7 East in the unsectioned San Luis Gonzaga Land Grant. The land grant was patented to Juan Pérez Pacheco on May 16, 1871 (Doc #PLC 234, BLM # CACAAA 094227) (BLM 2016). An 1879 GLO plat map depicts only the area not covered by the land grant. A 1909 GLO sketch map of the diseño of Rancho San Luis Gonzaga shows a stage route through the rancho, but does not appear to depict the CA-MER-488H dirt road segment (BLM 2016). The 1920 and 1940 Pacheco Pass 15-minute USGS topographic maps do not portray the dirt road segment (USGS 1920, 1940), nor do the 1955 (surveyed

in 1953) and 1972 Pacheco Pass 7.5-minute USGS topographic maps (USGS 1955, 1972). A 1946 aerial photograph of the surrounding area shows the road as an ephemeral route to the south of the 1920s-era SR 152 alignment (Fairchild Aerial Surveys 1946; USGS 1920).

CA-MER-488H appears to have been established prior to 1946 and may have been constructed or used at roughly the same time as the 1920s-era alignment of SR 152 (Fairchild Aerial Surveys 1946; USGS 1920). No other structures were noted proximate to the road segment on any historic period maps, and it does not appear to have been associated with any other known resources.

NRHP/CRHR Evaluation

CA-MER-488H is a historic period road segment that was likely constructed prior to 1946. It is evaluated under the historic context of *Transportation Development* in the American Period (*see* Section 3.3.3). Although the construction date of CA-MER-488H and its period of use remain unclear, it may be contemporaneous with the early alignment of SR 152 (Fairchild Aerial Surveys 1946; USGS 1920). The road does not appear on historic period maps and appears only on a 1946 aerial photograph. It could not be linked to any other buildings, structures, or sites within the vicinity or with the closest other known resource, a historic period dirt road segment (CA-MER-487H) located to the northeast. The road segment and surrounding area were not noted in an account of Merced County history (Tinkham 1923), and CA-MER-488H does not appear to have been linked to any significant local or regional events or developments. It is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

No links could be established between CA-MER-488H and any individuals significant in local, regional, or state history. The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

CA-MER-488H is an isolated road segment that could not be linked to any other buildings, structures, or sites within the vicinity. The road segment is not structurally unique and does not exemplify distinctive characteristics of a type, period, or method of construction. It is

recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

As an isolated road segment, there is little potential to encounter a subsurface component or vertical stratigraphy at CA-MER-488H. CA-MER-488H offers little potential to address important questions about Transportation or other potential research themes (*see* Section 3.3.3). Thus, the resource is recommended not eligible for listing in the NRHP/CRHR under Criterion D/4.

CA-MER-488H does not appear to be maintained or in active use. It remains in fair condition despite apparent impacts from erosion and retains integrity of location, design, feeling, materials, and workmanship. It lacks integrity of association, however because it could not be linked to a particular time, event, individual, or purpose and could not be clearly associated with any neighboring buildings, structures, or sites. It lacks integrity of setting, as the original alignment of SR 152 has been rerouted and the construction of the San Luis Reservoir has greatly altered the surrounding area. CA-MER-488H possesses fair overall integrity and is recommended not eligible for listing in the NRHP/CRHR.

CA-MER-489H
P-24-001979
PL-SLLP-A-013

Recommended Not Eligible for Listing in the NRHP/CRHR

Appendix B, Figure B-1a

Lower San Felipe Intake Alternative (Dinosaur Point)

Description

CA-MER-489H consists of a historic period graded dirt road segment with a hard-packed surface that crosses a steep-sided valley below Dinosaur Point Road. It then ascends a hillside to the south and continues north beyond the Lower San Felipe Intake Alternative APE into the San Luis Reservoir. There are small berms on either side of the road segment as it crosses the valley in addition to 3-foot deep cuts into the hillslopes that follow the road. The northwest side of the road (downslope) is also built up-slightly in some areas. CA-MER-489H measures approximately 2,450 feet in length and varies between 10-15 feet in width depending on the extent to which it has been eroded. It passes to the south of a historic period earthen dam and impound pond that are bordered by prehistoric deposits (CA-MER-26/H), a substantial prehistoric habitation site with surface and subsurface deposits (CA-MER-94), and another historic period road segment (CA-MER-477H).

CA-MER-489H is located along the western shore of the San Luis Reservoir below the average waterline. Soils

within the resource area have been heavily impacted by erosion and wave action, and only sparse non-native grasses and cockleburs grow in the area. Portions of the eastern end of the road segment have been destroyed by the slumping of the hillside over the road, while the western end of the resource has been washed out by an ephemeral drainage. The resource area is fully exposed, offers good (60%) ground surface visibility, and features a variable slope and aspect.

Archival Research Summary

CA-MER-489H is located in the unsectioned San Luis Gonzaga Land Grant in Township 10 South, Range 7 East. The land grant was patented to Juan Pérez Pacheco on May 16, 1871 (Doc #PLC 234, BLM # CACAAA 094227) (BLM 2016). An 1879 GLO plat map depicts only the area not covered by the land grant. A 1909 GLO sketch map of Rancho San Luis Gonzaga shows a stage route through the rancho, but it is unclear if the stage route may have corresponded to the CA-MER-489H road segment (BLM 2016).

The 1920 Pacheco Pass 15-minute USGS topographic map does not depict the road segment (USGS 1920), though the 1940 Pacheco Pass 15-minute USGS topographic map does portrays a telegraph or utility line that crossed the road location (USGS 1940). The 1955 Pacheco Pass 7.5-minute USGS topographic map depicts the road segment, which is also clearly shown on a 1946 aerial photograph of the area (USGS 1955; Fairchild Aerial Surveys 1946). The aerial photograph depicts CA-MER-489H to the south of the 1920s-era SR 152 alignment, and it may have served as an alternate, roughly parallel route. No other buildings, structures, or sites were noted proximate to the CA-MER-489H road segment on any historic period maps, and it did not appear to be associated with the historic period earthen dam and stock pond at CA-MER-26/H.

NRHP/CRHR Evaluation

CA-MER-489H is a historic period graded dirt road segment that was established by 1946. It is evaluated under the historic context of *Transportation Development* in the American Period (*see* Section 3.3.3). The construction date of CA-MER-489H and its period of use remain indeterminate, however it may have served as an alternate route associated with the 1920s-era alignment of

SR 152 (Fairchild Aerial Surveys 1946; USGS 1920). The road segment did not appear to be linked to any other buildings, structures, or sites within the vicinity, and it was not noted in association with an account of Merced County history (Tinkham 1923). CA-MER-489H does not appear to have been linked to any significant local or regional events or developments. The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

No links could be established between CA-MER-489H and any individuals significant in local, regional, or state history. The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

CA-MER-489H is a graded road segment that could not be definitively linked to other known resources within the vicinity. The road segment is not structurally unique and does not exemplify distinctive characteristics of a type, period, or method of construction. CA-MER-489H is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

As an isolated road segment, there is little potential to encounter a subsurface component or vertical stratigraphy at CA-MER-489H. The resource offers limited potential to address important research questions about *Transportation Development* in the American Period (*see* Section 3.3.3). Thus, CA-MER-489H is recommended not eligible for listing in the NRHP/CRHR under Criterion D/4.

CA-MER-489H does not appear to be maintained or in active use. It remains in fair condition despite apparent impacts from erosion and inundation and retains integrity of location, design, feeling, materials, and workmanship. It lacks integrity of association, however because it could not be linked to a particular time, event, individual, or use and could not be clearly associated with any known resources. It lacks integrity of setting, as the original alignment of SR 152 has been rerouted and the construction of the San Luis Reservoir has greatly altered the surrounding area. CA-MER-489H possesses fair overall integrity. It is recommended not eligible for listing in the NRHP/CRHR.

CA-MER-490H
P-24-001980
PL-SLLP-A-019

Recommended Not Eligible for Listing in the NRHP/CRHR

Appendix B, Figure B-1a

Lower San Felipe Intake Alternative (Dinosaur Point Road)

Description

CA-MER-490H is a historic period debris scatter located upslope from the modern Dinosaur Point Road and downslope from a historic period road segment (Segment D of CA-MER-477H). The scatter spans an area measuring 80 feet NE/SW by 25 feet NW/SE and consists of roughly 150 church-key opened beverage cans and larger ferrous metal cans. Fifteen have pull-tab openings, 20 are knife-opened, ten are screwdriver-opened, and the remaining cans feature church key-openings. Flat-topped cans with multi-tab seams also are present. One can bears faint markings reading "oil" and "lube." The scatter also includes non-diagnostic fragments of white improved earthenware and porcelain ceramics as well as 50 or more amber, colorless, brown, aqua, and green glass fragments. One bottle base is embossed with "WINE DALE / 23 OI [in a diamond] 52 / HA / REFILLING / PROHIBITED / 1489-W / VINYARDS CO." Two coke bottle fragments are included in the scatter: one is marked "OAKLAN/CAL" and the other is marked "LAS CRUCES/N.M." The debris scatter contains at least 210 artifacts with a total minimum number of items (MNI) equaling 159.

CA-MER-490H is in fair condition, with impacts from exposure and erosion. It is located on the northwest side of a southwest-northeast trending ridge top. The hillslope is very steep (>30°) and covered in dense chaparral with coyote bush, chamise, Manzanita, blue oaks, and non-native grasses. The site is approximately 70% exposed and features a northeastern aspect. Ground surface visibility is generally poor (20%).

Archival Research Summary

CA-MER-490H is located in the unsectioned San Luis Gonzaga Land Grant in Township 10 South, Range 7 East. The land grant was patented on May 16, 1871 to Juan Pérez Pacheco (Doc #PLC 234, BLM # CACAAA 094227) (BLM 2016). A GLO plat map from 1879 depicts only the area not covered by the land grant. A 1909 GLO sketch map of the rancho shows a stage route through Rancho San Luis Gonzaga (BLM 2016), though it does not appear to correspond to the historic period road segment located upslope from CA-MER-490H (Segment D of CA-MER-477H). The road segment instead corresponds to the 1920s-era alignment of SR 152 as depicted on the 1920 Pacheco Pass 15-minute USGS

topographic map (USGS 1920). Numerous other segments (Segments B, E, F, G, H, I, J, and K of CA-MER-477H) of the same road alignment were recorded along with five "C" blocks, or concrete posts with a "C" stamped into one side (Features 1 through 5), which were used to delineate highway ROW between 1914 and 1934 (Windmiller 2007). No standing buildings or structures were depicted in proximity to CA-MER-490H on the 1920 Pacheco Pass 15-minute USGS topographic map, nor were any shown on the later 1940 Pacheco Pass 15-minute USGS topographic map or 1955 Pacheco Pass 7.5-minute USGS topographic map (USGS 1940, 1955). It is likely, therefore, that the debris scatter is associated with casual historic period roadside discard rather than with a particular residence or ranch.

Based on the map evidence and the temporally diagnostic artifacts noted among the site's constituents, CA-MER-490H likely dates to the mid-1930s to the early 1960s. Church key-opened cans date to 1935 or later (Rock 1987: 112), while pull tab cans did not originate until the early 1960s (Maxwell 1993: 96). The wine bottle base dates to 1952 (Toulouse 1971: 403) while flat-topped cans with multi-tab seams date from the mid-1930s to the 1970s (Maxwell 1993: 96; Mar tells 1976: 44).

The debris scatter does not appear to be related to the 1920s-era alignment of SR 152 during its original period of use. The site may represent discard associated with 1950s-era ranching or recreation activities; it may also represent opportunistic discard from the abandoned 1920s-era road. As noted above, no structures were noted in proximity to the debris scatter on any historic period map, and it did not appear to be associated with any recorded site apart from CA-MER-477H.

NRHP/CRHR Evaluation

CA-MER-490H is a historic period debris scatter made up mostly of cans as well as lesser quantities of ceramic and glass artifacts. Temporally diagnostic items from the site indicate that the debris scatter likely dates to between the mid-1930s and the early 1960s (Toulouse 1972). The site appears to represent the opportunistic discard of materials from the 1920s-era alignment of SR 152, though it likely post-dates the main period in which the road was used. CA-MER-490H could not be linked to any other historic period sites in the vicinity through map evidence or

inventory survey, thus it could not be linked to a particular historic context. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

The site could not be linked to one or more individuals, historically significant or otherwise. CA-MER-490H is thus recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

As a historic period debris scatter, CA-MER-490H contains no engineered, designed, or artistic features. The site is thus recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

CA-MER-490H includes approximately 210 artifacts representing an estimated 159 items. Few revealed diagnostic maker's marks, though artifact typing provided a date range for the site spanning the mid-1930s through the early 1960s. Given its position on a steep slope and its exposure to erosion, the site likely retains little vertical or horizontal stratigraphy. The exposed artifact assemblage lacks any functional association with a particular historic context, and the assemblage does not retain a sufficient quantity or diversity of artifacts to address important research themes relating to transportation, ranching, recreation or other American Period developments (*see* Section 3.3.3). Thus, CA-MER-490H is recommended not eligible for listing in the NRHP/CRHR under Criterion D/4.

CA-MER-490H retains integrity of location and setting, though its position on a hillslope suggests that artifacts have been transported or displaced downhill. The aspect of design implies an intentional site layout, which is typically lacking in historic period debris scatters. Aspects of materials and workmanship are not relevant since there are no built features or structural remains present. Integrity of feeling and association are diminished by the lack of any clear functional association for the site. The site thus retains poor integrity. CA-MER-490H is recommended not eligible for listing in the NRHP/CRHR.

CA-MER-491H
P-24-001985
PL-SLLP-A-010

Description

CA-MER-491H is a dirt road segment that has been cut into the western slope of a north-south trending finger

Recommended Not Eligible for Listing in the NRHP/CRHR

Appendix B, Figure B-1d

Lower San Felipe Intake Alternative (Basalt Point Use Area)

ridge. It measures approximately 600 feet in length and 10 feet in width. The cut into the ridge is approximately 2 feet high at a 32° angle. The northern end of the dirt road segment joins a maintained dirt road segment that intersects Basalt Road. A large boulder (6-x-5-x-2.5 feet) rests in the middle of the road roughly 200 feet south of its northernmost section. The south end of the road ends at a high water mark near the southeastern shore of the San Luis Reservoir.

CA-MER-491H is characterized by steep-sided, grassy finger ridges with slopes ranging from 16-22°. Sparse trees and dry, non-native grasses grow throughout the area, though most of the trees in the vicinity represent modern landscaping planted adjacent to a boat ramp parking lot. CA-MER-491H is fully exposed with fair to limited (20%) ground surface visibility. The road is in fair condition but has been impacted by erosion.

Archival Research Summary

CA-MER-491H is located in Township 10 South, Range 8 East in the southeast quarter of Section 28. Section 28 represents a half-section, with the unsectioned northern half subsumed by the San Luis Gonzaga Land Grant. Section 28 was patented to Juan Pérez Pacheco on May 16, 1871 (Doc #PLC 234, BLM # CACAAA 094227) (BLM 2016). The northern half of the southeast quarter, which subsumed the resource area, and the eastern half of the southwest quarter were later patented on February 23, 1892 by Antonio Lopez (Doc #2241, BLM# CACAAA 096296) (BLM 2016). In 1895, he also patented the western half of the southwest quarter.

An 1860 GLO plat map shows the Butterfield Overland Mail route and a telegraph line as they crossed the northwest corner of Section 13, however no historic period features were depicted in Section 28. A 1909 GLO sketch map of the diseño of Rancho San Luis Gonzaga shows a stage route through the rancho—the future alignment of SR 152—but does not show the CA-MER-491H road alignment (BLM 2016). The 1920 and 1940 Pacheco Pass 15-minute USGS topographic maps do not depict the dirt road segment (USGS 1920, 1940a). The 1953 San Luis Creek 7.5-minute USGS topographic map shows an east-west trending unimproved road spanning Section 28 that corresponds to CA-MER-491H (USGS 1953). The road segment, however, is not depicted on the

1969[8] San Luis Dam 7.5-minute USGS topographic map (USGS 1969a), likely because the area was inundated by that time. A 1946 aerial photograph of the area clearly shows the road segment as a part of a road leading west from a north-south trending road in Section 26 (Fairchild Aerial Surveys 1946).

CA-MER-491H passes approximately 760 feet to the west of a possible former homestead site (CA-MER-261H) that may have been associated with Antonio Lopez. Antonio "Antone" Lopez was born in 1844, came to California in 1851, and died in 1907 in Los Banos (Findgrave.com 2016). His obituary noted that he "worked for 40 years as Head Vaquero for Henry Miller of Miller and Lux. Antone was married to Theresa Harper and they had four children Maria Antonia, Henry Francis, Albert Henry, and Frank Henry." Early 20th century US Census records noted that Antonio Lopez resided in Township 3, was married to Theresa Lopez, had four children, and listed his occupation as "farmer" (US Census Bureau 1900a: 9A, 1910: 9A). Since CA-MER-491H features no associated artifacts and aerial photographs reveal only that it was present by 1946, the road segment cannot be clearly linked to the Lopez land grant or to the possible former homestead.

NRHP/CRHR Evaluation

CA-MER-491H consists of a historic period road segment that was constructed prior to 1946 (Fairchild Aerial Surveys 1946). It is evaluated under the historic context of *Transportation Development* in the American Period (*see* Section 3.3.3). The construction date of CA-MER-491H and its period of use remain unclear, though it may have been associated with a possible former homestead (CA-MER-261H) or with homesteaders or ranchers who required an east-west route outside of the San Luis Gonzaga Land Grant. The road segment could not be clearly linked to any buildings, structures, or sites within the vicinity, though the possible former homestead site is located just 760 feet to the west. CA-MER-491H does not appear to have been linked to any significant events or developments in local or regional history. It is

[8] The 1969 San Luis Dam 7.5-minute USGS topographic map was based on aerial photographs taken in 1967 and field checked in 1969.

recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

CA-MER-491H lay within a land grant patented to Antonio Lopez in 1892, however no links could be established between Lopez or any subsequent landowners or leasees and the construction and use of the road segment. Although the builder or builders of the road remain unknown, it is unlikely that they figured prominently in local or regional history. CA-MER-491H is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

CA-MER-491H is an isolated road segment that could not be clearly linked to any other buildings, structures, or sites within the vicinity. The road segment is not structurally unique and does not exemplify distinctive characteristics of a type, period, or method of construction. Thus, the resource is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

As an isolated road segment, there is little potential to encounter a subsurface component or vertical stratigraphy at CA-MER-491H. It offers limited potential to address important research questions about *Transportation Development* in the American Period (*see* Section 3.3.3). The resource is thus recommended not eligible for listing in the NRHP/CRHR under Criterion D/4.

CA-MER-491H does not appear to be maintained or in active use, though the northern end of the road joins another road segment that is maintained and leads to Basalt Road. It is in fair condition despite impacts from erosion and retains integrity of location, design, feeling, materials, and workmanship. It lacks integrity of association, however, because it could not be clearly linked to a particular time, event, individual, or purpose and could not be associated with other buildings, structures, or sites in the vicinity. It also lacks integrity of setting, as the resource has been inundated by the San Luis Reservoir to the south and truncated by a more recent road to the north. CA-MER-491H possesses fair overall integrity and is recommended not eligible for listing in the NRHP/CRHR.

CA-MER-492H
P-24-001986
PL-SLLP-A-011

Recommended Not Eligible for Listing in the NRHP/CRHR, (Non-Contributing Element to the B.F. Sisk Dam System)

Appendix B, Figure B-1d

Lower San Felipe Intake Alternative (Basalt Point Use Area)

Description

CA-MER-492H is a historic period industrial resource measuring 1,600 feet N/S by 1,100 feet E/W. It represents a part of the larger Basalt Hill Quarry (CA-MER-509H) and separation plant complex built in 1963 to process basalt into riprap for construction of the B.F. Sisk Dam (Autobee 2011: 11-12; Berman 2012: pers. comm.; Reclamation 1974: 49). The Basalt Hill Quarry (CA-MER-509H) is located approximately 2,500 feet to the southwest and comprises the main component of the complex, which also includes two historic period access roads (CA-MER-493H and CA-MER-494H). CA-MER-492H features five main loci (Locus 1 through 5). Locus 1 is a concrete tunnel through a small hill covered with piled riprap on top of which are three concrete foundation pads, six vertically embedded I-beams, a road segment, and a large number of cuts, flats, and bulldozer ramps. Locus 2 consists of a deep road cut, a road segment, and a flat. Locus 3 comprises a number of bulldozer scrapes as well as road segments and piled riprap. Locus 4 consists of two large bulldozer scrapes and two road segments. The final main locus, Locus 5, consists of two large bulldozer scrapes.

Considerable amounts of earth were moved during the formation of CA-MER-492H, and the hill that the tunnel is built through appears to be artificial. The site is located in a wide, flat, round valley situated between Basalt Hill to the southwest and San Luis Reservoir to the northeast. The terrain surrounding the resource area is relatively flat to the north and east, with moderate ground surface visibility obscured only by non-native grasses and occasional coyote bushes. The area has a 0-5° slope, is fully exposed, and features a northeastern aspect. The relatively level nature of the site may be due to historic period earthmoving. A 6-foot deep bank runs roughly parallel to the northwest-trending segment of one access road, separating the main portion of the site from the rest of the valley. A small knoll rests between the bank and Basalt Road, with portions of the knoll exhibiting bulldozer activity. The hills to the south and west are steep (>20°), particularly Basalt Hill, which has a maximum elevation of 1,707 feet amsl. Soils within the resource area are tan-brown silty loam and have been graded away in some areas, exposing the sedimentary bedrock beneath. Large portions of the resource area are covered by riprap, either piled or strewn, that would have

arrived via a conveyor belt from the Basalt Hill Quarry (CA-MER-509H). The conveyor belt is no longer in place, but does appear in historic period photographs.

CA-MER-492H is in fair condition with few visible impacts. The main impacts relate to the decommissioning of resource—standing superstructures in Locus 1 were removed, leaving only embedded I-beams and concrete pads. Grading of an access road has also damaged or covered the historic period access road that led through the tunnel. There are very few artifacts present at CA-MER-492H, likely as a result of cleanup activities following the facility's closure (Poole 2012: pers. comm.).

Archival Research Summary

CA-MER-492H is located in Township 10 South, Range 8 East in the southwest quarter of Section 27. The southern half of Section 27 was patented to the Southern Pacific Railroad Company on April 20, 1875 (Doc #4, BLM# CACAAA 093859) (BLM 2016). No railroad was ever built through the section, however, and it was likely sold to local ranchers or other property owners. An 1860 GLO plat map depicts drainages along the northern edge of Section 27, but no historic period development (BLM 2016). The 1920 Pacheco Pass 15-minute USGS topographic map shows that the resource area was dominated by a northeast-southwest oriented drainage originating from a spring to the southwest in Section 34, but no access routes to or from the resource area are depicted (USGS 1920). The 1940 Pacheco Pass 15-minute USGS topographic map does not show CA-MER-492H but does depict a portion of a road that accesses the resource area (USGS 1940). The 1953 San Luis Creek 7.5-minute USGS topographic map shows that the resource area in Section 27 and the Basalt Hill Quarry (CA-MER-509H) area to the southwest in Section 33 remained unmodified (USGS 1953). To the south of CA-MER-492H in Section 34, the same map shows a fire lookout (P-24-000078) on the top of Basalt Hill and a south-trending access road leading away from it (USGS 1953). An access road through Section 27 to the north of the resource area is also depicted, though only a portion to the northwest currently remains on dry land. The concrete tunnel in Locus 1 of CA-MER-492H first appears on the 1969 San Luis Dam 7.5-minute USGS topographic map

(USGS 1969a), which also depicts the San Luis Reservoir and the Basalt Hill Quarry (CA-MER-509H).

Historic period map evidence supports other accounts that the Basalt Hill Quarry (CA-MER-509H) and separation plant complex were established in 1963 to support construction of the B.F. Sisk Dam and San Luis Reservoir, which were completed in 1967 (Autobee 2011: 11-12; Reclamation 1974: 49). In describing how the complex would have operated, Autobee (2011: 11) noted that Rock for zones 4 and 5 on the upstream face of the dam were extracted from a quarry at the top of nearby Basalt Hill. The quarry-run rock was excavated with a 15 cubic yard electric shovel and transported by 75-ton trucks to a separation plant. This plant separated the rock into plus-and-minus nine-inch sizes. Huge bar screens directed the larger size rock into a hopper that loaded the zone 5 material into 60-ton rear-dump trucks. The trucks had special braking systems for hauling safely down the steep access road. The smaller zone 4 rock dropped onto a 3,200-foot long conveyor belt down the hillside. This ended on a cantilevered tower over a 100-foot high stockpile at the bottom. There was a drive-through tunnel under the pile that allowed 100-ton trucks to be loaded in two minutes.

The Basalt Hill Quarry (CA-MER-509H) and separation plant complex was thus used for quarrying and separating rock fill, bedding, and riprap. CA-MER-492H would have been on the receiving end for "smaller zone 4 rock" that would have been transported from the Basalt Hill Quarry (CA-MER-509H) via the "3,200-foot long conveyor belt" (Autobee 2011: 11). Although the conveyor belt is no longer extant, the hill cut for the belt remains highly visible. The concrete footings and embedded I-beams in Locus 1 of CA-MER-492H likely represent the remains of the end of the conveyor belt and the tower. The poured concrete tunnel in Locus 1 would have been used in loading separated material onto vehicles for conveyance to the reservoir embankment and dam construction area.

After construction of the B.F. Sisk Dam was completed in 1967, the quarry and riprap separation plant were shut down, and the tunnel in Locus 1 of CA-MER-492H was reused for storage. Chain-link fencing was bolted to each tunnel entrance, and openings in the roof for loading rock were closed with metal sheeting. The conveyor belt

linking CA-MER-492H with the Basalt Hill Quarry (CA-MER-509H) was removed, and superstructures such as the cantilevered tower noted by Autobee (2011: 11) were dismantled.

NRHP/CRHR Evaluation

CA-MER-492H is a historic period resource that was associated with the Basalt Hill Quarry (CA-MER-509H) and separation plant complex. This complex was established in 1963 to support the construction of the B.F. Sisk Dam and the San Luis Reservoir and comprises a part of the larger dam system. CA-MER-492H is evaluated as a part of that larger system under the historic context of *Water Conveyance* in the American Period (*see* Section 3.3.3).

The B.F. Sisk Dam and its appurtenant features were recommended eligible for listing in the NRHP and CRHR under Criterion A/1 as a contributing element to the CVP and SWP and for their contribution to the expansion and sustainability of farmland and municipal and industrial development in the Central Valley (JRP 2018). As a feature within the B.F. Sisk Dam system, CA-MER-492H may be regarded as a contributing or non-contributing element under Criterion A/1. A connection to significant historic period events or trends is insufficient, in and of itself, to render a resource eligible for listing in the NRHP/CRHR under Criterion A/1. Rather, the role the resource played in those events or trends must be significant. The dam symbolizes the first and only state-federal collaboration in California water development to be conducted on such a large scale (Autobee 2011). The Basalt Hill Quarry and separation plant complex was created and used to support the construction of the B.F. Sisk Dam, however its role in the development of the dam and its key facilities was transitory and not sufficiently significant to render CA-MER-492H a critical part of the larger system. CA-MER-492H is thus recommended as a non-contributing element to the B.F. Sisk Dam system under NRHP/CRHR Criterion A/1.

No connection between the resource and one or more individuals significant in local, state, or national history could be established. Although the dam is named for former US Congressman Bernice Sisk, that association is commemorative and too tenuous to be regarded as significant under NRHP/CRHR Criterion B/2. CA-MER-

492H is thus recommended as a non-contributing element to the B.F. Sisk Dam system under NRHP/CRHR Criterion B/2.

The Basalt Hill Quarry (CA-MER-509H) and separation plant complex was used for quarrying and separating rock fill, bedding, and riprap. Structurally, the complex is not unusual or distinctive in engineering, or architecture. Cedar Spring Dam and Silverwood Lake in Southern California also used a gravity separation plant when quarrying rock for construction in the 1960s (California Dept. of Water Resources 1974: 328). The tunnel in Locus 1 of CA-MER-492H is lined with board-molded concrete and is not distinctive from other man-made tunnels. CA-MER-492H is recommended as a non-contributing element to the B.F. Sisk Dam system under NRHP/CRHR Criterion C/3.

As an industrial resource, there is little potential to encounter a subsurface component or vertical stratigraphy at CA-MER-492H, and few surface artifacts remain. Much of the research potential for the Basalt Hill Quarry (CA-MER-509H) and separation plant complex may be found through archival documents and historic period photographs rather than through the resource's physical remains. CA-MER-492H is recommended as a non-contributing element to the B.F. Sisk Dam system under NRHP/CRHR Criterion D/4.

CA-MER-492H does not appear to be actively maintained or used. It remains in fair condition despite impacts from decommissioning and retains integrity of location and workmanship. Integrity of materials is diminished because portions of the resource have been removed. It retains integrity of setting and association as the reservoir and dam are nearby, though integrity of association has been somewhat lessened by the removal of super-structures (i.e., tower and conveyor belt) that tied the site to the upper quarry area and separator plant. A current access road has damaged the historic period road system, which also diminishes its integrity of setting. The purpose of the tunnel system is no longer evident and no longer visually or physically connected to the larger complex. The aspect of feeling has been diminished, as construction of the dam and reservoir have long been completed. The overall integrity of CA-MER-492H is fair. CA-MER-492H possesses fair overall integrity. It is recommended

as a non-contributing element to the NRHP/CRHR eligibility of the B.F. Sisk Dam system, recently defined as the B.F. Sisk Dam/San Luis Reservoir Historic District (JRP 2018).

CA-MER-493H
P-24-001987
PL-SLLP-A-014

Recommended Not Eligible for Listing in the NRHP/CRHR

Appendix B, Figure B-1d

Lower San Felipe Intake Alternative (Basalt Point Use Area)

San Luis Reservoir Expansion Alternative (Construction Impact Area)

Description

CA-MER-493H is an earthworks road segment that measures approximately 5,400 feet or 1.02 miles in length and 15 feet in width. It is oriented roughly northeast-southwest and connects with another road (CA-MER-494H) at its midpoint that trends southwest towards the Basalt Hill Quarry (CA-MER-509H). A 3,100-foot long segment of the road was recorded during the 2012 inventory survey of the Lower San Felipe Intake Alternative APE while a 2,300-foot long segment was later recorded during the 2016 inventory survey of the San Luis Reservoir Expansion Alternative APE. The road is built up to a height of 25 feet in some sections and cut 13 feet into the hillside in others to maintain a consistent grade. The road is mostly covered by gravels, which become sparse and eventually disappear as the road continues southwest. A small southern offshoot of this road was also discovered descending due south towards a drainage. It is covered by gravels and features two metal culverts. The main alignment contains one 3-foot diameter iron culvert in the center of a built-up causeway. Roughly 80% of the main road alignment and the small southern offshoot segment lie beneath the current average waterline of the San Luis Reservoir.

An orange-white CCS core (P-24-001990) and a red CCS biface fragment (P-24-001991) were discovered along the main road alignment near where CA-MER-493H and CA-MER-494H intersect. The core was embedded in the road while the biface fragment was found lying on the surface of the road. Neither was believed to be *in situ*. CA-MER-493H was likely built to facilitate dam construction, as it leads from an industrial resource (CA-MER-492H) that was a part of the Basalt Hill Quarry (CA-MER-509H) and separation plant complex to the B.F. Sisk Dam area. The road is in fair condition despite impacts from erosion, inundation, and use by four-wheel drive vehicles.

Archival Research Summary

CA-MER-493H is located in Township 10 South, Range 8 East in the southern half of Section 27 and in the

unsectioned San Luis Gonzaga Land Grant. The land grant was patented on May 16, 1871 to Juan Pérez Pacheco (Doc #PLC 234, BLM # CACAAA 094227) (BLM 2016). The southern half of Section 27 was patented to the Southern Pacific Railroad Company on April 20, 1875 (Doc #4, BLM# CACAAA 093859) (BLM 2016). No railroad was ever built through the section, which was likely sold to unknown ranchers or other landholders. On February 23, 1892, Antonio Lopez patented the northern half of the southeast quarter and the eastern half of the southwest quarter in Section 28, which is just west of and adjacent to Section 27. He also patented the western half of the southwest quarter of Section 29 on Mary 30, 1895. Antonio Lopez had a homestead that was adjacent to an east-west road that crossed Sections 27 and 28, which may have included a small portion of the CA-MER-493H road alignment. That east-west road may have served as an early access route to the homestead during Lopez's tenure on the property (ca. 1890s to 1900).

An 1860 GLO plat map shows the Butterfield Overland Mail route and a telegraph line roughly 2 miles northeast of CA-MER-493H as they crossed Section 13, however no cultural features are depicted in Section 27. A 1909 GLO sketch map of the diseño of Rancho San Luis Gonzaga shows a stage route through the rancho, but does not show roads to the south or southeast and does not depict a road in the CA-MER-493H location (BLM 2016). The 1920 and 1940 Pacheco Pass 15-minute USGS topographic maps do not depict the road segment (USGS 1920, 1940), though they depict the east-west trending road that may have crossed or just slightly overlapped the location of CA-MER-493H. Similarly, a 1946 aerial photograph of the area and the 1953 San Luis Creek 15-minute USGS topographic map depict the east-west road alignment but not CA-MER-493H (Fairchild Aerial Surveys 1946; USGS 1953). The resource first appears on the 1969 San Luis Dam 7.5-minute USGS topographic map (USGS 1969a), which depicts the inundated San Luis Reservoir and a small segment of the road as it ascends northeast towards the dam. As it would have been inundated, most of the recorded road segment is not depicted. The tunnel associated with the neighboring industrial resource (CA-MER-492H) also first appears on the 1969 map (USGS 1969a).

Based on historic period map evidence, CA-MER-493H appears to have been established prior to the inundation of the San Luis Reservoir in 1968 but after 1953 (USGS 1953, 1969). This supports the idea that the road was established to facilitate the construction of the dam and reservoir. CA-MER-493H does not appear to have been related to the east-west trending road that passed through Sections 27 and 28, though it may have slightly overlapped that earlier alignment.

NRHP/CRHR Evaluation

CA-MER-493H is a historic period road segment that was likely constructed after 1953 and prior to 1968. As recorded in 2012 and 2016, it serves as a link between an industrial resource (CA-MER-492H) associated with construction of the B.F. Sisk Dam and a point just southwest of the dam itself. It appears to have been established to support dam and reservoir construction activities. It is evaluated under the historic contexts of *Transportation* and *Water Conveyance* in the American Period (*see* Section 3.3.3).

The B.F. Sisk Dam has been recommended eligible for listing in the NRHP and CRHR under Criterion A/1 as a contributing element to the CVP and SWP and for its contribution to the expansion and sustainability of farmland and municipal and industrial development in the Central Valley (JRP 2018). There is no evidence to indicate that CA-MER-493H was the first or only road used the in the construction of the B.F. Sisk Dam. It was likely used to convey building materials to the dam construction area, but it does not contribute to the importance of the B.F. Sisk Dam system or the wider CVP and SWP. CA-MER-493H is thus recommended as a non-contributing element to the B.F. Sisk Dam system under NRHP/CRHR Criterion A/1.

There is no evidence indicating that CA-MER-493H was developed or used during the 19th century, and no evidence linking the resource to early settlers or ranchers such as Juan Pérez Pacheco or Antonio Lopez. No connection between the resource and one or more people significant in local, state, or national history could be established. CA-MER-493H is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

CA-MER-493H is an earthworks road segment. It is not structurally unique, nor does it exemplify distinctive characteristics of a type, period, or method of construction. CA-MER-493H is recommended not eligible for inclusion in the NRHP/CRHR under Criterion C/3.

As a road segment, there is little potential to encounter a subsurface component or vertical stratigraphy at CA-MER-493H. The resource offers limited potential to address important research questions about *Transportation* and *Water Conveyance* in the American Period (*see* Section 3.3.3). CA-MER-493H is recommended not eligible for inclusion in the NRHP/CRHR under Criterion D/4.

CA-MER-493H does not appear to be actively maintained or used. It remains in fair condition despite apparent impacts from erosion and inundation and retains integrity of location, design, materials, and workmanship. Physically and functionally, it lacks some integrity of association, feeling, and setting because the industrial resource (CA-MER-492H) it once supported is no longer in operation, dam construction has been completed, and the resource is largely inundated during non-drought years. Overall, CA-MER-493H retains fair integrity. CA-MER-493H is recommended not eligible for inclusion in the NRHP/CRHR.

CA-MER-494H
P-24-001988
PL-SLLP-A-015

Recommended Not Eligible for Listing in the NRHP/CRHR

Appendix B, Figure B-1d

Lower San Felipe Intake Alternative (Basalt Point Use Area)

Description

CA-MER-494H is a historic period graded dirt road that measures approximately 8,130 feet or 1.54 miles in total length and 20 feet in width. It is oriented generally northeast-southwest and bridges the Basalt Hill Quarry (CA-MER-509H) to the south and an earthworks road (CA-MER-493H) to the north. Two segments of the road (Segments 1 and 2) were recorded during the 2012 field inventory of the Lower San Felipe Intake Alternative APE to either side of Basalt Road. Segment 1, located to the south of Basalt Road, measures approximately 1,950 feet in length and 20 feet in width. It contours though the hills downslope from the quarry and includes a number of hill cuts and causeways to maintain an approximate 5% road grade. Segment 2, located north of Basalt Road, measures 830 feet in length and 20 feet in width. It consists of a built-up causeway road covered in gravels that stands approximately 20 feet high on its west side

San Luis Reservoir Expansion Alternative (Basalt Hill Borrow Area; Proposed Staging Area; Haul Road Area)

and 15 feet high on its east side. The east side is covered with riprap and basalt boulders. During the 2016 inventory survey of the San Luis Reservoir Expansion Alternative APE, a 5,350-foot long segment of the road was recorded descending southwest towards the Basalt Hill Quarry (CA-MER-509H) from Segment 1. It also measures 20 feet in width and is consistent in construction with Segment 1.

Segment 1 and the portion of the road recorded in 2016 are located above the reservoir's high waterline and both pass through a non-native grassland area with no trees or shrubs. The northern end of Segment 1 features a berm that was constructed to deny vehicle access from Basalt Road. Segment 2 is located below the reservoir's high waterline and is bordered by sparser non-native grasses, cockleburs, and the occasional willow tree. The CA-MER-494H road alignment slopes (3-5°) to the northeast and is fully exposed. It exhibits impacts from erosion, inundation, and the use of four-wheel drive vehicles.

Archival Research Summary

CA-MER-494H is located in Township 10 South, Range 8 East in the northeastern quarter of Section 33, the northwest quarter of Section 34, and the southern half of Section 27. The southern half of Section 27 was patented to the Southern Pacific Railroad Company on April 20, 1875 (Doc #4, BLM# CACAAA 093859) (BLM 2016). No railroad was built through the section, which was likely sold to unknown ranchers or other landholders. Those areas of Sections 33 and 34 that encompass the road were patented to the State of California in 1924 (BLM# CACAAA 002567, 096293, and 096298) (BLM 2016). The area includes a natural spring, and the land may have been leased for ranching or grazing.

An 1860 GLO plat map shows the Butterfield Overland Mail route and a telegraph line roughly 2 miles northeast of CA-MER-494H as they crossed Sections 12 and 13, however no cultural features are depicted in Sections 27, 33, or 34. A 1909 GLO sketch map of the diseño of Rancho San Luis Gonzaga shows a stage route through the rancho, but does not show roads to the south or southeast and does not depict a road near the CA-MER-494H location (BLM 2016). The 1920 and 1940 Pacheco Pass 15-minute USGS topographic maps do not depict the road (USGS 1920, 1940). The 1953 San Luis Creek 15-

minute USGS topographic map depicts an east-west road alignment in Section 27 but it does not correspond to CA-MER-494H (USGS 1953). Perhaps most surprisingly, the 1969 San Luis Dam 7.5-minute USGS topographic map (USGS 1969a) does not shows the road alignment, though it does portray the inundated San Luis Reservoir and a road leading north from the Basalt Hill Mine as well as a dirt road leading southeast through Section 34. A 1946 aerial photograph of the site vicinity shows the east-west trending road through Section 27 as well as Segments 1 and 2 of CA-MER-494H (Fairchild Aerial Surveys 1946). The road segments appear to lead towards the spring in Section 34 or possibly the Basalt Hill Quarry (CA-MER-509H).

Historic period map evidence and land patent information provided few clues about when CA-MER-494H was built. In construction, it greatly resembles the historic period road (CA-MER-493H) that it intersects to the north. That road was associated with dam construction, and CA-MER-494H, which acts as a bridge between the Basalt Hill Quarry (CA-MER-509H) and the northern road, was almost certainly used during dam construction as well. Given its appearance on a 1946 aerial photograph, however, it may have originated as an earlier alignment leading to the natural spring in Section 34.

NRHP/CRHR Evaluation

CA-MER-494H is a historic period road that was likely constructed, at least in part, prior to 1946. As recorded in 2012 and 2016, it serves as a link between the Basalt Hill Quarry (CA-MER-509H) to the southwest and a historic period access road (CA-MER-493H) to the northeast that leads to the B.F. Sisk Dam area. It appears to have been established, or at least used primarily, to support the construction of the B.F. Sisk Dam and the San Luis Reservoir. It is evaluated under the historic contexts of *Transportation* and *Water Conveyance* in the American Period (*see* Section 3.3.3).

The B.F. Sisk Dam has been recommended eligible for listing in the NRHP and CRHR under Criterion A/1 as a contributing element to the CVP and SWP and for its contribution to the expansion and sustainability of farmland and municipal and industrial development in the Central Valley (JRP 2018). As a feature within the B.F. Sisk Dam system, CA-MER-494H may be regarded as a

contributing or non-contributing element under Criterion A/1. A connection to significant historic period events or trends however does not necessarily render a resource eligible for listing in the NRHP/CRHR. Rather, the role the resource played in those events or trends must be significant. There is no evidence to indicate that CA-MER-494H was the first or only road used in the construction of the B.F. Sisk Dam. It was likely used to convey stone from the Basalt Hill Quarry (CA-MER-509H) to the dam construction area, but it does not contribute in a meaningful way to the importance of the B.F. Sisk Dam system as a component within the wider CVP and SWP. CA-MER-494H is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

There is no evidence indicating that CA-MER-494H was developed or used during the 19th century, and no evidence linking the resource to early settlers or ranchers in the vicinity. No connection between the resource and one or more people significant in local, state, or national history could be established. CA-MER-494H is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

CA-MER-494H is a graded dirt road. It is not structurally unique and it does not exemplify distinctive characteristics of a type, period, or method of construction, nor does it represent the work of a master engineer. CA-MER-494H is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

As a road segment, there is little potential to encounter a subsurface component or vertical stratigraphy at CA-MER-494H. The resource offers limited potential to address important research questions about *Transportation* and *Water Conveyance* in the American Period (*see* Section 3.3.3). CA-MER-494H is recommended not eligible for listing in the NRHP/CRHR under Criterion D/4.

CA-MER-494H does not appear to be actively maintained or used. A berm blocks access to much of the resource from Basalt Road, and the northern portion of the resource would be inundated in non-drought years. Overall, it remains in fair condition despite impacts from erosion and inundation and retains integrity of location,

design, materials, and workmanship. Physically and functionally it lacks integrity of association, feeling, and setting because the quarry location (CA-MER-509H) it once supported is no longer in operation, dam construction has been completed, and the resource is partially inundated during non-drought years. Overall, CA-MER-494H retains fair integrity. CA-MER-494H is recommended not eligible for inclusion in the NRHP/CRHR.

CA-MER-495H
P-24-001989
PL-SLLP-A-016

Recommended Not Eligible for Listing in the NRHP/CRHR

Appendix B, Figure B-1d

Lower San Felipe Intake Alternative (Basalt Point Use Area)

San Luis Reservoir Expansion Alternative (Construction Impact Area)

Description

CA-MER-495H consists of a dirt road that is graded into the contour above the western end of Basalt Road and below a gated access road that leads to the Basalt Hill Quarry (CA-MER-509H). It ascends the hillslope from the northeast where it intersects a steep ravine as well as the quarry access road before continuing southwest and west towards the center of Section 28 in Township 10 South, Range 8 East. The eastern portion of the resource was first recorded during the 2012 inventory survey of the Lower San Felipe Intake Alternative APE and the western portion of the alignment was mapped during the 2016 inventory survey of the San Luis Reservoir Expansion Alternative APE. The total recorded road segment measures approximately 2,955 feet in length and 15 feet in width. The road is cut approximately 3-4 feet into the south-facing slope of a hillside and is built up about 2-3 feet on the downslope side. The road is wide enough for single vehicles to pass but not wide or stable enough to have supported heavy traffic or the large vehicles that would have been used to construct the B.F. Sisk Dam.

CA-MER-495H appears infrequently used and has been built above the inundation level of the reservoir, though it has been heavily impacted by erosion. The area surrounding the resource is fully exposed and marked by slopes of roughly 20°. The San Luis Reservoir is located just 750 feet to the northwest. Non-native grasses prevail along the road alignment, and no trees or shrubs are located in the vicinity.

Archival Research Summary

CA-MER-495H is located in Township 10 South, Range 8 East in the southeast quarter of Section 28. Section 28 represents a half-section, with the unsectioned northern half subsumed by the San Luis Gonzaga Land Grant. Section 28 was patented to Juan Pérez Pacheco on May

16, 1871 (Doc #PLC 234, BLM # CACAAA 094227) (BLM 2016). The northern half of the southeast quarter, which subsumed most of the resource area, and the eastern half of the southwest quarter were later patented by Antonio Lopez on February 23, 1892 (Doc #2241, BLM# CACAAA 096296) (BLM 2016). In 1895, Lopez also patented the western half of the southwest quarter.

An 1860 GLO plat map shows the Butterfield Overland Mail Stage route and a telegraph line as they crossed Sections 12 and 13 well to the northeast of the resource, however no historic period features were depicted in Section 28. A 1909 GLO sketch map of the diseño of Rancho San Luis Gonzaga shows a stage route through the rancho—a future alignment of SR 152—but does not show CA-MER-495H (BLM 2016). The 1920 and 1940 Pacheco Pass 15-minute USGS topographic maps do not depict the road alignment (USGS 1920, 1940). The 1953 San Luis Creek 7.5-minute USGS topographic map shows an east-west trending unimproved road spanning Sections 27, 28, and 29 to the north of the resource, but it does not appear to correspond to CA-MER-495H (USGS 1953). The road segment may represent a later southwestern offshoot from the other alignment, which may indicate a 1940s-1950s date for CA-MER-495H. The 1969 San Luis Dam 7.5-minute USGS topographic map (USGS 1969a) also fails to depict the resource, though it does depict the gated road to the Basalt Hill Quarry (CA-MER-509H).

Aerial photographs from 1946 and 1956 show the more northern east-west road alignment in the resource vicinity, but do not capture CA-MER-495H (Fairchild Aerial Surveys 1946; USDA 1957). CA-MER-495H passes approximately 750 feet south of a possible former homestead site (CA-MER-261H). Since CA-MER-495H features no associated artifacts and aerial photographs and historic period maps reveal only that it may have been present by the 1940s to 1950s, the road cannot be clearly linked to the Lopez land grant, the possible former homestead, or to any specific historic context or function.

NRHP/CRHR Evaluation

CA-MER-495H is a historic period road segment that may have been constructed in the 1940s-1950s based on its proximity and likely association with an east-west trending road to the north. It is evaluated under the historic context of *Transportation Development* in the

American Period (*see* Section 3.3.3). The construction date of CA-MER-495H and its period of use remain unclear, though it may have been associated with homesteaders or ranchers who required an east-west route outside of the San Luis Gonzaga Land Grant. The road segment could not be clearly linked to any buildings, structures, or sites within the vicinity, though a possible former homestead site (CA-MER-261H), is located just 750 feet to the north. CA-MER-495H does not appear to have been linked to any significant events or developments in local or regional history. It is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

CA-MER-495H lies within a land grant patented to Antonio Lopez in 1892, however no links could be established between the construction or use of the road segment and Lopez or any subsequent landowners or leasees. Although the builder or builders of the road remain unknown, it is unlikely that they figured prominently in local or regional history. CA-MER-495H is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

CA-MER-495H is an isolated road segment that could not be clearly linked to any other buildings, structures, or sites within the vicinity. The road segment is not structurally unique and does not exemplify distinctive characteristics of a type, period, or method of construction. The resource is thus recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

As an isolated road segment, there is little potential to encounter a subsurface component or vertical stratigraphy at CA-MER-495H. It offers very limited potential to address important research questions about *Transportation Development* in the American Period (*see* Section 3.3.3). The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion D/4.

CA-MER-495H does not appear to be maintained or in active use. Although it has been impacted by erosion, it lies above the average waterline level of the San Luis Reservoir and remains in fair condition. It retains integrity of location, design, feeling, materials, and workmanship. It lacks integrity of association, however, because it could

not be clearly linked to a particular time, event, individual, or purpose and could not be associated with other buildings, structures, or sites in the vicinity. Its integrity of setting has also likely been diminished by the inundation of the San Luis Reservoir. CA-MER-495H possesses fair overall integrity. The resource is recommended not eligible for listing in the NRHP/CRHR.

7.4.2 Combination Alternative

One historic period site, a surface debris scatter with a subsurface component dating from the late 19th century through the mid-20th century (CA-SCL-799H), was previously recorded within the Combination Alternative APE (Morgan et al. 1996). No traces of the resource were observed within the APE during the 2012 inventory survey. No cultural resources were newly discovered within the Combination Alternative APE and none were evaluated under the SLLPIP.

7.4.3 Treatment Alternative

No cultural resources were previously recorded or newly discovered within the Treatment Alternative APE (Cartier 2002), and none are evaluated as a part of the SLLPIP.

7.4.4 San Luis Reservoir Expansion Alternative

Preliminary evaluations are offered below for five previously recorded cultural resources that were encountered within the San Luis Reservoir Expansion Alternative APE. These include five prehistoric sites (CA-MER-15, CA-MER-28, CA-MER-82, and CA-MER-83), most with midden soils, groundstone, and lithic debitage, as well as a historic period ranching site (CA-MER-521H) that was recorded by Pacific Legacy in 2013 for the San Luis Transmission Line Project (Holm et al. 2014). One previously recorded resource that intersects both the San Luis Reservoir Expansion Alternative APE and the Lower San Felipe Intake Alternative APE is listed in the NRHP and the CRHR (San Luis Gonzaga Archaeological District, P-24-000489) (*see* Table 6-8). Three other previously recorded resources within the San Luis Reservoir Expansion Alternative APE include one prehistoric site (CA-MER-130) listed in the NRHP and the CRHR as a contributing element to the San Luis Gonzaga Archaeological District (P-24-000489); one historic period road network (CA-MER-477H) recommended not eligible for listing in the NRHP and CRHR; and the B.F. Sisk Dam with its appurtenant features, which have been recommended eligible for listing in the NRHP and the CRHR as the B.F. Sisk Dam/San Luis Reservoir Historic District.

Seven historic period resources (CA-MER-484H, CA-MER-489H, CA-MER-491H, CA-MER-492H, CA-MER-493H, CA-MER-494H, and CA-MER-495H) that were newly identified in 2012 within the Lower San Felipe Intake Alternative also intersect the San Luis Reservoir Expansion Alternative APE; these resources were discussed and evaluated in Section 7.4.1. Two previously

recorded isolated finds (P-24-001990 and P-24-001991) that were found within the Lower San Felipe Intake Alterative and intersect the San Luis Reservoir Expansion Alternative APE are not evaluated.

Twelve archaeological sites or built environment resources that were newly identified within the San Luis Reservoir Expansion Alternative APE in 2012 or 2016 are evaluated below. One is a prehistoric site with lithics, groundstone, and midden soils (CA-MER-517). Eleven are historic period resources and include the Basalt Hill Quarry (CA-MER-509H), two road segments (CA-MER-513H and CA-MER-519H), three earthen dams (CA-MER-515H, CA-MER-516H, and CA-MER-518H), two foundation remnants or pads (CA-MER-510H and CA-MER-512H), one ditch (CA-MER-514H), a water tank on railroad ties (CA-MER-511H), and a series of survey markers and monitoring wells (CA-MER-520H) associated with B.F. Sisk Dam construction and maintenance (*see* Table 6-8).

Of the 17 archaeological sites or built environment resources discussed below, seven have been determined not eligible for listing in the NRHP with SHPO concurrence (Polanco 2018) and recommended not eligible for inclusion in the CRHR (CA-MER-510H, CA-MER-511H, CA-MER-512H, CA-MER-513H, CA-MER-514H, CA-MER-520H, and CA-MER-521H). An additional four historic period resources (CA-MER-515H, CA-MER-516H, CA-MER-518H, and CA-MER-519H) are recommended not eligible for listing in the NRHP or CRHR, and one (CA-MER-509H) is recommended not eligible for inclusion in either register as an individual resource or as a element of the B.F. Sisk Dam/San Luis Reservoir Historic District. The evaluation of five prehistoric sites (CA-MER-15, CA-MER-28, CA-MER-82, CA-MER-83, and CA-MER-517) remains pending further investigation.

Previously Recorded Cultural Resources

CA-MER-15
P-24-000116

Pending Evaluation for Listing in the NRHP/CRHR under Criteria A/1 and D/4

Appendix A, Figure A-4c; Appendix B, Figure B-4c

Description

CA-MER-15 is a prehistoric site that was first recorded by F.A. Riddell in 1962 as a "small village site among boulders and oaks" with a former quarry on the eastern side of the site area, "several areas cleared among boulders for homes," several bedrock mortar features, and a lithic scatter (Riddell 1962b). It was later recorded that same year as a bedrock mortar site with numerous pestles, a lithic scatter with chert and obsidian and "a few arrowheads" (Gray-MacDonald 1962). A sketch map included with the later site record indicated that some surface artifacts were collected. In 1965, the site was again recorded by W.H. Olsen as a bedrock mortar, petroglyph and occupation site with "small rock shelters," one house ring, a pitted boulder, a bowl mortar, "some chippage," and a "broken fossil bone" (Olsen 1965g). None of the site records for CA-MER-15 from the 1960s include location or sketch maps

San Luis Reservoir Expansion Alternative (Reservoir Shoreline – South of Dinosaur Point Boat Ramp)

drawn to scale, though Riddell's map places the steep break of the hill some distance from the site, which is portrayed as a rocky outcrop among trees. A map of the site (author unknown) depicts some bedrock mortar measurements, a petroglyph, a pictograph, four living areas, and a midden area.

When CA-MER-15 was revisited during the 2016 inventory survey of the San Luis Reservoir Expansion Alternative APE, a complex of 73 rock features (Features 1 through 73) with petroglyphs, bedrock mortars, cupules, and milling surfaces was noted in addition to midden soils, six cleared areas (C1 through C6), 36 flaked stone tools, and a lithic scatter with three loci (Loci A through C). As most recently recorded, the site spans an area measuring 97 meters N/S by 116 meters E/W. The 73 features are spread across 94 modified boulders. Twenty-three boulders have bedrock mortars only; 33 boulders feature cupules but no bedrock mortars, though five also feature petroglyphs; 29 boulders feature both bedrock mortars and cupules, two with petroglyphs also; and three boulders exhibit one or more milling surfaces, two with petroglyphs also. One boulder contains only petroglyphs, though five boulders with cupules, two boulders with cupules and bedrock mortars, and two boulders with one or milling surfaces also feature petroglyphs. In all, 11 of the boulders exhibit petroglyphs. One large prominent boulder features pecked lines, areas with crosshatch lines, rows of cupules, and a few individual cupules. The 73 features were recorded in the western portion of the site furthest from the San Luis Reservoir waterline.

The eastern portion of CA-MER-15 is dominated by the lithic scatter, cleared areas, and midden soils. The lithic scatter contains three loci, and roughly 50% of the debitage in each was counted and analyzed during inventory survey. Locus A, the southernmost of the three, is spatially associated with three of the cleared areas (CL3 through CL5) and features dark, sandy sediment that may represent eroded midden. The locus sits on two relatively flat, narrow, very rocky benches that are dotted by large boulders that liter the surrounding east-facing slope. Sixty-two pieces of debitage were noted in Locus A, including seven pieces of chalcedony as well as 23 pieces of heat-treated chert; the remaining debitage included white or off-white to red, orange, or brown chert, mostly shatter. One chert core fragment was recorded within the

locus in addition to an area with ten small pieces of calcined mammal bone.

Locus B is located roughly 13.5 meters east of Locus C. At least 136 pieces of debitage were noted in the locus, which varied from Locus A in that it also contained purplish-red or blue and white cherts as well as a higher percentage of smaller interior percussion, complex, and bifacial thinning flakes. Several artifacts, including a vesicular basalt bowl fragment (Artifact 24), an obsidian biface fragment (Artifact 25), a unidirectional chalcedony core (Artifact 27), and a unifacial chalcedony scraper (Artifact 28) were found within or near the locus. Locus B rests on a moderately steep, east-facing slope studded with boulders and marked by light brown loamy sand with dense gravels and patches of darker brown soils that may represent redeposited midden or lacustrine sediment.

Locus C is located approximately 24 meters north of Locus A. At least 61 pieces of debitage were noted within the locus, including chalcedony and various colors of chert. The locus is dominated by simple and complex interior percussion flakes followed by bifacial thinning flakes and relatively few pieces of shatter or primary and secondary flakes. Artifacts noted within the locus included a pestle fragment (Artifact 1), a complete portable milling slab (Artifact 15), a complete basalt handstone (Artifact 16), a complete rhyolite mortar (Artifact 32), a rhyolite handstone fragment (Artifact 33), a late-stage rhyolite biface margin (Artifact 34), and a piece of calcined and possibly polished small mammal bone (Artifact 35). Other calcined bone fragments were found throughout Locus C. Approximately 75-100 pieces of debitage were observed outside of the three loci and were not analyzed.

The cleared areas at CA-MER-15 range in size from 10 meters N/S by 38 meters E/W (CL1) to just 5.5 meters N/S by 5 meters (E/W) (CL6). These areas correspond to flat areas within the site noted by Olsen in 1965 and the “living areas” plotted on another sketch map by an unknown author. The 36 tools include nine pestles, nine bowl mortars, five cores and/or hammerstones, four handstones, three portable milling slabs, one groundstone fragment, one portable mortar, two bifaces, one uniface, and one polished bone fragment. The nine pestles include three complete artifacts (Artifacts 19, 21, and 30) and five fragments (Artifacts 1, 2, 4, 7, 11, and 17); the nine bowl mortars are

all fragmentary (Artifacts 3, 5, 8, 9, 10, 22, 24, 29, and 31) and include two (Artifacts 3 and 24) that have been repurposed with single mortars; there are five complete cores, core tools/hammerstones (Artifact 12, 18, 23, 26, and 27); four handstones, including two complete artifacts (Artifact 13 and 16) and two fragments (Artifacts 14 and 33); one complete portable milling slab (Artifact 36) as well as two fragmentary ones (Artifacts 15 and 20); one groundstone fragment (Artifact 6); one complete portable mortar on a small boulder (Artifact 32); two bifaces fragments (Artifacts 25 and 34); one uniface fragment (Artifact 28); and one polished bone fragment (Artifact 35). Many of these artifacts were found within and around the three loci. The pictographs that were plotted on one of the early site maps could not be relocated and may have been destroyed through inundation or reservoir level fluctuations.

CA-MER-15 is located on the west side of the San Luis Reservoir on an east-facing slope within an oak grassland vegetation community. Grasses, wild oats, star thistle, and cockleburs also mark the site area. Soils range brown to grayish-brown sandy loam to light-brown or medium-brown loamy sand with dense gravels overlain with sporadic patches of dark brown sediment. The dark brown sediment may represent redeposited midden or organic, lacustrine-based sediment. Large and small boulders and angular scree are scattered throughout the site area. Portions of the site sit on narrow, relatively flat, very rocky benches formed by reservoir wave action. The site features an eastern aspect, a slope of approximately 6-8°, and is fully exposed. Ground surface visibility ranges from approximately 40-75%.

NRHP/CRHR Evaluation

CA-MER-15 is an extensive site containing 73 features with petroglyphs, bedrock mortars, cupules, and milling surfaces as well as midden soils, cleared areas or possible house-pits, flaked and groundstone tools, calcined bone, and a lithic scatter with three loci. Those features and cultural constituents indicate that CA-MER-15 likely represents a permanent habitation site or a temporary habitation site that was occupied repeatedly through time (*see* Section 7.3.1). Permanent habitation sites typically feature accumulated midden deposits, indicating long-term occupation; numerous, diverse cultural constituents; and house-pits or living areas. Temporary or seasonally occupied habitation sites typically lack some or most of

these indicators (*see* Section 7.3.1). An examination of the soils at CA-MER-15 suggests that the site likely contains subsurface deposits or buried cultural constituents. Repeated wave action may have removed, redeposited, or buried site sediments—impacts that may become clearer through subsurface testing. The resource is evaluated under the themes of *Economy, Settlement,* and *Cultural History and Identity* (*see* Section 7.2), particularly as they relate to prehistoric settlement practices, foodways, and group identity.

A search of the Sacred Lands Inventory by the NAHC for the CA-MER-15 vicinity did not reveal any information about the site locale, and the resource is not known to have been associated with any significant events in local or regional Native American history. The presence of numerous petroglyphs at the site and the reported presence of pictographs (not relocated) suggest that CA-MER-15 may have been locally significant to its inhabitants as a locus or expression of communal activity, shared identity, and/or ceremonial practice. Further research at CA-MER-15 would be necessary to make a recommendation as to the site's eligibility for listing in the NRHP/CRHR under Criterion A/1. Establishing the site's chronology, for instance, would allow for a better understanding of its use as an episodic or long-term occupation area.

No definitive association with one or more individuals could be established for CA-MER-15, and a literature review did not identify any prominent individuals who may have been associated with the site during the ethnographic period. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

Despite the presence of 11 petroglyph boulders at CA-MER-15, the site does not exhibit structurally or artistically unique features and does not exemplify distinctive characteristics of a type, period, or method of construction. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

The potential for CA-MER-15 to reveal subsurface components or vertical stratigraphy is high. The data potential of the site (e.g., its depth, integrity, age, and artifact diversity) thus has not been fully explored. Further investigation of CA-MER-15 may reveal information that could be used to address important research questions about

chronology, settlement, economy, and technology in northern San Joaquin Valley prehistory (*see* Section 7.2). Based on the data acquired during the 2016 inventory survey, an informed recommendation regarding the eligibility of CA-MER-15 for listing in the NRHP/CRHR under Criterion D/4 cannot be offered. If activities associated with the San Luis Reservoir Expansion Alternative may affect CA-MER-15, subsurface testing is recommended at the site to determine if it offers the potential to address important research questions such as those outlined in Section 7.2.

CA-MER-28
P-24-000129

Pending Evaluation for Listing in the NRHP/CRHR under Criterion D/4

Appendix A, Figure A-4c; Appendix B, Figure B-4c

San Luis Reservoir Expansion Alternative (Reservoir Shoreline – South of Dinosaur Point Boat Ramp)

Description

CA-MER-28 is a prehistoric site that was first recorded in 1965 by W.H. Olsen as an "occupation deposit on top of knoll" with a "few silicate flakes" (Olsen 1965c). As recorded in 2016, the site consists of midden soils with fire-affected rock, one possible heated rock feature, 31 pieces of debitage, one chert core (Artifact 1), and six groundstone artifacts (Artifacts 2-7) that span an area measuring 75 meters SE/NW by 35 meters SW/NE. The heated rock feature measures 0.5 meters N/S x 0.6 meters E/W and contains over 30 cobbles or fire-affected rocks, all of which measure 10 centimeters or less in diameter. The sediment within the feature appears to be a lighter gray and possibly hardened on the surface, which may indicate firing within an excavated pit. A single large white chert secondary flake was located along the margin of the feature.

The six groundstone artifacts include two handstones (Artifacts 5 and 6) and four groundstone fragments (Artifacts 2, 3, 4, and 7). The debitage is variable in color but is locally sourced and white to off-white and mottled with spots and bands of reddish-brown. The debitage reflects the generally poor quality of the raw material, as 17 of the 31 pieces are broken flakes or shatter. Fifteen of the 31 flakes measure 3-6 centimeters in length or more with no small (<1 centimeters) flakes identified. The single chert core is small (7.1-x-4.5-x-1.9 centimeters), and exhibits at least five flake removals. The core may have come from sandstone outcrops to the west of the site, which feature similar material embedded in the visible strata. It may also have come from the sandstone and cobble conglomerate exposed at the western end of the site near the mouth of a nearby creek. The six pieces of groundstone are all basalt. Dark to very dark gray ashy midden soils occur across the entire site area and include a deposit of eroded fire-affected

rock.

CA-MER-28 is located on a gently sloping (1-2°), southeast-facing terrace. It lies at the base of a large hill to the west and just north of an unnamed seasonal drainage that opens broadly from a narrow, V-shaped canyon. A taller, oak-studded, east-trending ridge defines the landform south of the drainage. To the east, the landscape opens up and slopes gently eastward towards the San Luis Reservoir on. The site area is fully exposed but covered in dense, knee-high grasses that offer very poor (10%) surface visibility.

CA-MER-28 contains midden soils with fire-affected rock, a possible heated rock feature, debitage, a chert core, and six groundstone artifacts. Another site, CA-MER-517, was newly discovered 35 meters to the east of CA-MER-28 and to the south of the drainage that borders it. No midden soils or fire-affected rock was observed at CA-MER-517, though the two sites may have been associated.

NRHP/CRHR Evaluation

CA-MER-28 consists of midden soils with fire-affected rock, a possible heated rock feature, 31 pieces of debitage, one chert core, two basalt handstones and four basalt groundstone fragments. CA-MER-28 may represent a short-term habitation site (*see* Section 7.3.1). Short-term habitation sites are those that were occupied for a short duration or were occupied repeatedly, though on a seasonal or short-term basis. They typically lack accumulated midden deposits, and the cultural constituents present tend to be less diverse or numerous than at permanent habitation sites (*see* Section 7.3.1). Based on the feature and artifacts observed, CA-MER-28 may have been used for short-term food processing. The presence of a possible heated-rock feature, midden, and fire-affected rock suggest that the site contains a subsurface deposit. The resource is evaluated under the themes of *Economy* and *Settlement* (*see* Section 7.2), particularly as they relate to prehistoric subsistence.

Prehistoric temporary habitation sites are relatively common in the foothills of the Diablo Range. Little is known, however, about their relationship to larger, more prominent prehistoric sites located on the western edge of the valley floor or to habitation sites located along major stream courses. A search of the Sacred Lands Inventory by the NAHC did not reveal any information about the CA-

MER-28 locale, and the resource does not appear to have been associated with any significant events in local or regional Native American history. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

No definitive association with one or more individuals could be established for CA-MER-28, and a literature review did not identify any prominent individuals who may have been associated with the site during the ethnographic period. The

site is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

CA-MER-28 does not contain structurally or artistically unique features and does not exemplify distinctive characteristics of a type, period, or method of construction. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

Given that CA-MER-28 includes midden soils with fire-affected rock, a possible heated rock feature, groundstone, and lithic debitage, the potential for the site to reveal subsurface components or vertical stratigraphy is high. Thus, the data potential of the site (e.g., its depth, integrity, age, and artifact diversity) has not been fully explored. Further investigation of CA-MER-28 may bring to light information regarding its potential to address important research questions about chronology, settlement, economy, and technology in northern San Joaquin Valley prehistory (*see* Section 7.2). Based on the limited data acquired during inventory survey, an informed recommendation regarding the eligibility of the site for listing in the NRHP/CRHR under Criterion D/4 cannot be offered. If any of the San Luis Reservoir Expansion Alternative are implemented, subsurface testing is recommended to determine if CA-MER-28 offers the potential to address important research questions such as those outlined in Section 7.2.

CA-MER-82 P-24-000182

Pending Evaluation for Listing in the

Description

CA-MER-82 is a prehistoric site that was first recorded in 1966 by W.H. Olsen as a small occupation deposit on a bench above a creek featuring dark, rocky midden soils as well as lithic debitage and fire-affected rock. As recorded in 2016, the site comprises one edge-modified flake (Artifact 1), eight pieces of chert debitage, and three pieces of

NRHP/CRHR under Criterion D/4

Appendix A, Figure A-4e; Appendix B, Figure B-4e

groundstone (Artifacts 2-4) along the northern margin of the previously recorded site boundary within an area that measures 30 meters N/S and 62 meters E/W. Several of the artifacts were found in a sandy area in slightly darker soil that may represent the remnants of an eroded midden deposit.

Artifact 1 consists of an edge-modified flake fashioned from dark gray chert that measures 5.2-x-3.1-x-0.8 centimeters and exhibits use wear along its margins. Artifact 2 is a vesicular basalt groundstone fragment that measures 18-x-12-x-3.6 centimeters found in a sandstone conglomerate in close proximity the main area of the site. Both Artifacts 3 and 4 consist of possible millingstone fragments fashioned from sandstone that measure 3.15-x-14.2-x-7.5 centimeters and 18.2-x-11.4-x-4.0 centimeters.

San Luis Reservoir Expansion Alternative (Reservoir Shoreline – West Side of San Luis Creek Inlet)

CA-MER-82 is located on the western side of the San Joaquin Valley along the southwestern edge of the San Luis Reservoir. It is situated within a northeast-facing trough or swale formed by rolling hills to the south, west, and north. Several deeply entrenched seasonal drainages flow into the swale from the south, west, and southwest. The site itself rests on a relatively level, wave-eroded bench that is bordered to the southeast by an unnamed drainage. All artifacts at CA-MER-82 were recorded below the current maximum waterline at an elevation of 400-440 feet amsl and would typically be inundated in non-drought years. On-site vegetation consists of dense knee-high grass, mustard weed, and patches of cockleburs. Several artifacts were found in a sandy area with slightly darker soils and that may represent eroded midden; soils on-site generally consist of tan/orange gravelly sand. The site features a northeastern aspect, minimal slope (1-2°), and is fully exposed.

CA-MER-82 consists of one edge-modified flake, eight pieces of chert debitage, and three pieces of groundstone, including two possible milling slab fragments. Another site, CA-MER-42, was previously recorded approximately 215 meters to the northeast of CA-MER-82 and would have bordered the same seasonal drainage. As originally recorded, it included a rocky midden deposit with lithic debitage (Olsen 1966c); groundstone artifacts were also observed at the site during the 2016 inventory survey. The site may have been associated with CA-MER-82.

NRHP/CRHR Evaluation

CA-MER-82 consists of eight pieces of debitage and three pieces of groundstone as well as a possible remnant midden soils area. The site may have been a short-term habitation or activity-specific site (*see* Section 7.3.1), though given apparent effects to the site from prior inundation its function may be difficult to distinguish. Short-term habitation sites were occupied for a short duration or occupied repeatedly on a seasonal or limited basis while activity-specific sites tended to be used for a fairly narrow range of tasks (e.g., quarrying for lithic material, food processing). Based on the artifacts observed, CA-MER-82 may have been used for food processing. The presence of possible midden at the site suggests that it may retain a subsurface component. The resource is evaluated under the themes of *Economy* and *Settlement* (*see* Section 7.2), specifically as they relate to prehistoric subsistence.

Prehistoric temporary habitation and activity-specific sites are relatively common in the foothills of the Diablo Range. A search of the Sacred Lands Inventory by the NAHC for the site vicinity did not reveal any information about the CA-MER-82 locale, and the resource does not appear to have been associated with any significant events in local or regional Native American history. The site is therefore recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

No definitive association with one or more individuals could be established for CA-MER-82, and a literature review did not identify any prominent individuals who may have been associated with the site during the ethnographic period. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

Based on surface evidence from an inventory survey, CA-MER-82 does not contain any unique features and does not exemplify distinctive characteristics of a type, period, or method of construction. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

CA-MER-82 includes surface artifacts in the form of two possible milling slab fragments, one groundstone fragment, one edge-modified flake, and eight pieces of chert debitage. It may also include the remnants of a midden deposit, evident though an area featuring darker soils as well as several artifacts. The potential for the site to reveal a

subsurface component or vertical stratigraphy is considered moderate to high, though the data potential of CA-MER-82 (e.g., its depth, integrity, age, and artifact diversity) has not been fully explored. Further investigation of the site could reveal more about its potential to address important research questions relating to chronology, settlement, economy, and technology in northern San Joaquin Valley prehistory (*see* Section 7.2). Based on the materials observed during inventory survey, a recommendation regarding the eligibility of the site for listing in the NRHP/CRHR under Criterion D/4 cannot be made. If any of the San Luis Reservoir Expansion Alternative are implemented, subsurface testing is recommended to determine if CA-MER-82 offers the potential to address

important research questions that might render it eligible for listing in the NRHP/CRHR.

CA-MER-83 P-24-000183

Pending Evaluation for Listing in the NRHP/CRHR under Criterion D/4

Appendix A, Figure A-4e; Appendix B, Figure B-4e

San Luis Reservoir Expansion Alternative (Reservoir Shoreline – South of Dinosaur Point Boat Ramp)

Description

W.H. Olsen first recorded CA-MER-83 in 1966 as a prehistoric "rocky midden deposit on prominence just above stream" (Olsen 1966d). In 2016, the site was recorded as an area of midden soils with fire-affected rock, eight groundstone artifacts (Artifacts 3-8 and 13-14), and six pieces of lithic debitage (Artifacts 1-2 and 9-12) distributed across an area measuring 59 meters N/S by 53 meters E/W. The midden soils are concentrated in the central portion of the site and consist of dark gray or nearly black soils with fire-affected rock. The eight groundstone artifacts include five handstone fragments (Artifacts 3-5 and 13-14), two fragments of indeterminate shape and function (Artifacts 7-8), and one possible milling slab fragment (Artifact 6). The lithic debitage includes three pieces of chert shatter (Artifacts 1, 2, and 9) as well as two chert secondary flakes (Artifacts 10-11) and one chalcedony secondary flake (Artifact 12). The chert debitage is fashioned from white or cream colored material with orange or brown inclusions and the groundstone artifacts are composed of basalt.

CA-MER-83 consists of an area of midden soils with fire-affected rock, eight groundstone artifacts, and six pieces of debitage. Another site, CA-MER-138, was previously recorded approximately 130 meters to the southwest of CA-MER-83 and would have bordered the same seasonal drainage. It was recorded as a large midden site on a knoll (Olsen 1973), and it may have been associated with CA-

MER-83. CA-MER-138 was not relocated in 2016 but lay well outside of the San Luis Reservoir Expansion Alternative APE.

CA-MER-83 is located in an open oak woodland vegetation zone with sparsely scattered oaks. The site area is densely covered with Indian rice grass, wild oats, foxtails, star thistle, and seasonal forbs and grasses that offer very poor (0-10%) surface visibility. The site lies on a flat bench on the south side of an unnamed drainage. CA-MER-83 features a northwestern aspect, a gentle (0-5°) slope, and is fully exposed. Non-midden soils are a rocky, semi-compact, light brown to brown silty clay loam.

NRHP/CRHR Evaluation

The site consists of midden soils with fire-affected rock, eight groundstone fragments, and six pieces of debitage. CA-MER-83 may have functioned as a short-term habitation or activity-specific site (*see* Section 7.3.1). Short-term habitation sites were occupied for a limited duration or occupied repeatedly on a seasonal or short-term basis while activity-specific sites would have been used for a limited range of tasks (e.g., quarrying for lithic material, food processing). The presence of midden and groundstone suggest that CA-MER-83 may have been used for food processing. The presence of possible midden at the site also suggests that it may retain a subsurface component. The resource is evaluated under the themes of *Economy* and *Settlement* (*see* Section 7.2), with emphasis on prehistoric subsistence.

A search of the Sacred Lands Inventory by the NAHC for the site vicinity did not reveal any information about the CA-MER-83 locale, and the resource does not appear to have been associated with any significant events in local or regional Native American history. The site is therefore recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

No definitive association with one or more individuals could be established for CA-MER-83, and a literature review did not identify any prominent individuals who may have been associated with the site vicinity during the ethnographic period. The site is recommended not eligible

for listing in the NRHP/CRHR under Criterion B/2.

Based on surface evidence from an inventory survey, CA-MER-83 does not contain any unique features and does not exemplify distinctive characteristics of a type, period, or method of construction. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

CA-MER-83 includes surface artifacts in the form of one possible milling slab fragment, five handstone fragments, two indeterminate groundstone fragments, six pieces of debitage, and midden soils with fire-affected rock. The site offers moderately high potential to reveal a subsurface component or vertical stratigraphy, though its data potential (e.g., its depth, integrity, age, and artifact diversity) has not been fully explored. Further investigation of the site could reveal more about its potential to address important research questions relating to chronology, settlement, economy, and technology in northern San Joaquin Valley prehistory (*see* Section 7.2). Based on the limited data acquired during inventory survey, a recommendation regarding the eligibility of the site for listing in the NRHP/CRHR under Criterion D/4 cannot be offered. If any of the San Luis Reservoir Expansion Alternative are implemented, subsurface testing is recommended to determine if CA-MER-83 offers the potential to address important research questions that might render it eligible for listing in the NRHP/CRHR.

CA-MER-521H
P-24-002173
SLTP-B-11

Determined Not Eligible for Listing in the NRHP

Recommended Not Eligible for Listing in the CRHR

Appendix A, Figure A-4d; Appendix B,

Description

CA-MER-521H is a historic period livestock watering locale that consists of an elevated, cylindrical water tank and a circular trough. Pacific Legacy personnel first recorded the site in 2013 during the Western Area Power Administration's San Luis Transmission Line Project (Holm et al. 2014). The final archaeological survey report for the project remains pending submission to the CCIC by Western. When the site was revisited in 2016, it was found to be unchanged and its features remained intact.

The elevated arc-welded, ferrous metal water tank sits on a railroad tie platform enclosed by an electric fence (Feature 1). It measures 6 feet in diameter and 17 feet in length. The circular trough (Feature 2) is made of corrugated metal with railroad tie and milled lumber supports. It measures 9 feet

Figure B-4d

San Luis Reservoir Expansion Alternative (Borrow Area 6 - South of O'Neill Forebay)

in diameter, stands 2 feet high, and rests on 52-inch high supports. No artifacts or other materials were observed in association with the site, which encompasses an area measuring 79 feet east-west by 66 feet north-south. CA-MER-521H is located roughly 0.5 miles to the southeast of the San Luis Reservoir on a flat floodplain that is dominated by dry seasonal grasses and mustard weed. It is located at an elevation of 259 feet amsl and is fully exposed.

Archival Research Summary

CA-MER-521H lies within Section 18 of Township 10 South, Range 9 East. An 1855 GLO plat map of Section 18 depicted no structures or cultural features within the site vicinity (BLM 2016). Records indicate that on May 20, 1869, B. Bryant obtained a land patent for Sections 18, 24, 10, and 14 through cash entry (Doc #3279, #CACAAA 097971). A later 1888 GLO plat map depicts a road trending north from Section 19 through the south-central portion of Section 18 before terminating near the center of the section. The north-south road was labeled "the Road from D[???'s] San Luis and Stockton" and passed through an area that is today dominated by the Los Banos Substation (BLM 2016). The northwest corner of Section 18 was labeled as "the old sec. corner at corner of Miller and Lux's fence" (BLM 2016). An agricultural field lay at the center of the southern Section 18 line and was crossed by the road. The closest structure to CA-MER-521H depicted on the 1888 GLO plat map was described as "J. Alamanie's house," which was sited in the northwest corner of Section 19, roughly 1 mile to the southwest of CA-MER-521H (BLM 2016). Section 18 appears to have been used as an agricultural or ranch property in the 1870s to at least 1890, but it remains unclear if the property was associated with B. Bryant, J. Alamainie, or with the landholdings of Miller and Lux (*see* Section 3.3.3). Well records dating to 1916 revealed wells in Sections 1 and 24, but none were recorded in Section 18 (Mendenhall et al. 1916: Table 45; Davis et al. 1959).

The 1920 Pacheco Pass and 1922 San Luis Creek USGS 15-minute topographic maps show no buildings, structures, or access roads within the vicinity of CA-MER-521H (USGS 1920, 1922a). The 1940 Pacheco Pass USGS 15-minute topographic map shows no roads leading to the site area, but does depict two structure complexes located approximately 0.5 miles to the northwest and southeast of

CA-MER-521H. A utility line appeared along the southern border of Section 18 by 1939 (USGS 1940a). The 1953 San Luis Creek USGS 7.5-minute topographic shows no developments in Section 18, though it does depict several wells and windmills in the surrounding sections (USGS 1953).

The 1925 *History of Merced County* did not mention B. Bradley, who was noted in 1869 land patent records in association with Section 18, though it did mention that "Sadie Bradley was born at Mustang, Merced County" to William T. and Frances Bradley (Outcalt 1925: 650). In the 1900 US Census, William T. Bradley was listed as a farmer in Newman Township, Merced County (US Census Bureau 1900b). By 1906, voter records showed that the Bradleys resided in Ingomar where William T. Bradley ran a general store and served as postmaster (Merced County 1906). No clear association between the Bradley family and Section 18 or the CA-MER-521H vicinity could be established for the early to mid-20th century period when the water tank and trough were likely constructed, however, nor could the site be clearly linked to the Miller and Lux operation or to any other specific landowner.

NRHP/CRHR Evaluation

CA-MER-521H appears to be a mid-20th century livestock watering locale. The site is evaluated under the historic context of *Ranching and Agriculture* in the American Period (*see* Section 3.3.3). Based on evidence derived from historic period maps, land patent records, a history of Merced County, and the site's material constituents, the site appears to post-date the height (the late 19th century through the 1920s) of Central Valley agricultural and ranching development. The livestock watering locale does not appear to have been associated with significant events in local or state history, thus the site is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

Archival research did not identify the owners and operators of the ranch with which CA-MER-521H was associated. The property may have been associated with the Bradley family, J. Alamainie, Miller and Lux, or with another unidentified party. No firm association with any individual or individuals c

not exemplify distinctive characteristics of a type, period, or method of construction. The site is recommended not

eligible for listing in the NRHP/CRHR under Criterion C/3.

ot eligible for listing in the NRHP/CRHR under Criterion D/4.

CA-MER-521H is in good condition despite the installation of an electric fence around the site. It retains integrity of location, design, setting, materials, t has likely altered the site's integrity of feeling and association.good overall integrity. CA-MER-521H is recommended not eligible for listing in the NRHP/CRHR.

In support of NHPA Section 106 Consultation for the B.F. Sisk Dam Corrective Action Study Geotechnical Investigations, Merced County, California (Project # 18-SCA0-002.00 I), the SHPO concurred that CA-MER-521H is not eligible for listing in the NRHP (Polanco 2018).

Newly Identified Cultural Resources

CA-MER-509H
P-24-002154
PL-SLLPIP-16-01

Recommended Not Eligible for Listing in the NRHP/CRHR, (Non-Contributing Element to the B.F. Sisk Dam System)

Appendix B, Figure B-4f

San Luis Reservoir Expansion Alternative (Basalt Hill Borrow Area; Haul Road Area)

Description

CA-MER-509H, or the Basalt Hill Quarry, is a historic period industrial resource that spans 3,900 feet NW/SE by 2,550 feet NE/SW. It represents the main element of a quarry and separation plant complex built in 1963 to process basalt into riprap for construction of the B.F. Sisk Dam (Autobee 2011: 11-12; Berman 2012: pers. comm.; Reclamation 1974: 49). A smaller industrial resource (CA-MER-492H) that was connected to the Basalt Hill Quarry via a conveyor belt is located approximately 2,500 feet downslope and to the northeast; it received riprap separated at the main quarry area that was then transported for construction of the dam and its appurtenant facilities. The conveyor belt was removed following construction of the dam, but the grade that supported it remains clearly visible. A historic period earthworks road (CA-MER-494H) linked the Basalt Hill Quarry to the dam area, while a second graded dirt road (CA-MER-493H) led from CA-MER-492H to the dam area.

The Basalt Hill Quarry has largely modified the entire western shoulder of Basalt Peak, which is located approximately 1,500 feet to the east and reaches a maximum elevation of 1,707 feet amsl. Descending from near the top of the hillslope, the quarry is divided into five terraces (Terraces 1-5) representing five elevations of the mining operation. Four features were identified, including a

cairn with a metal post (Feature 1); a series of concrete equipment pads (Feature 2); a large gravity separator built into the hillside (Feature 3); and a triangular equipment pad (Feature 4) that falls outside of the quarry boundary but may be associated with the operation of Feature 3. Few cultural materials were noted across the quarry area, but included a few pieces of milled lumber, heavy 3-inch diameter wire rope, nuts and bolts, heavy equipment parts, and pieces of metal grating. A single soft-top beverage can was found that dates from the late 1950s to the early 1960s (Maxwell 1993). An area near Feature 3 identified as Concentration 1 contains additional materials such as plate glass, indicating that some form of structure, potentially an operations office, once stood there. Several two-track roads provide access to much of the site, and massive rock ramps, likely for heavy equipment, link the terraces.

The features present at the Basalt Hill Quarry reflect how infrastructure within the site was likely placed and used. Most significant was Feature 3, a large (85 feet N/S by 75 feet E/W) rock and aggregate size-sorter/separator that was built into a steep, north-facing slope at the northern edge of the resource. This 80-foot tall reinforced concrete structure was used to sort larger mined materials from the quarry into various sizes for use in different locations or aspects of the dam's construction. Material from the quarry was used for rock fill, riprap, and bedding. Quarried material was pushed into the top of Feature 3 and separated at the eight-inch size, with some materials crushed to manufacture bedding materials (California Department of Water Resources 1974: 279). The smaller fraction was transported via conveyor belt to CA-MER-492H where the material was picked up by trucks.

Much of the Basalt Hill Quarry area has essentially been denuded of soils and surface vegetation, offering good (70-80%) ground surface visibility, though portions of the site are dominated by low grasses and occasional shrubs. The 1953 San Luis Creek 7.5-minute USGS topographic map shows that the site area featured a relatively gentle slope (5-6°) to the northwest, with a steep drop along the western margin of the landform. After the quarry was abandoned, the area had been leveled in five main, nearly flat terraces, with piles of rock spotting the landscape and some rock debris pushed off the steep western flank of the hillside. The area surrounding the site is dominated by waist-high and taller grasses, sparse mustard and thistle, and occasional

trees in the lower lying areas. The Basalt Hill Quarry remains in fair condition with few visible impacts. The main impacts relate to the decommissioning of the resource—standing superstructures have been removed and there are very few artifacts present, likely as a result of cleanup activities following construction of the dam.

Archival Research Summary

CA-MER-509H is located in Township 10 South, Range 8 East in Section 33. All of Section 33 was patented to the Southern Pacific Railroad Company on April 20, 1875 (Doc #4, BLM# CACAAA 093859) (BLM 2016), though no railroad was ever built through the area. An 1860 GLO plat map depicts drainages along the northern edge of the section, but no historic period development (BLM 2016).

The 1920 Pacheco Pass and 1922 San Luis Creek 15-minute USGS topographic maps do not show the quarry or any access routes at the site location, though they do show that later quarrying activates flattened much of the Basalt Hill area (USGS 1920, 1922a). Similarly, the 1940 Pacheco Pass 15-minute USGS topographic map does not show any historic period development within the site area (USGS 1940). The 1953 San Luis Creek 7.5-minute USGS topographic map shows that the resource area remained unmodified (USGS 1953), though a fire lookout (P-24-000078) and a south-trending access road had been established on the top of Basalt Hill by that time. The Basalt Hill Quarry first appears on the 1969 San Luis Dam 7.5-minute USGS topographic map (USGS 1969a), which also depicts the San Luis Reservoir and one of the features at CA-MER-492H. This supports historic period accounts that the Basalt Hill Quarry and separation plant complex were established in 1963 to support construction of the B.F. Sisk Dam and San Luis Reservoir, which were completed in 1967 (Autobee 2011: 11-12; Reclamation 1974: 49).

In describing how the complex would have operated, Autobee (2011: 11) noted that

> Rock for zones 4 and 5 on the upstream face of the dam were extracted from a quarry at the top of nearby Basalt Hill. The quarry-run rock was excavated with a 15 cubic yard electric shovel and transported by 75-ton trucks to a separation plant. This plant separated the rock into plus-and-minus nine-inch sizes. Huge bar screens directed the

> larger size rock into a hopper that loaded the zone 5 material into 60-ton rear-dump trucks. The trucks had special braking systems for hauling safely down the steep access road. The smaller zone 4 rock dropped onto a 3,200-foot long conveyor belt down the hillside. This ended on a cantilevered tower over a 100-foot high stockpile at the bottom. There was a drive-through tunnel under the pile that allowed 100-ton trucks to be loaded in two minutes.

The Basalt Hill Quarry and separation plant complex was thus used for quarrying and separating rock fill, bedding, and riprap. CA-MER-492H would have been used to receive "smaller zone 4 rock" transported from the Basalt Hill Quarry via the "3,200-foot long conveyor belt" (Autobee 2011: 11).

After construction of the B.F. Sisk Dam was completed in 1967, the quarry and riprap separation plant were shut down. The conveyor belt linking the Basalt Hill Quarry to CA-MER-492H was removed, and superstructures were dismantled as a part of site cleanup (Autobee 2011: 11). The gravity rock separator at CA-MER-509H represents a substantial structure, though it was not unique. Similar separators were built for the 1966-1971 construction of Cedar Springs Dam and Silverwood Lake in Southern California (California State Parks 2009: 8).

NRHP/CRHR Evaluation

CA-MER-509H is a historic period resource that comprised the main element of the Basalt Hill Quarry and separation plant complex. This complex was established in 1963 to support the construction of the B.F. Sisk Dam and the San Luis Reservoir and was a part of the larger dam system. CA-MER-509H is evaluated as a part of that larger system under the historic context of *Water Conveyance* in the American Period (*see* Section 3.3.3).

The B.F. Sisk Dam and its appurtenant features were recommended eligible for listing in the NRHP and CRHR under Criterion A/1 as a contributing element to the CVP and SWP and for its contribution to the expansion and sustainability of farmland and municipal and industrial development in the Central Valley (JRP 2018). As a feature within the B.F. Sisk Dam system, CA-MER-509H may be

regarded as a contributing or non-contributing element under Criterion A/1. A connection to significant historic period events or trends is insufficient by itself to render a resource eligible for listing in the NRHP/CRHR under Criterion A/1. Rather, the role the resource played in those events or trends must be significant. The dam symbolizes the first and only state-federal collaboration in California water development to be conducted on such a large scale (Autobee 2011). The Basalt Hill Quarry and separation plant complex was created and used to support the construction of the B.F. Sisk Dam, however its role in the development of the dam and its key facilities was transitory and not sufficiently significant to render CA-MER-509H a critical part of the dam complex. CA-MER-509H is recommended as non-contributing element to the B.F. Sisk Dam system under NRHP/CRHR Criterion A/1.

No connection between the resource and one or more individuals significant in local, state, or national history could be established. Although the dam is named for former US Congressman Bernice Sisk, that association is commemorative and too tenuous to be regarded as significant under NRHP/CRHR Criterion B/2. CA-MER-509H is thus recommended as a non-contributing element to the B.F. Sisk Dam system under NRHP/CRHR Criterion B/2.

The Basalt Hill Quarry and separation plant complex was used for quarrying and separating rock fill, bedding, and riprap. Structurally, the complex is not unique or distinctive in engineering or architecture. Cedar Spring Dam and Silverwood Lake in Southern California also used a gravity separation plant when quarrying rock for construction in the 1960s (California Dept. of Water Resources 1974: 328). Similarly, other elements of CA-MER-509H such as the terraces and other features are not structurally unique or distinctive. CA-MER-509H is recommended as a non-contributing element to the B.F. Sisk Dam system under NRHP/CRHR Criterion C/3.

As an industrial resource, there is little potential to encounter a subsurface component or vertical stratigraphy at CA-MER-509H, and few surface artifacts remain. Much of the research potential for the Basalt Hill Quarry and separation plant complex may be derived from archival documents and historic period photographs rather than through the resource’s physical remnants. CA-MER-509H

is recommended as a non-contributing element to the B.F. Sisk Dam system under NRHP/CRHR Criterion D/4.

CA-MER-509H is not actively maintained or used. It remains in fair condition despite impacts from decommissioning and retains integrity of location and workmanship. Integrity of materials is diminished because portions of the resource have been removed. It retains integrity of setting and association as the reservoir and dam are nearby, though integrity of association has been somewhat lessened by the removal of superstructures (i.e., possible structure near Concentration 1, conveyor belt) that were a part of the site and that tied the site to other areas of the complex. The aspect of feeling also has been somewhat diminished as construction of the dam and reservoir have long been completed. CA-MER-509H possesses fair overall integrity. CA-MER-509H possesses fair overall integrity. It is recommended as a non-contributing element to the NRHP/CRHR eligibility of the B.F. Sisk Dam system, recently defined as the B.F. Sisk Dam/San Luis Reservoir Historic District (JRP 2018).

CA-MER-510H
P-24-002155
PL-SLLPIP-16-02

Determined Not Eligible for Listing in the NRHP
Recommended Not Eligible for Listing in the CRHR

Appendix B, Figure B-4d

San Luis Reservoir Expansion Alternative (Borrow Area 6 - South of O'Neill Forebay)

Site Description

CA-MER-510H consists of a concrete foundation pad (Feature 1) with four raised concrete blocks with 1-inch diameter threaded studs with nuts. Approximately 100 feet east-southeast of Feature 1 is a large basalt rock with a 5-inch diameter bore hole drilled through it that does not appear to be associated with the resource. The concrete foundation pad may have supported compressors or similar equipment, but its function is unclear. Feature 1 is shaped roughly like the Roman numeral "II" and is made from rounded aggregate; it has a smoothed surface and beveled edges. No artifacts were noted in association with the feature, and its date of construction remains indeterminate. Nearby structures depicted on historic period topographic maps of the area indicate that the foundation may date to the 1940s or 1950s.

CA-MER-510H is located on the west side of the San Joaquin Valley along the southern shore of the O'Neill Forebay in a flat, open area. Surface visibility is poor due to dense knee-high vegetation that includes grasses, foxtails, mustard weed, vinegar weed, and sticky tarweed. The site is located roughly 80 feet south of an inoperative electric fence and 100 feet south of an east-west trending access

road.

Archival Research Summary

CA-MER-510H is located in Township 10 South, Range 8 East in the northwest corner of Section 13. An 1860 GLO plat map depicts the Butterfield Overland Stage route and telegraph line in Section 13 but does not depict any structures near the resource location (BLM 2016). The Southern Pacific Railroad Company patented all of Section 13 on April 20, 1875, (BLM 2016) but did not develop the land.

The 1920 Pacheco Pass 15-minute USGS topographic map shows that the original alignment of SR 152 passed through Section 13 near the site location (USGS 1920). By 1940, three houses were depicted on the General Highway Map of Merced County within Section 13, roughly 0.25 miles to the west, south-southwest, and south-southeast of the resource location (DPW-DH 1940). The 1940 Pacheco Pass 15-minute USGS topographic map shows that SR 152 had by then been rerouted to the southern edge of Section 13; it also shows that a series of telegraph lines followed the 1920 road alignment to the western edge of Section 13 before proceeding south along the section line to follow the new road alignment (USGS 1940). The 1940 map portrays a cluster of four buildings and an access road to the northeast of the resource area. The 1953 San Luis Creek 7.5-minute topographic map shows a house and windmill to the northeast of the site area, while the 1969 San Luis Dam 7.5-minute USGS topographic map shows the resource location to the south of O'Neill Forebay and to the north of a utility line (USGS 1953, 1969). Aerial photographs from 1946 depict structures to the northeast of the site area, but no structures could be clearly discerned near CA-MER-510H (Fairchild Aerial Surveys, Inc. 1946). CA-MER-510H may have been associated with the 1940s-era structures or with the 1950s-era house and windmill to the northeast.

NRHP/CRHR Evaluation

CA-MER-510H is a historic period concrete foundation pad with no associated artifacts. The site is evaluated under the historic context of *Ranching and Agriculture* in the American Period (*see* Section 3.3.3). Based on historic period maps, land patent records, and historic period aerial photographs, the site was most likely associated with nearby structures constructed in the 1940s to 1950s-era. The site is

also located near the 1940s-era alignment of SR 152 and may be associated with it. If CA-MER-510H was associated with ranching and/or agricultural activities, it likely post-dated the height of ranching in the Central Valley (the late 19th century through the 1920s). CA-MER-510H does not appear to have been associated with events significant in local or regional history, and is therefore recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

No association between CA-MER-510H and one or more individuals was revealed through archival research, so no link could be established between the feature and persons significant in local or regional history. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

CA-MER-510H consists of a concrete foundation that is missing its superstructure. The feature is not structurally unique and does not exemplify distinctive characteristics of a type, period, or method of construction. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

The site is made up of a single foundation. A boulder with a 5-inch diameter drilled hole lies roughly 100 feet east-southeast of the foundation, but it is temporally non-diagnostic and its association with the resource remains uncertain. The site does not contain materials that might be used to address important research questions regarding ranching and agriculture, transportation, or other potential research themes. Thus, the site is recommended not eligible for listing on NRHP/CRHR under Criterion D/4.

CA-MER-510H is in poor condition; it is largely subsumed by vegetation and the concrete that forms the foundation is crumbling. Although the resource retains integrity of location, the equipment and/or superstructure that once made up a part of the site has been removed, thus affecting its integrity of design, materials, and workmanship. Its integrity of setting, feeling, and association has presumably been diminished by the construction of the reservoir and dam and, possibly, by the re-routing of SR 152. Overall, the integrity of CA-MER-510H is fair to poor. CA-MER-510H is recommended not eligible for listing in the NRHP/CRHR.

In support of NHPA Section 106 Consultation for the B.F. Sisk Dam Corrective Action Study Geotechnical

Investigations, Merced County, California (Project # 18-SCA0-002.00 I), the SHPO concurred that CA-MER-510H is not eligible for listing in the NRHP (Polanco 2018).

CA-MER-511H
P-24-002156
PL-SLLPIP-16-03

Determined Not Eligible for Listing in the NRHP

Recommended Not Eligible for Listing in the CRHR

Appendix B, Figure B-4d

San Luis Reservoir Expansion Alternative (Borrow Area 6 - South of O'Neill Forebay)

Site Description

CA-MER-511H is an apparent historic period livestock corral and watering location. It consists of a large, welded water tank set atop railroad tie supports situated within a corral that features a loading chute, a livestock access gate, fencing, and two circular metal water troughs. The corral fencing is portable and constructed of a variety of materials including metal piping, barbed wire, 4-x-4 wooden posts, remnant telephone poles, and other wooden posts. The welded water tank is set atop railroad tie supports for stabilization and constructed in three sections. The tank measures 17 feet in length and stands 6 feet high. The livestock-loading chute is positioned at the far northwestern corner of the corral. The livestock access gate is situated along the northeastern side of the corral and is constructed from metal piping and sheet metal. The "W" ranch brand or logo was cut into areas of the metal gate and on the corral fencing adjacent to the gate, but could not be identified as a current California brand (CDFA 2010). One metal water trough lies within the corral; it is circular with a wood-framed float protector. An upside-down circular metal water trough lies outside and to the west of the corral. Most of the components that make up CA-MER-511H are portable and could be reconfigured.

CA-MER-511H is located 0.36 miles to the south of the O'Neill Forebay and 0.26 miles north of the current alignment of SR 152. It lies just south of a northwest-southeast oriented transmission line and north of a road and a second transmission line. A gated access road to the north extends to the east from the main road around O'Neill Forebay. The site area is fully exposed, relatively flat, and densely covered by knee-high grasses, mustard weed, vinegar weed, and sticky tar weed that limit ground surface visibility.

Archival Research Summary

CA-MER-511H is located in Township 10 South, Range 9 East in the southeast quarter of Section 13. An 1879 GLO plat map depicts the Butterfield Overland Mail route and a telegraph line crossing the northwest quarter of Section 13 but depicts nothing in the resource location (BLM 2016). The 1920 Pacheco Pass 15-minute USGS topographic map

shows the original alignment of SR 152 through the northwest quarter of Section 13 (USGS 1920). The 1940 Pacheco Pass 15-minute USGS topographic map shows that SR 152 had been rerouted to the southern edge of Section 13 and that one cluster of four buildings and another cluster of two buildings had been built in the northeast quarter of Section 13 (USGS 1940a). The 1953 San Luis Creek 7.5-minute USGS topographic map shows two wells and a windmill in the northeast quarter and a northwest-southeast trending utility line (USGS 1953). The 1969 San Luis Dam 7.5-minute USGS topographic map portrays the O'Neill Forebay to the north as well as an east-west trending utility line that follows SR 152. It also depicts a paired utility line immediately north of the resource that trends northwest-southeast and does not follow the alignment depicted on the 1953 map (USGS 1972). A 1946 aerial photograph shows the structures in the northeast quarter of Section 13, but no features are discernible in the area surrounding CA-MER-511H. A 1940 General Highway Map of Merced County depicts houses in the southwest, southeast, and northwest quarters of Section 13, and it is possible that the livestock complex is associated with the house in the southeast quarter.

The Final EIS/EIR for the San Luis Reservoir State Recreation Area mentions recent use of the resource area:

> March 19, 1996, Concession Contract, Cattle Grazing. Located at San Luis Reservoir State Recreation Area, Medeiros Area in Merced County. This is a legal contract between the State and Chet Vogt, granting Mr. Vogt the right, privilege, and duty to graze cattle on an approximately 1,000-acre tract of the Medeiros Area located south of O'Neill Forebay, for the period of 8 months. Attached to the contract is a CEQA project evaluation (Reclamation 2013: Appendix A: A-19).

The 1940 US Census noted that George Vogt, a farmer, lived north of Merced in Merced County (United States Census Bureau 1940). Although the connection is tenuous and not traceable through land patent records, it is possible that the Vogts have had ties to the area since the historic period, perhaps as lease holders and/or landowners. Ultimately, CA-MER-511H could not be tied to any specific individuals or to a particular time period. The

complex may be associated with ranching activities that pre-date the reservoir's construction (ca. 1940s-1950s) or it may be associated with San Luis Reservoir Recreation Area grazing leases (Reclamation 2013: Appendix A-19).

NRHP/CRHR Evaluation

CA-MER-511H is a livestock complex that includes a water tank, a corral with a loading chute, a livestock access gate, fencing, and two circular metal water troughs that potentially date to the historic period. The site is evaluated under the historic context of *Ranching and Agriculture* in the American Period (*see* Section 3.3.3). Based historic period maps, land patent records, county history data, and chronological markers from the site's features, the site may have been constructed between 1919 and 1940, remaining in use into the late 20th century. The site post-dates the height of Central Valley ranching (the late 19th century through the 1920s). CA-MER-511H does not appear to have been associated with events significant in local or regional history, and is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

CA-MER-511H may be associated with Chet Vogt and/or with George Vogt, though no clear link could be established between the site and any individual from the historic period. The site is thus recommended not eligible for the NRHP/CRHR under Criterion B/2.

CA-MER-511H is made up of components that are commonly used to control and maintain livestock (i.e., a water tank, a corral, a loading chute, a livestock access gate, fencing, and metal water troughs). None of these components is structurally unique, nor do they exemplify distinctive characteristics of a type, period, or method of construction. The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

The resource is made up mostly of moveable livestock control features that could be reconfigured as required. No portable artifacts were noted at CA-MER-511H, and it could not be linked to a particular time period. The site does not contain materials that might be used to address important research questions concerning *Ranching and Agriculture* in the American Period (*see* Section 3.3.3). CA-MER-511H is recommended not eligible for listing on NRHP/CRHR under Criterion D/4.

CA-MER-511H is in fair condition. The resource's integrity of location is uncertain given the potential mobility of many of its components. Its potential mobility also diminishes its integrity of design and workmanship, which are diminished by uncertainties regarding what features might be missing. Aspects of setting, association, and feeling may have been impacted by the construction of the dam and reservoir during the 1960s, or by the removal of the structures noted on historic period maps from the 1940s and 1950s (USGS 1940a, 1953). Overall, the resource possesses fair integrity. CA-MER-511H is recommended not eligible for listing in the NRHP/CRHR.

In support of NHPA Section 106 Consultation for the B.F. Sisk Dam Corrective Action Study Geotechnical Investigations, Merced County, California (Project # 18-SCA0-002.00 I), the SHPO concurred that CA-MER-511H is not eligible for listing in the NRHP (Polanco 2018).

CA-MER-512H
P-24-002157
PL-SLLPIP-16-05

Determined Not Eligible for Listing in the NRHP

Recommended Not Eligible for Listing in the CRHR

Appendix B, Figure B-4d

San Luis Reservoir Expansion Alternative (Potential Construction Staging Areas – Block East of B.F. Sisk Dam)

Description

CA-MER-512H is a control center and helicopter landing pad that spans a 2-acre area atop a cut and leveled hill 0.65 miles east of the B.F. Sisk Dam and the San Luis Reservoir. Two well-developed asphalt roads provide access to the resource area from Basalt Road, which lies 300 feet to the southwest. The top of the hill that makes up the resource area was cut and leveled for the concrete landing pad and the spoils were used to expand its dimensions. Several features were identified at CA-MER-512H including two circular concrete equipment pads (Features 1 and 2), a white-painted boulder (Feature 3), two reflector posts (Features 4 and 5), two white lines painted on a portion of the landing pad (Feature 6), and an underground telecommunications/radio terminal (Feature 7).

Features 1 and 2 measure approximately 8 to 9 feet in diameter and rest at ground level. One pad has four metal pipe-lined holes in a triangular configuration with one hole in the center; the other pad has only three holes. The holes are situated in the center 12 inches of each pad and are threaded with 0.5-inch diameter pipe that likely served as attachments to equipment or former superstructures. Feature 3, the white-painted boulder, rests on the south side of the pad just west of an access road and may not be *in-situ*. It was likely used as a reflector for safety purposes. Features 4 and 5 are metal posts with orange reflectors located in the western portion of the resource area near the perimeter of

the pad. The posts are vertical pipes that stand approximately 2 feet high with protruding wires that are inserted in a 1-foot diameter circular concrete post support. Feature 7, the telecommunications/radio terminal, lies within in the far western portion of the site. It consists of an upright post with wires and cables that extend underground. The only other cultural constituents noted at CA-MER-512H include two downed and cut wood distribution line poles that likely post-date the construction and use of the landing pad.

CA-MER-512H lies within an oak woodland vegetation community with sparsely scattered oaks. The site is in poor condition with much of the concrete landing pad eroded or no longer present. The immediate area is fully exposed and dominated by tall grasses and mustard weed that cover much of the landing pad. Features 1 and 2 lack any superstructure and the remaining features appear to be broken, dismantled, heavily eroded, or displaced.

Archival Research Summary

CA-MER-512H is located in Township 10 South, Range 8 East in the unsectioned San Luis Gonzaga Land Grant. The San Luis Gonzaga Land Grant, which included much of Township 10 South, was patented to Juan Pérez Pacheco (Doc # PLC 234, BLM # CACAAA 094227) on May 16, 1871 (BLM 2016). An 1879 GLO plat map depicts the area outside of the land grant but does not show the area encompassing CA-MER-512H.

The 1940 Pacheco Pass 15-minute USGS topographic map and a 1946 aerial photograph do not depict CA-MER-512H but do portray the rise on which the helicopter landing pad would be built (USGS 1940a, Fairchild Aerial Surveys 1946). The 1950[9] San Luis Creek 7.5-minute USGS topographic map and a 1957 aerial view of the site show the headquarters of nearby San Luis Ranch but do not show the helicopter landing pad or the roads leading to it (USGS 1950, USDA-CSS 1957). The site first appears on the 1969 San Luis Dam 7.5-minute USGS topographic map (USGS 1969a). Land grant and historic period map data offer no evidence of development within the resource area prior to the establishment of the helicopter landing pad.

[9] The 1950 San Luis Creek 7.5-minute USGS topographic map was based on 1950 aerial photographs and was field checked in 1953.

An account of the groundbreaking ceremony for the B.F. Sisk Dam, which was captured in a 1962 film clip (YouTube 2016), may mention the resource area:

> The still morning of August 18, 1962 grew warm as the sun rose over 15,000 people driving the two-lane Pacheco Pass Highway leading to the site of the San Luis Dam. They gathered to view President John F. Kennedy as he presided over the dam's groundbreaking ceremonies, and at 11:30a.m., the presidential helicopter landed near
>
> the 100-foot-long speakers' platform (Autobee 1996).

The California Department of Water Resources (1974: 276) noted that the B.F. Sisk Dam, initially called the San Luis Dam, was constructed in 1963-1967. The "General Plan and Sections of San Luis Dam and O'Neill Forebay" show a "helicopter pad" cut into the hilltop at the site location. The plan does not show the helicopter landing pad's date of construction, but it almost certainly dates to the early 1960s period of dam construction and pre-dates the August 1962 groundbreaking ceremony (California Department of Water Resources 1974: 278).

NRHP/CRHR Evaluation

CA-MER-512H is a historic period helicopter landing pad and control center that includes two circular concrete equipment pads (Features 1 and 2), a white-painted boulder (Feature 3), two reflector posts (Features 4 and 5), two white lines painted on a portion of the landing pad (Feature 6), and an underground telecommunications/radio terminal (Feature 7). Historic period maps indicate that the site was built after 1957 and before 1967, though it was likely constructed shortly before the 1962 groundbreaking ceremony or during the 1963-1967 period of dam construction (California Department of Water Resources 1974: 276).

On August 18, 1962, John F. Kennedy arrived by helicopter for the San Luis Dam groundbreaking ceremony. After comparing film footage of the event and current inventory survey photographs, it remains unclear whether CA-MER-512H marks the location of the President's arrival or of any other groundbreaking event (YouTube 2016). The B.F. Sisk

Dam has been recommended eligible for listing in the NRHP and CRHR under Criterion A/1 as a contributing element to the CVP and SWP and for its contribution to the expansion and sustainability of farmland and municipal and industrial development in the Central Valley (JRP 2018). No definitive link could be made between CA-MER-512H and the 1962 groundbreaking ceremony, however, which was one of many commemorative events associated with CVP and SWP history. Any role CA-MER-512H may have played in the dam's construction or commemoration remains unclear. CA-MER-512H is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

Although CA-MER-512H lay within the San Luis Gonzaga Land Grant conferred to Juan Pérez Pacheco (Doc # PLC 234, BLM # CACAAA 094227) (BLM 2016), there is no evidence that the resource area was used or developed during the rancho period. CA-MER-512H may have been associated with President John F. Kennedy's 1962 groundbreaking ceremony for the B.F. Sisk Dam. If it was associated, its connection to the president's visit was tenuous and transitory, thus insufficient to render the site eligible for listing in the NRHP/CRHR under Criterion B/2. No other potential connection between CA-MER-512H and one or more people significant in local, state, or national history could be established. CA-MER-512H is thus recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

The site consists of a control center and helicopter landing pad on a leveled hilltop with seven internal features. CA-MER-512H does not display distinctive characteristics of a type, period, or method of construction or represent the work of a master engineer. The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

CA-MER-512H has no associated artifact deposit and consists only of two concrete equipment pads, a white-painted boulder, two reflector posts, two white painted landing pad lines, and an underground telecommunications/radio terminal. Based on its extant features and the lack of any associated artifact deposit, the site does not offer sufficient data potential to contribute to our understanding of dam and reservoir construction, transportation systems, or other potential research themes. The resource is recommended not eligible for listing in the

NRHP/CRHR under Criterion D/4.

The resource retains integrity of location, setting, feeling, and association. Its integrity of design, materials, and workmanship have been somewhat diminished by the lack of superstructures at two of the site's features and by the condition of the site as a whole (e.g., its features have been mostly broken, dismantled, heavily eroded, or displaced).

Overall, the integrity of the site is fair. CA-MER-512H is recommended not eligible for listing in the NRHP/CRHR. In support of NHPA Section 106 Consultation for the B.F. Sisk Dam Corrective Action Study Geotechnical Investigations, Merced County, California (Project # 18-SCA0-002.00 I), the SHPO concurred that CA-MER-512H is not eligible for listing in the NRHP (Polanco 2018).

CA-MER-513H
P-24-002158
PL-SLLPIP-16-06

Determined Not Eligible for Listing in the NRHP

Recommended Not Eligible for Listing in the CRHR

Appendix B, Figure B-4d

San Luis Reservoir Expansion Alternative (Potential Construction Staging Areas – Block East of B.F. Sisk Dam)

Description

CA-MER-513H is a historic period road segment situated on a low berm. The two-lane segment is located east of the B.F. Sisk Dam, trends east-southeast from the 1940s-era alignment of SR 152, and lies just 210 feet to the south of the modern SR 152 alignment. Most of the road segment is asphalt-paved with a white-painted centerline, though an unpaved portion of the road trends to the northwest. The entire road segment measures approximately 300 feet in length and 30 feet in width. The underlying berm measures 50 feet in width and stands roughly 4.5 feet above the ground surface and slightly higher than the 1940s-era SR 152 alignment. No historic period structures or features were noted in association with the road, which has largely become overgrown with dense grasses and mustard weed. A portion of a metal Ford emblem was noted in association with the resource and likely dates to the 1960s.

CA-MER-513H is located on a broad, relatively level (1-2°) plain immediately south of Gonzaga Road and east of Basalt Road. A large engineered drainage lies immediately south of the resource. CA-MER-513H is fully exposed, though dense vegetation greatly impedes ground surface visibility.

Archival Research Summary

CA-MER-513H is located in Township 10 South, Range 8 East in the unsectioned San Luis Gonzaga Land Grant just west of Section 13. The land grant was patented to Juan Pérez Pacheco on May 16, 1871 (Doc #PLC 234, BLM #

CACAAA 094227) (BLM 2016). An 1879 GLO plat map depicts the Butterfield Overland Mail route and a telegraph line within the northwest quarter of Section 13, but does not depict the CA-MER-513H road segment. The 1920 Pacheco Pass 15-minute USGS topographic map does not depict the resource (USGS 1920), though it does show the original alignment of SR 152 through the northern half of Section 13. The 1940 Pacheco Pass 15-minute USGS topographic map also does not portray the resource (USGS 1940a), though it does show that SR 152 had by then been rerouted along the southern edge of Section 13. The 1953 San Luis Creek and 1969 San Luis Dam 7.5-minute USGS topographic maps show the 1940s-era alignment of SR 152, now Gonzaga Road, which appears to pass immediately north of the resource (USGS 1953, 1969), though CA-MER-513H itself is not depicted.

The 1940 General Highway Map of Merced County shows a house to the west of the southwest quarter of Section 13 and north of the recorded road segment but does not depict a road to the south of the 1940s-era alignment of SR 152 (DPW-DH 1940). A 1946 aerial photograph, however, shows what may be a small structure at the approximate location of the resource (Fairchild Aerial Surveys 1946). CA-MER-513H may thus represent a turnout for some sort of service structure or roadside feature that no longer remains extant.

NRHP/CRHR Evaluation

CA-MER-513H comprises a short road segment that was likely constructed prior to 1946 and may have been associated with the 1940s-era alignment of SR 152. The resource is evaluated under the historic context of *Transportation Development* in the American Period (*see* Section 3.3.3). Historic period map evidence for CA-MER-513H was inconclusive, though a 1946 aerial photograph indicates that the resources may have been associated with a small structure just south of the 1940s-era alignment of SR 152 (Fairchild Aerial Surveys 1946). Ultimately, the resource could not be clearly linked to any extant structure or feature and thus could not be tied to a specific function or period. As a remnant road segment with no clear ties to significant historic period events or trends, CA-MER-513H is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

CA-MER-513H could not be linked to any individual or

group of individuals, historically significant or otherwise. The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

Although it may have been associated with the 1940s-era alignment of SR 152 and possibly with a former structure located south of the highway, CA-MER-513H could not be clearly linked to any extant buildings, structures, or sites within the vicinity. The road segment is not structurally unique and does not exemplify distinctive characteristics of a type, period, or method of construction. The resource is

recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

As an isolated road segment, there is little potential to encounter subsurface components or vertical stratigraphy along CA-MER-513H. Lacking any secure context or association, the resource offers little potential to address important research questions about *Transportation Development* in the American Period (*see* Section 3.3.3). Thus, CA-MER-513H is recommended not eligible for listing in the NRHP/CRHR under Criterion D/4.

The overall condition of CA-MER-513H is poor, as the road segment has become almost wholly obscured by vegetation. It retains integrity location and materials, though vegetation growth has diminished its aspects of workmanship and materials. Integrity of design has been diminished by modern construction and development within the reservoir area, which also has affected its integrity of setting. Aspects of association and feeling have presumably been impacted by reservoir construction and the re-routing of the 1940s-era alignment of SR 152. The overall integrity of CA-MER-513H is thus poor to fair. CA-MER-513H is recommended not eligible for listing in the NRHP/CRHR.

In support of NHPA Section 106 Consultation for the B.F. Sisk Dam Corrective Action Study Geotechnical Investigations, Merced County, California (Project # 18-SCA0-002.00 I), the SHPO concurred that CA-MER-513H is not eligible for listing in the NRHP (Polanco 2018).

CA-MER-514H
P-24-002159
PL-SLLPIP-16-07

Description

CA-MER-514H is an excavated earthen ditch that measures approximately 0.98 miles in length, 5 to 6 feet in width at

Determined Not Eligible for Listing in the NRHP

Recommended Not Eligible for Listing in the CRHR

the top, 1 to 2 feet in width at the bottom, and varies from 2 to 4 feet in depth. The ditch originates in the southwest near a deeply entrenched drainage that is partially lined with concrete. The drainage and ditch are located adjacent to an access road associated with the B.F. Sisk Dam. The ditch head lies above the depth of the entrenched concrete ditch, which may indicate that this resource predates dam construction or that it serves as overflow for the larger concrete channel. The ditch trends to the northeast and terminates roughly 900 feet southwest of the modern alignment of SR 152.

Appendix B, Figure B-4d

San Luis Reservoir Expansion Alternative (Potential Construction Staging Areas – Block East of B.F. Sisk Dam)

CA-MER-514H loosely parallels Basalt Road to the east. It passes through a broad, gently sloping (1-2°) open flat dominated by dense, low grasses that limit ground surface visibility. The B.F. Sisk Dam is located roughly 800 feet to the southwest of the southern end of the ditch. A historic period road segment (CA-MER-513H) is located 760 feet to the east of the northern end of the ditch.

Archival Research Summary

CA-MER-514H is located in Township 10 South, Range 8 East in the unsectioned San Luis Gonzaga Land Grant. Section 24 is located to the east, and Section 13 is located to the northeast. The resource area was patented on May 16, 1871 to Juan Pérez Pacheco (Doc #PLC 234, BLM # CACAAA 094227) (BLM 2016). An 1879 GLO plat map depicts only the area not covered by the land grant. A 1909 GLO sketch map of the diseño of Rancho San Luis Gonzaga shows a stage route through the rancho as well as two alternate stage routes, but does not depict the earthen ditch (BLM 2016). The 1920 Pacheco Pass 15-minute USGS topographic map shows the original alignment of SR 152 through the north of Section 13 while the 1940 Pacheco Pass 15-minute USGS topographic map shows that SR 152 had been rerouted to the southern edge of Section 13 (USGS 1920, 1940a). Neither map depicts the earthen ditch. The 1953 San Luis Creek and the 1969 San Luis Dam 7.5-minute USGS topographic maps show the 1940s-era and modern alignments of SR 152 respectively, but neither depict CA-MER-514H (USGS 1953, 1969). An aerial photograph from 1946 shows what appears to be the ditch to the south of SR 152 and south-southeast of the San Luis Ranch headquarters, so it appears that the resource was present by that time (Fairchild Aerial Surveys, Inc. 1946).

The San Luis Gonzaga Rancho was a Mexican land grant given in 1843 to Juan Pérez Pacheco and José Maria Mejía. The grant was bounded by the San Joaquin River to the east; Los Banos Creek to the south; and Rancho Ausaymas y San Felipe to the west, which was held by Juan Pacheco's father Francisco Pérez Pacheco (Beck and Haase 1974). When Juan Pacheco died in 1855, the property reverted to his father Francisco. Francisco died in 1860. His property, including the San Luis Gonzaga Rancho and half of Rancho Ausaymas y San Felipe, passed to his only surviving child Ysidora after Francisco's wife died in 1892. Ysidora married Mariano Malarin in 1850 and had two daughters. One married Dr. Ramon Roca while the other married Dr. Luis Fatjo. The Fatjos and their children inherited the Merced portion of San Luis Gonzaga Rancho (Hoover et al. 1999: 200). In 1949, Paula Fatjo, the great-great granddaughter of Francisco Pérez Pacheco, moved to the rancho and remodeled the original 1843 adobe that once stood on the property (Pierce 1977: 107). San Luis Gonzaga was an operating cattle ranch during Paula Fatjo's time, though she also bred and boarded Arabian horses (Pierce 1977: 107-111). If the earthen ditch was present by 1946, it may or may not have been used by Fatjo.

NRHP/CRHR Evaluation

CA-MER-514H is a historic period earthen ditch with no associated artifacts that appears to have been constructed sometime prior to 1946 (Fairchild Aerial Surveys, Inc. 1946). The purpose of the ditch remains unknown, and its possible association with other historic period features or activities remains unclear. It may have been used for agricultural or ranching activities, but it cannot be securely linked to a particular historic context. CA-MER-514H does not appear to have been associated with events significant in local or regional history, however, and is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

No association between CA-MER-514H and any individuals was revealed through archival research, so no link could be established between the feature and one or more persons significant in local or regional history. The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

CA-MER-514H consists of an earthen ditch with no associated artifacts, features, or structures. The ditch is not structurally unique and does not exemplify distinctive

characteristics of a type, period, or method of construction. CA-MER-514H is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

CA-MER-514H contains no artifacts or materials that might be used to link the resource to a particular time period. It lacks the data potential to address important research questions regarding early farming or ranching activities, water conveyance, or other potential research themes. The resource is recommended not eligible for listing on NRHP/CRHR under Criterion D/4.

CA-MER-514H remains in fair condition. It retains integrity of location, materials, and workmanship. Aspects of design, association, and feeling are diminished because no clear functional or temporal context could be established for the resource. As it appears to predate 1946, reservoir and dam construction have likely impacted the resource's integrity of setting. Overall, the integrity of CA-MER-514H is fair to poor. CA-MER-514H is recommended not eligible for listing in the NRHP/CRHR.

In support of NHPA Section 106 Consultation for the B.F. Sisk Dam Corrective Action Study Geotechnical Investigations, Merced County, California (Project # 18-SCA0-002.00 I), the SHPO concurred that CA-MER-514H is not eligible for listing in the NRHP (Polanco 2018).

CA-MER-515H
P-24-002160
PL-SLLPIP-16-09

Recommended Not Eligible for Listing in the NRHP/CRHR

Appendix B, Figure B-4c San Luis Reservoir Expansion Alternative (Reservoir Shoreline – South of SR 152)

Description

CA-MER-515H is an earthen dam that spans a small inlet of the San Luis Reservoir. The dam is oriented northeast-southwest and impounds water on the western side, forming a pond. The southern end of the dam is truncated by a drainage that flows out of the impound pond; it may be an intentional breach that was formed when the dam was built. The dam measures 275 feet NE/SW by 140 feet NW/SE at the base. The top of the dam is approximately 15-18 feet wide. The eastern side of the dam stands roughly 35-40 feet high from the base to the top. Including the impound pond, the total dimensions of the resource measure approximately 510 feet NW/SE by 320 feet NE/SW. The dam is flat on top and pedestrian accessible, though dead and dying trees along the western base of the dam make it less accessible. No additional artifacts or features were noted at CA-MER-515H.

CA-MER-515H is located on the northwestern side of the reservoir to the north of a boat ramp and the original alignment of SR 152. The site area is characterized by oak woodland and riparian vegetation. Oak trees are sparsely scattered near the drainage with wild oats, cheatgrass, thistle, bursage, datura, mustard, and seasonal grasses. Willow trees, grasses, wild oats, cheatgrass, and several unidentified perennials border or are proximate to the pond. Soils, where visible, consist of light tan, rocky clay loam.

Archival Research Summary

CA-MER-515H is located in the unsectioned San Luis Gonzaga Land Grant in Township 10 South, Range 7 East. The resource area was patented on May 16, 1871 to Juan Pérez Pacheco (Doc #PLC 234, BLM # CACAAA 094227) (BLM 2016). An 1879 GLO plat map depicts only the area not covered by the land grant. A 1909 GLO sketch map of the diseño of Rancho San Luis Gonzaga shows a stage route through the rancho as well as two alternate stage routes, but does not depict the earthen dam or impound pond (BLM 2016). The 1920 and 1940 Pacheco Pass 15-minute USGS topographic maps do not show the dam or impound pond, but do depict the 1920s-era SR 152 alignment to the south (USGS 1920, 1940a). The 1940 map also depicts a 104kV PG&E line to the north of the resource location. The 1955 Pacheco Pass 7.5-minute USGS topographic map shows the San Luis Reservoir and the realigned route of SR 152. The "Boat Ramp" road depicted on the 1955 map appears to be an existing segment of the original SR 152 alignment; the dam and impound pond are shown as present but abandoned features, thus they would have been constructed by 1955 but had evidently fallen into disuse by 1971 (USGS 1955). A 1946 aerial photograph of the resource location does not shows the dam or pond, thus CA-MER-515H likely post-dates 1946 and pre-dates 1955 (Fairchild Aerial Surveys 1946).

Francisco Pérez Pacheco, who inherited the San Luis Gonzaga Rancho upon the death of his son Juan, had one daughter, Lola. She married Mariano Malarin, and they in turn had two daughters; one married Dr. Ramon Roca, while the other married Dr. Luis Fatjo. The Fatjos and their children inherited the Merced portion of the rancho. In 1949, Paula Fatjo, the great-great granddaughter of Francisco Pérez Pacheco, moved to the rancho and remodeled the original 1843 adobe that once stood on the property (Pierce 1977: 107). San Luis Gonzaga, or San Luis

Ranch, was an operating cattle ranch during Paula Fatjo's time, though she also bred and boarded Arabian horses (Pierce 1977: 107-111). If construction of the dam and impound pond do post-date 1946 and pre-date 1955, they may have been associated with Fatjo's tenure on the property. The resource was almost certainly associated with agricultural or ranching activities and could have functioned as a stock watering locale.

NRHP/CRHR Evaluation

CA-MER-515H is a historic period earthen dam and impound pond with no other associated features, structures, or surface artifacts. Based on historic period map and aerial photographic evidence, the resource appears to have been constructed prior to 1955 but after 1946 (Fairchild Aerial Surveys 1946; USGS 1955). While the resource was likely associated with ranching or farming activities, it could not be linked to particular historic period events, significant or otherwise. The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

Although CA-MER-515H may be associated with Paula Fatjo's tenure at the San Luis Ranch, no clear link could be established between her or any other individual and the construction or use of the resource. CA-MER-515H could not be linked to one or more individuals significant in local, regional, state, or national history. It is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

As a historic period earthen dam and impound pond, CA-MER-515H consists of a single engineered feature. That feature is not unique and does not exemplify distinctive characteristics of a type, period, or method of construction, nor does it embody innovative construction techniques. The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

CA-MER-515H contains no artifacts or materials that might be used to link the resource to a particular time period. It lacks the data potential to address important research questions regarding early farming or ranching activities, water conveyance, or other important research themes. The resource is recommended not eligible for listing on NRHP/CRHR under Criterion D/4.

CA-MER-515H remains in good condition and has not been greatly impacted by erosion. It retains integrity of location,

design, materials, workmanship, feeling, and association. The resource's integrity of setting has presumably been impacted by the development and inundation of the San Luis Reservoir. Overall, the resource possesses good integrity. CA-MER-515H is recommended not eligible for listing in the NRHP/CRHR.

CA-MER-516H
P-24-002161
PL-SLLPIP-16-10

Recommended Not Eligible for Listing in the NRHP/CRHR

Appendix B, Figure B-4c

San Luis Reservoir Expansion Alternative (Reservoir Shoreline – South of SR 152)

Description

CA-MER-516H is an earthen dam constructed across an east-flowing seasonal drainage that emanates from between two prominent hills to the west. The dam is oriented north-south, and the base measures approximately 65 feet in length and 20 feet in width. The top of the dam measures 10 feet in width and is marked by a barbed wire fence with T-posts that is in poor condition. The impound area behind the dam measures roughly 100 feet in diameter and does not retain any water due to a breach 8 feet from the northern end. As a whole, the resource measures 150 feet NW/SE by 100 feet NE/SW.

CA-MER-516H lies within an oak woodland vegetation community with sparsely scattered oaks and seasonal grasses as well as wild oats, cheatgrass, thistle, bursage, datura, and mustard. Visible soils within the resource area consist of light tan, very rocky clay loam. The resource is fully exposed and features a variable slope (0-15°). The canyon upstream from CA-MER-516H quickly narrows and contains a dense stand of oaks. The canyon opens into a narrow mouth that forms an inlet of the San Luis Reservoir.

Archival Research Summary

CA-MER-516H is located in Township 10 South, Range 7 East in the unsectioned San Luis Gonzaga Land Grant. The resource area was patented to Juan Pérez Pacheco on May 16, 1871 (Doc #PLC 234, BLM # CACAAA 094227) (BLM 2016). An 1879 GLO plat map depicts only the area not covered by the land grant. A 1909 GLO sketch map of the diseño of Rancho San Luis Gonzaga shows a stage route through the rancho but does not depict the earthen dam or impound pond (BLM 2016). The 1920 and 1940 Pacheco Pass 15-minute USGS topographic maps do not depict the dam or impound pond, though the 1940 map does show the original 1920s-era SR 152 alignment to the north (USGS 1920, 1940a). The 1955 Pacheco Pass 7.5-minute USGS topographic map shows the San Luis Reservoir and a "Boat Ramp" road to the northwest, but does not portray the dam or impound pond (USGS 1955). A 1946 aerial photograph

of the resource location does not shows the CA-MER-516H features, thus they likely post-date 1946 and pre-date 1963 when construction began for the dam and reservoir (Fairchild Aerial Surveys 1946).

Francisco Pérez Pacheco, who inherited the San Luis Gonzaga Rancho upon the death of his son Juan, had one daughter, Lola. She married Mariano Malarin, and they in turn had two daughters; one married Dr. Ramon Roca, while the other married Dr. Luis Fatjo. The Fatjos and their children inherited the Merced portion of the rancho. In 1949, Paula Fatjo, the great-great granddaughter of Francisco Pérez Pacheco, moved to the rancho and remodeled the original 1843 adobe that once stood on the property (Pierce 1977: 107). San Luis Gonzaga, or San Luis Ranch, was an operating cattle ranch during Paula Fatjo's time, though she also bred and boarded Arabian horses (Pierce 1977: 107-111). It is likely that the earthen dam and impound pond supported ranching and/or farming, but it could not be definitively associated with a specific landowner such as Paula Fatjo or with a specific function such as stock watering.

NRHP/CRHR Evaluation

CA-MER-516H is a historic period earthen dam and impound pond with no other associated features, structures, or surface artifacts. Based on historic period map and aerial photographic evidence, the resource appears to have been constructed prior to the dam and reservoir (1963-1967) but after 1946 (Fairchild Aerial Surveys 1946) and perhaps after 1955 (USGS 1955). While the resource was likely associated with ranching or farming activities, it could not be linked to particular historic period events, significant or otherwise. The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

CA-MER-516H could not be linked to one or more individuals significant in local, regional, state, or national history. The resource may have been associated with Paula Fatjo and her time at the San Luis Ranch, or it may have been associated with an unknown individual or lease holder. CA-MER-516H is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

As a historic period earthen dam and impound pond, CA-MER-516H consists of a single engineered feature. That feature is not unique and does not exemplify distinctive

characteristics of a type, period, or method of construction, nor does it embody innovative construction techniques. CA-MER-516H is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

CA-MER-516H contains no artifacts or materials that might be used to link the resource to a particular time period. It lacks the data potential to address important research questions regarding early farming or ranching activities, water conveyance, or other potential research themes. The resource is recommended not eligible for listing on NRHP/CRHR under Criterion D/4.

CA-MER-516H remains in fair condition and has not been measurably impacted by erosion. The dam features a major breach, however, and the barbed wire fence that spans the top of the dam is in poor condition. CA-MER-516H retains integrity of location, design, materials, workmanship, and feeling. The resource's integrity of setting has presumably been impacted by the development of the San Luis Reservoir, while the aspect of association is impacted because the resource could not be linked to a particular landowner/ranch complex, function, or time period. The resource possesses fair overall integrity. CA-MER-516H is recommended not eligible for listing in the NRHP/CRHR.

CA-MER-517
P-24-002162
PL-SLLPIP-16-11

Pending Evaluation for Listing in the NRHP/CRHR under Criterion D/4

Appendix B, Figure B-4c

San Luis Reservoir Expansion Alternative (Reservoir Shoreline – South

Description

CA-MER-517 is a prehistoric site with groundstone and flaked stone artifacts that measures 35 meters N/S by 65 meters E/W. The site features four complete basalt milling slabs (Artifacts 1, 5, 9, and 10), one complete sandstone milling slab (Artifact 6), and one fragmentary basalt milling slab (Artifact 13). Seven chert cores (Artifacts 2, 3, 4, 7, 8, 11, and 12) and ten pieces of chert debitage also were noted. Six pieces of debitage consist of larger specimens (>3 centimeters diameter), including two primary and three secondary flakes, though one is a smaller (1-2 centimeter) bifacial thinning flake. Most of the debitage is white to off-white and mottled and banded with red and orange; two pieces are a light pinkish-brown and appear to represent higher quality material. CA-MER-28, a previously recorded prehistoric site with midden soils, fire-affected rock, a possible heated rock feature, groundstone artifacts, and debitage, is located just 40 meters to the northwest on the other side of a steep drainage. Its association with CA-MER-517 is unclear.

of Dinosaur Point Boat Ramp)

CA-MER-517 is situated on a broad, slightly sloping (3-4°) north and north-northeast facing terrace that overlooks a deep east-flowing creek immediately to the north of the site. Across the drainage to the north, the slope rises up towards a fenceline located mid-slope. To the east, the landform opens up out of the hills towards the San Luis Reservoir. To the south, a series of dissected hills rises steeply. To the west, the hills constrict into a narrow V-shaped canyon. A large rock outcrop is located immediately south of the site, though no evidence of grinding surfaces or other cultural materials were noted. The site is covered with relatively sparse, low grasses that offer fair to good visibility (50-60%). Tall, knee-high grasses dominate the area around the site and may obscure additional cultural materials. Two large cottonwood trees are present in the creek bottom, and oaks form dense stands upslope to the south. Soils in the site area are a very rocky, light brown sandy loam. No midden soils were observed. The majority of the surface rock in the area comprises sandstone slab fragments and rounded cobbles, likely from sandstone conglomerate outcrops located upslope.

NRHP/CRHR Evaluation

CA-MER-517 contains six whole or fragmentary milling slabs, seven chert cores, and ten pieces of chert debitage. CA-MER-517 may represent a short-term habitation site (*see* Section 7.3.1). Short-term habitation sites are those that were occupied for a short duration or were occupied repeatedly, though on a seasonal or short-term basis. They typically lack accumulated midden deposits, and the cultural constituents present tend to be less diverse or numerous than at permanent habitation sites (*see* Section 7.3.1). Based on the cultural constituents observed, CA-MER-517 may have been used for short-term food processing. Although no midden soils or fire-affected rocks were observed, the presence of groundstone milling slabs suggests that the site may contain a subsurface deposit. The resource is evaluated under the themes of *Economy* and *Settlement* (*see* Section 7.2), particularly as they relate to prehistoric subsistence.

Prehistoric temporary habitation sites are relatively common in the Diablo Range foothills. Little is known, however, about their relationship to larger, more prominent prehistoric sites located on the western edge of the valley floor or to habitation sites located along major stream courses. A search of the Sacred Lands Inventory by the NAHC for the site vicinity did not reveal any specific

information about the CA-MER-517 area, and the resource does not appear to have been associated with any significant events in local or regional Native American history. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

No definitive association with one or more individuals could be established for CA-MER-517, and a literature review did not identify any prominent individuals who may have been associated with the site during the ethnographic period. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

CA-MER-517 does not contain structurally or artistically unique features and does not exemplify distinctive characteristics of a type, period, or method of construction. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

Although no midden soils were observed at CA-MER-517, the site includes six groundstone artifacts and may have the potential to reveal intact subsurface components and vertical stratigraphy. The data potential of the site (e.g., its depth, integrity, age, and artifact diversity) thus has not been fully explored. Further investigation of the site may yield information that can be used to address important research questions about chronology, settlement, economy, and technology in northern San Joaquin Valley prehistory (*see* Section 7.2). Based on the limited data acquired during inventory survey, an informed recommendation regarding the eligibility of the site for listing in the NRHP/CRHR under Criterion D/4 cannot be offered. If any of the San Luis Reservoir Expansion Alternative are implemented, subsurface testing is recommended to determine if CA-MER-517 offers the potential to address important research questions such as those outlined in Section 7.2. CA-MER-517 is recommended not eligible for listing in the NRHP/CRHR under Criteria A/1, B/2, and C/3 but remains pending evaluation under Criterion D/4.

CA-MER-518H
P-24-002163
PL-SLLPIP-16-12

Recommended Not Eligible for

Description

CA-MER-518H is an earthen dam constructed across a north-flowing seasonal drainage that flows into San Luis Creek. The earthen dam is oriented east-west and measures approximately 160 feet in length at the top and 30-35 feet in width at the base, forming an impound pond to the southern side of the dam. The northern side of the dam stands 25 feet

Listing in the NRHP/CRHR

Appendix B, Figure B-4g

high while the southern side stands 12-15 feet above the pond. The water impound area is roughly triangular, measuring 225 feet N/S by 100 feet E/W. A historic period dirt road (CA-MER-519H) segment is located approximately 735 feet to the north of CA-MER-518H and across the current San Luis Reservoir spillway.

CA-MER-518H lies to the north of the mouth of San Luis Creek at the far southern end of the San Luis Reservoir. It is situated within an oak woodland vegetation community with sparsely scattered oaks and seasonal grasses. The resource area features a variable slope (0-15°) and is fully exposed. Soils, where visible, are a light tan, very rocky and compact silty clay loam.

San Luis Reservoir Expansion Alternative (Reservoir Shoreline – South side of San Luis Creek Inlet)

Archival Research Summary

CA-MER-518H is located in Township 11 South, Range 8 East in the northeast quarter of Section 18, though current USGS topographic maps depict the land as unsectioned (USGS 1956, 1969). No land patent information is available for the resource area, which is approximately 1.2 miles to the south of the San Luis Gonzaga Rancho. Adjacent areas were patented to Daniel T. Haley on June 2, 1919, including the southeast quarter of the northeast quarter and the northwest quarter of the southeast quarter of Section 18 (Doc # 011232, BLM # CASF 0011232) (BLM 2016). On December 18, 1922, George Haley, Daniel's brother, patented the southeast quarter of the northwest quarter of Section 8 (Doc # 08821, BLM # CASF 0008821) (BLM 2016), which is roughly 0.75 miles to the northeast.

The *History of Merced County, California* (Outcalt 1925) notes that Daniel T. Haley was the son of Esther Byrne and William Haley, an Irish immigrant who settled in San Francisco in 1850 and started the Dairy Delivery Company. Esther and William had eight children together. Daniel was born in 1854, and he followed his father into the dairy delivery business. Daniel settled in Gustine and managed a local plant that distributed 85-100 ten-gallon cans of cream to San Francisco each day for processing. Roughly 10,000 gallons of milk were then distributed to customers throughout the San Francisco and Burlingame areas (Outcalt 1925: 762). William Haley appears to have managed distribution for the family's company while Daniel managed supply. Daniel Haley married Grace Truit and was elected mayor of Gustine when it was incorporated

in 1915. The Town of Gustine is located approximately 7 miles northeast of the site area, so it is not clear how much time Daniel may have spent in the San Luis flat area.

The 1922[10] and 1940[11] Quien Sabe 15-minute USGS topographic maps show the resource vicinity as sectioned land. Both depict a dirt road (CA-MER-519H) to the north of the resource but do not show the earthen dam or impound pond (USGS 1922b, 1940b). The 1956[12] Quien Sabe 15-minute USGS topographic map also shows the site vicinity as sectioned, and "Haley Ranch" is depicted roughly 0.75 miles to the northeast in Section 8 in the same quarter that was patented by George Haley in 1922 (USGS 1956, BLM 2016). The dirt road first depicted on the 1922 map remains unchanged (USGS 1956). The 1969[13] Mariposa Peak 7.5-minute USGS topographic map no longer depicts the road to the north of the resource but does depict a road to the south; the earthen dam and impound pond are still not shown and the site vicinity is shown as unsectioned land (USGS 1969b). Although map evidence failed to indicate a likely date range for CA-MER-518H, its construction probably predated construction of the B.F. Sisk Dam and San Luis Reservoir. No clear tie could be made between CA-MER-518H and Daniel or George Haley, though it seem likely that the resource was used as a stock watering locale, perhaps as a part of the Haley dairy operation.

NRHP/CRHR Evaluation

CA-MER-518H is an earthen dam and impound pond with no other associated features, structures, or surface artifacts. Historic period map evidence failed to indicate a date range for the resource, but it likely pre-dates the construction of the B.F. Sisk Dam and San Luis Reservoir. While the resource was likely associated with ranching or farming activities, perhaps with the Haley family dairy operation, it could not be linked to significant historic period events or trends. The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

Although CA-MER-518H may be associated with Daniel and George Haley who patented nearby parcels in 1919 and

[10] The 1922 Quien Sabe 15-minute USGS topographic map was surveyed in 1917-1918.
[11] The 1940 Quien Sabe 15-minute USGS topographic map was revised using aerial photographs in 1939-1940.
[12] The 1956 Quien Sabe 15-minute USGS topographic map revised from aerial photographs taken 1949-1950; field checked 1956.
[13] The 1969 Mariposa Peak 7.5-minute USGS topographic map is based on aerial photographs taken in 1967; field checked in 1969.

1922, no clear link could be established between the Haleys and the resource location. Because the resource could not be linked to one or more individuals significant in local, regional, state, or national history, CA-MER-518H is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

As a historic period earthen dam and impound pond, CA-MER-518H consists of a single engineered feature. That feature is not unique and does not exemplify distinctive characteristics of a type, period, or method of construction. The resource does not embody innovative construction techniques, nor does it represent the work of a master. CA-MER-518H is thus recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

CA-MER-518H contains no artifacts or materials that might be used to link the resource to a particular time period. It lacks the data potential to address important research questions regarding early farming or ranching activities, water conveyance, or other potential research themes. The resource is recommended not eligible for listing on NRHP/CRHR under Criterion D/4.

CA-MER-518H remains in good condition and has not been heavily impacted by erosion. It retains integrity of location, design, materials, workmanship, feeling, and association. The resource's integrity of setting has presumably been affected by the development and inundation of the San Luis Reservoir. Overall, the resource possesses good integrity. CA-MER-518H is recommended not eligible for listing in the NRHP/CRHR.

CA-MER-519H
P-24-002164
PL-SLLPIP-16-13

Recommended Not Eligible for Listing in the NRHP/CRHR

Appendix B, Figures B-4e and B-4g

San Luis

Description

CA-MER-519H is a historic period dirt road that includes four discontinuous segments (Segments A-D) that were observed during the 2016 inventory survey as well as one digitized segment that was noted on historic period USGS topographic maps and is now largely inundated. The digitized segment extends south from the 1920s-era alignment of SR 152 through a broad flat and the center of what is currently a spillway for the San Luis Reservoir. The northernmost end of the digitized road segment begins roughly 1 mile west of Basalt Hill and descends south for 2.4 miles before curving northwest to follow the contour of San Luis Creek for another 0.6 miles. Most of the alignment is under water or no longer evident on the ground. A

Reservoir Expansion Alternative (Reservoir Shoreline –San Luis Creek Inlet)

historic period earthen dam and impound pond (CA-MER-518H) are located roughly 750 feet south of the southernmost point along the digitized alignment of CA-MER-519H. The four discontinuous road segments that were observed during the 2016 inventory survey begin near the southwestern end of the main alignment and continue northwest for 0.43 miles up the San Luis Creek Canyon. Each measures 375-500 feet in length and approximately 10 feet in width. These segments are bordered by steep 10-15 foot high road cuts and steep drop-offs towards the adjacent drainage, allowing passage along a narrow, single-track corridor.

CA-MER-519H is situated largely within an oak woodland vegetation community with sparsely scattered oaks and dense seasonal grasses. The road alignments themselves feature a moderate grade of 0-5°, though the areas that border them feature a variable slope of up to 45°. Soils, where visible, comprise light tan, very rocky, and compact silty clay loam. The recorded road segments border the southern side of San Luis Creek and terminate near its confluence with Portuguese Creek.

Archival Research Summary

According to current USGS topographic maps, CA-MER-519H is located in Section 32 in Township 10 South, Range 8 East and in Section 5 and unsectioned lands in Township 11 South, Range 8 East. Historic period maps, however, indicate that currently unsectioned lands encompassing the southernmost portion of the resource were previously designated as Sections 7 and 8 of Township 11 South, Range 8 East. The southernmost portion of the digitized alignment lay in both, while the four segments identified during inventory survey were noted in Section 7 (USGS 1940b). A GLO plat from 1875 for the site vicinity depicts a road from the north that descends towards northern Los Banos Valley, which may reflect portions of the CA-MER-519H alignment (BLM 2016). The 1922 Quien Sabe 15-minute USGS topographic map shows the main alignment of CA-MER-519H terminating near the confluence of San Luis and Portuguese Creeks (USGS 1922b). The 1940 Quien Sabe 15-minute USGS topographic map (USGS 1940b) shows an ephemeral road or trail segment continuing further south-southwest along Portuguese Creek to end at a structure. At least portions of the road, therefore, appear to have been in place by 1922. The 1956 Quien Sabe 15-minute USGS topographic map mirrors the 1940 map

but also appears to show the four discontinuous road segments continuing from near the southern end of the main alignment as a jeep trail (USGS 1956). The 1969 Mariposa Creek 7.5-minute USGS topographic map depicts the inundated San Luis Reservoir and no longer depicts the CA-MER-519H road segments but does depict a road from the east that skirts the southern edge of the spillway before turning southwest to border Portuguese Creek and continue west (USGS 1969b).

Land patent information for Township 11 South, Range 8 East indicates that George Haley patented the southeast quarter of the northwest quarter of Section 8 on December 18, 1922 (Doc # 08821, BLM # CASF 0008821) (BLM 2016). Neighboring areas were patented to Daniel T. Haley on June 2, 1919, including the southeast quarter of the northeast quarter and the northwest quarter of the southeast quarter of Section 18 (Doc # 011232, BLM # CASF 0011232) (BLM 2016). No information was available for lands surrounding the structure near the end of the main road alignment as it appears on the 1956 Quien Sabe 15-minute USGS topographic map (USGS 1956). It is possible that the main road alignment of CA-MER-519H was established to bridge the 1920s-era alignment of SR 152 with the Haley's lands or with the lands of other unknown ranchers or farmers. The *History of Merced County, California* (Outcalt 1925: 762) notes that Daniel T. Haley was the son of William Haley, the owner of the San Francisco Dairy Delivery Company. Daniel followed his father into the dairy business, concentrating his efforts on production and supply while his father focused on delivery within the San Francisco and Burlingame areas. Daniel settled in and became the mayor of Gustine, so it is unclear how much time he may have actually spent on lands near San Luis Creek.

NRHP/CRHR Evaluation

CA-MER-519H is a historic period dirt road that consists of one main alignment detectable mostly through historic period topographic maps and four discontinuous road segments that appear to have come into use prior to 1956. All appear to have been abandoned by the time the San Luis Reservoir was inundated. The resource was likely associated with local ranching or farming activities, perhaps with the Haley family dairy operation, though it could not

be linked to particular historic period events or uses. The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

CA-MER-519H may be associated with the Haley family dairy operation, though no clear link could be established between Daniel or George Haley and the construction or use of the main road alignment or its offshoots. The resource could not be clearly linked to one or more individuals significant in local, regional, state, or national history and CA-MER-519 H is therefore recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

The CA-MER-519H road segments could not be clearly linked to any other buildings, structures, or sites within the vicinity. They are not structurally unique and do not exemplify distinctive characteristics of a type, period, or method of construction. Thus, the resource is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

As isolated road segments, there is little potential to encounter a subsurface component or vertical stratigraphy along CA-MER-519H. It offers limited potential to address important research questions about *Transportation Development* in the American Period (*see* Section 3.3.3). The resource is recommended not eligible for listing in the NRHP/CRHR under Criterion D/4.

The four visible, discontinuous portions of CA-MER-519H do not appear to be maintained or in active use, and the main alignment of the road is now inundated by the San Luis Reservoir. Despite impacts from erosion, the visible road segments are in fair condition and retain integrity of location, design, materials, and workmanship. They lack integrity of feeling and association, however because they cannot be clearly linked to a particular time or purpose, and because the main road alignment of which they were presumably a part retains only integrity of location. As a whole, CA-MER-519H possesses poor integrity. CA-MER-519H is recommended not eligible for listing in the NRHP/CRHR.

CA-MER-520H
P-24-002165
PL-SLLPIP-16-14

Description

CA-MER-520H consists of 38 historic period survey markers, elevation markers, control points, or observation wells that are associated with the construction, use, and

Determined Not Eligible for Listing in the NRHP

Recommended Not Eligible for Listing in the CRHR

Appendix B, Figures B-4d and B-4f

San Luis Reservoir Expansion Alternative (Downstream Stability Berms/Fill Impact Areas; Potential Construction Staging Areas)

maintenance of the B.F. Sisk Dam. The markers and control points include 15 stamped brass caps set in concrete pads, two 1.5-foot tall concrete markers, and four 5-foot tall concrete obelisks. Some of the markers are surrounded by piled rocks or are painted silver, presumably to aid identification and/or to offer protection from disturbance. One marker is noteworthy because the surrounding concrete pad features inscribed names, dates (1966), handprints, a child's footprint, and a stylized drawing. The 15 brass markers are stamped with "US Department of the Interior" and below that "Bureau of Reclamation" with an elevation in feet amsl. There are also 17 observation wells that consist of metal or plastic tubes that extend from the ground surface with associated marker signs; they are used to monitor ground water levels and potential dam seepage.

All of the markers and observation wells that make up CA-MER-520H are located on the eastern side of the San Luis Reservoir, and all but two are located to the east of the B.F. Sisk Dam. Thirty-six of the survey markers or observation wells are positioned between a point roughly 0.6 miles north of the Gianelli Pumping Station and below SR 152. They extend south to near the southern edge of the dam. From west to east, they are positioned between the dam and the eastern edge of the San Luis Gonzaga land grant. Two 5-foot tall concrete obelisks lie outside of that area. One is positioned near the 697-foot elevation point on a promontory 0.9 miles southwest of the dam while another is positioned near the top of Basalt Hill. The condition of these survey markers and observation wells varies. Some have fallen into disuse while others appear to be actively maintained.

The setting for these markers and observation wells differs greatly. Some, including those adjacent to the B.F. Sisk Dam, lie within heavily modified environments while others lie within undisturbed areas featuring dense, high grasses and shrubs. The survey markers likely served as benchmarks for the survey and construction of the B.F. Sisk Dam and its appurtenant features. The 5-foot tall concrete obelisks may have acted as major control points while the other markers may have fulfilled more localized survey or construction needs.

Archival Research Summary

The California Department of Water Resources (1974: 276) noted that the B.F. Sisk Dam, formerly the San Luis Dam,

was constructed between 1963 and 1967. The isolated survey markers, elevation markers, control points, and observation wells that make up CA-MER-520H were likely established shortly before to shortly after that period. The site features occur in Township 10 South, Range 8 East in the unsectioned San Luis Gonzaga Land Grant and in Section 34. The 5-foot tall concrete obelisks occur near USGS elevation benchmark locations, but do not precisely correspond to them. They and the other concrete markers are not depicted on USGS topographic maps (USGS 1920, 1940a, 1950, 1969), nor do they appear on a 1957 aerial view of the vicinity (USDA-CSS 1957).

NRHP/CRHR Evaluation

CA-MER-520H comprises a series of historic period survey markers, elevation markers, control points, and observation wells that were likely set in place prior to or shortly after the 1963 to 1967 construction period for the B.F. Sisk Dam (California Department of Water Resources 1974: 276). The dam and its associated structures have been recommended eligible for listing in the NRHP and the CRHR under Criterion A/1 as a historic district significant in the development of the CVP and SWP and important to the expansion and sustainability of farmland and municipal and industrial development in the Central Valley. CA-MER-520H would have been used for surveying and engineering in support of the dam's construction, while the observation wells have been used to measure seepage as a part of dam monitoring and maintenance. Though important in practical terms, these features played a minor role in the overall development of the B.F. Sisk Dam System. CA-MER-512H is thus recommended not eligible for listing in the NRHP/CRHR under Criterion A/1.

No connection between CA-MER-520H and one or more people significant in local, state, or national history could be established. CA-MER-520H is recommended not eligible for listing in the NRHP/CRHR under Criterion B/2.

CA-MER-520H consists of a series of isolated features that do not display distinctive characteristics of a type, period, or method of construction, nor do they represent the work of a master engineer. CA-MER-520H is recommended not eligible for listing in the NRHP/CRHR under Criterion C/3.

CA-MER-520H is made up of survey markers, elevation markers, control points, and observation wells that lack

associated artifacts or deposits. They do not offer sufficient data potential, either individually or collectively, to contribute to our understanding of water conveyance systems, dam and reservoir construction, or other potential research themes. The site is recommended not eligible for listing in the NRHP/CRHR under Criterion D/4.

The individual elements of CA-MER-520H retain integrity of location, setting, feeling, association, materials, and workmanship. Their integrity of design, however, may have been somewhat diminished because it is unclear how some markers were used or how they may have been configured when they were first put in place. Overall, CA-MER-520H possesses good integrity. CA-MER-520H is commended not eligible for listing in the NRHP/CRHR.

In support of NHPA Section 106 Consultation for the B.F. Sisk Dam Corrective Action Study Geotechnical Investigations, Merced County, California (Project # 18-SCA0-002.00 I), the SHPO concurred that CA-MER-520H is not eligible for listing in the NRHP (Polanco 2018).

7.5 Summary and Recommendations

Approximately 855.5 acres within the 2,097.5-acre Lower San Felipe Intake Alternative APE were subject to inventory survey in 2012. Twenty-four cultural resources were documented within the APE, including six previously recorded districts, archaeological sites, or built environment resources; 12 newly identified archaeological sites or built environment resources; and six newly identified isolated finds (*see* Table 6-2). One previously recorded resource is listed in the NRHP and the CRHR (P-24-000489), one is listed in the CRHR (CHL-829, P-24-000643), and one features no surface expression within the APE that might be evaluated (P-24-001856). Of the other three previously recorded resources, one is recommended eligible for listing in the NRHP and the CRHR (CA-MER-94), one remains pending evaluation (CA-MER-26/H, prehistoric component), and one is recommended not eligible for listing in the NRHP and the CRHR (CA-MER-477H). Of the 12 newly identified resources, 11 are recommended not eligible for listing in the NRHP and CRHR (CA-MER-484H, CA-MER-485H, CA-MER-486H, CA-MER-487H, CA-MER-488H, CA-MER-489H, CA-MER-490H, CA-MER-491H, CA-MER-493H, CA-MER-494H, and CA-MER-495H) while one historic period industrial site (CA-MER-492H) is recommended not eligible for individual listing in the NRHP and CRHR and also is regarded as a non-contributing element to the recently defined B.F. Sisk Dam/San Luis Reservoir Historic District (JRP 2018) (*see* Table 7-1).

Within the former Combination Alternative APE, approximately 107.9 acres were subject to inventory or reconnaissance level survey in 2012, including 23.4 acres that remained a part of the final 28.5-acre APE and 85.2 acres that were excluded from consideration after the inventory survey was completed. One historic period archaeological site (CA-SCL-799H) was revealed within the Combination Alternative APE through archival and records searches. It was excavated in 1996 and found to be heavily disturbed (Morgan et al. 1996); no surface traces of the site were encountered during the 2012 inventory survey, and its reported location was centered beneath the paved ROW of West Hedding Street. No newly identified resources were recorded within the final Combination Alternative APE or within groundwater well or pipeline locations that were removed from the APE in 2012 (*see* Section 6.2.2). In 2017, the alternative was removed from consideration as a part of the SLLPIP.

Table 7-1. Evaluations Summary for Cultural Resources within the Area of Potential Effects for the Lower San Felipe Intake Alternative.

Resource Designation	APE Location	Description	NRHP/CRHR Status/ Recommendation	Additional Evaluation Measures Recommended
Lower San Felipe Intake Alternative – Previously Recorded Cultural Resources				
CA-MER-26/H P-24-000127	Dinosaur Point	Multi-component site featuring a prehistoric midden with lithic scatters and a historic period earthen dam with stock pond	Prehistoric component pending evaluation for listing in the NRHP/CRHR; historic period component recommended not eligible for listing	If resource cannot be avoided, subsurface testing is recommended to further evaluate the prehistoric site component
CA-MER-94 P-24-000194	Dinosaur Point	Prehistoric midden and lithic scatter	Recommended eligible for listing in the NRHP/CRHR under Criteria A/1 and D/4	No additional evaluation efforts recommended
CA-MER-477H[1] P-24-001822	Dinosaur Point; Dinosaur Point Road	Fourteen historic period road segments	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
P-24-000489[1]	Dinosaur Point; Dinosaur Point Road	San Luis Gonzaga Archaeological District comprised of five prehistoric midden sites (CA-MER-107, CA-MER-126 CA-MER-130, CA-MER-134, and CA-MER-135)	Listed in the NRHP and CRHR (code 1S)	No additional evaluation efforts recommended
P-24-000643 CHL-829	Aeration Facility	Historic period California State Historical Landmark plaque commemorating Moraga's 1805 exploration of Pacheco Pass	Listed in the CRHR (CHL-829); not evaluated for listing in the NRHP	No additional evaluation efforts recommended

Resource Designation	APE Location	Description	NRHP/CRHR Status/ Recommendation	Additional Evaluation Measures Recommended
P-24-001856	Dinosaur Point; Dinosaur Point Road	San Luis Gonzaga Rancho-Paula (Pacheco) Fatjo Ranch Historic District	Not evaluated/ district components not relocated for the SLLPIP	No additional evaluation efforts recommended
Lower San Felipe Intake Alternative – Newly Identified Archaeological Sites or Built Environment Resources				
CA-MER-484H[1] P-24-001974 PL-SLLP-A-001	Dinosaur Point	Historic period transmission poles and debris scatter	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-485H P-24-001975 PL-SLLP-A-003	Dinosaur Point	Historic period debris scatter	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-486H P-24-001976 PL-SLLP-A-004	Dinosaur Point	Historic period earthworks dam	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-487H P-24-001977 PL-SLLP-A-005	Dinosaur Point	Historic period road segment	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-488H P-24-001978 PL-SLLP-A-009	Dinosaur Point	Historic period road segment	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-489H[1] P-24-001979 PL-SLLP-A-013	Dinosaur Point	Historic period road segment	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-490H P-24-001980 PL-SLLP-A-019	Dinosaur Point Road	Historic period debris concentration	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-491H[1] P-24-001985 PL-SLLP-A-010	Basalt Point Use Area	Historic period road segment	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-492H[1] P-24-001986 PL-SLLP-A-011	Basalt Point Use Area	Historic period industrial site used in construction of the B.F. Sisk Dam	Recommended not eligible for listing in the NRHP/CRHR and a non-contributing element of the B.F. Sisk Dam/San Luis Reservoir Historic District (JRP 2018)	No additional evaluation efforts recommended
CA-MER-493H[1] P-24-001987 PL-SLLP-A-014	Basalt Point Use Area	Historic period road segment	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-494H[1] P-24-001988 PL-SLLP-A-015	Basalt Point Use Area	Historic period road segment	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-495H[1] P-24-001989 PL-SLLP-A-016	Basalt Point Use Area	Historic period road segment	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended

[1] Resource also occurs within the San Luis Reservoir Expansion Alternative APE

The existing Santa Teresa WTP, which makes up the current 11.8-acre Treatment Alternative APE, was subject to a full inventory survey in 2002 (Cartier 2002). The 6.5-acre Rinconada WTP, which was dropped from the Project in 2017, also was surveyed in 2002. No previously recorded cultural resources were noted through an archival and records search of the current Treatment Alternative APE, and no newly identified resources were recorded during the inventory survey. All infrastructural elements within the Santa Teresa WTP are less than 50 years old.

Within the current 5,022-acre San Luis Reservoir Expansion Alternative APE, approximately 3,888 acres were subject to inventory survey by Pacific Legacy personnel in 2012 or 2016. A further 195 acres were subject to a recent prior inventory and so were not revisited (Johnston and Brewer 2015). Thirty-seven cultural resources lie within the San Luis Reservoir Expansion Alternative APE (*see* Table 6-7). They include nine previously recorded districts, archaeological sites, or built environment resources; 19 newly identified archaeological sites or built environment resources; and nine newly recorded isolated finds. Two previously recorded resources are listed in the NRHP and the CRHR (CA-MER-130 and P-24-000489). Another, the B.F. Sisk Dam and its key features, has been recommended eligible for listing in the NRHP and the CRHR as the B.F. Sisk Dam/San Luis Reservoir Historic District (JRP 2018). One previously recorded resource (CA-MER-521H) has been determined not eligible for listing in the NRHP with SHPO concurrence and recommended not eligible for inclusion in the CRHR (Polanco 2018). Another resource (CA-MER-477H) has been recommended not eligible for listing in the NRHP and the CRHR. The four remaining previously recorded archaeological sites (CA-MER-15, CA-MER-28, CA-MER-82, and CA-MER-83) remain pending evaluation.

Of the 19 archaeological sites or built environment resources newly recorded in 2012 or 2016, six (CA-MER-510H, CA-MER-511H, CA-MER-512H, CA-MER-513H, CA-MER-514H, and CA-MER-520H) have been determined not eligible for inclusion in the NRHP with SHPO concurrence and recommended not eligible for listing in the CRHR (Polanco 2018). Two industrial resources associated with construction of the B.F. Sisk Dam system (CA-MER-492H and CA-MER-509H) are recommended not eligible for listing in the NRHP or CRHR and are considered non-contributing elements of the B.F. Sisk Dam/San Luis Reservoir Historic District (JRP 2018). One prehistoric archaeological site (CA-MER-517) remains pending evaluation. The remaining ten resources (CA-MER-484H, CA-MER-489H, CA-MER-491H, CA-MER-493H, CA-MER-494H, and CA-MER-495H, CA-MER-515H, CA-MER-516H, CA-MER-518H, and CA-MER-519H) have all been recommended not eligible for listing in the NRHP and the CRHR (*see* Table 7-2).

Based on the NRHP/CRHR evaluations and assessments presented above, 17 districts, archaeological sites, or built environment resources within the Lower San Felipe Intake Alternative APE should require no additional evaluation efforts while one resource may require further investigation if it cannot be

avoided by ground disturbing activities associated with the SLLPIP (*see* Table 7-1). Twenty-two districts, archaeological sites, or built environment resources within the San Luis Reservoir Expansion Alternative APE should require no further investigation while six resources may require additional research or testing if they cannot be avoided by SLLPIP activities. These include two known resources (CA-MER-130 and CA-MER-484H) that may be newly inundated by an increase in the maximum pool level of the San Luis Reservoir (*see* Table 7-2).

Table 7-2. Evaluations Summary for Cultural Resources within the Area of Potential Effects for the San Luis Reservoir Expansion Alternative

Resource Designation	APE Location	Description	NRHP/CRHR Status/ Recommendation	Additional Evaluation Measures Recommended
San Luis Reservoir Expansion Alternative – Previously Recorded Cultural Resources				
B.F. Sisk Dam System	Reservoir Shoreline – Fronting the B.F. Sisk Dam	Historic period B.F. Sisk Dam and facilities	Recommended eligible for listing in the NRHP/CRHR as the B.F. Sisk Dam/San Luis Reservoir Historic District (JRP 2018); key elements of the district not individually eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-15 P-24-000116	Reservoir Shoreline – South of Dinosaur Point Boat Ramp	Prehistoric pictographs, bedrock mortars, cupules, cleared areas midden soil, lithic scatter	Pending evaluation for listing in the NRHP/CRHR under Criterion D/4	If resource cannot be avoided, subsurface testing is recommended to further evaluate the site
CA-MER-28 P-24-000129	Reservoir Shoreline – South of Dinosaur Point Boat Ramp	Prehistoric occupation site with lithic scatter	Pending evaluation for listing in the NRHP/CRHR under Criterion D/4	If resource cannot be avoided, subsurface testing is recommended to further evaluate the site
CA-MER-82 P-24-000182	Reservoir Shoreline – West side of San Luis Creek Inlet	Prehistoric lithic scatter with groundstone	Pending evaluation for listing in the NRHP/CRHR under Criterion D/4	If resource cannot be avoided, subsurface testing is recommended to further evaluate the site
CA-MER-83 P-24-000183	Reservoir Shoreline – South of Dinosaur Point Boat Ramp	Prehistoric midden soil with lithic scatter and groundstone	Pending evaluation for listing in the NRHP/CRHR under Criterion D/4	If resource cannot be avoided, subsurface testing is recommended to further evaluate the site

Resource Designation	APE Location	Description	NRHP/CRHR Status/ Recommendation	Additional Evaluation Measures Recommended
CA-MER-130 P-24-000220	Reservoir Shoreline – North of Dinosaur Point Boat Ramp	Prehistoric midden soil with two bedrock mortar features with five mortars and groundstone	Listed in the NRHP/CRHR as a contributing element to the San Luis Gonzaga Archaeological District	If resource cannot be avoided, subsurface testing is recommended to further evaluate the site
CA-MER-477H P-24-001822[1]	Dinosaur Point Boat Launch Modification Area; Reservoir Shoreline – Dinosaur Point Area	Fourteen historic period road segments	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
P-24-000489[1]	Reservoir Shoreline – Dinosaur Point Area; Cottonwood Bay Levee Modification and Levee Raise Areas	San Luis Gonzaga Archaeological District comprising five prehistoric midden deposits	Listed in the NRHP/CRHR (code 1S)	No additional evaluation efforts recommended
CA-MER-521H P-24-002173 SLTP-B-11	Borrow Area 6 - South of O'Neill Forebay	Historic period water tank and trough	Not eligible for listing in the NRHP with SHPO concurrence (Polanco 2018), recommended not eligible for listing in the CRHR	No additional evaluation efforts recommended
San Luis Reservoir Expansion Alternative – Newly Identified Archaeological Sites or Built Environment Resources				
CA-MER-484H[1] P-24-001974 PL-SLLP-A-001	Reservoir Shoreline – Dinosaur Point Area	Historic period transmission poles and debris scatter	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-489H[1] P-24-001979 PL-SLLP-A-013	Reservoir Shoreline – Dinosaur Point Area	Historic period road segment	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-491H[1] P-24-001985 PL-SLLP-A-010	Construction Impact Area – West of Goosehead Point	Historic period road segment	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-492H[1] P-24-001986 PL-SLLP-A-011	Construction Impact Area – West of Goosehead Point	Historic period industrial site used in construction of the B.F. Sisk Dam	Recommended not eligible for listing in the NRHP/CRHR and a non-contributing element of the B.F. Sisk Dam/San Luis Reservoir Historic District (JRP 2018)	No additional evaluation efforts recommended
CA-MER-493H[1] P-24-001987 PL-SLLP-A-014	Construction Impact Area – West of Goosehead Point	Historic period road segment	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-494H[1] P-24-001988 PL-SLLP-A-015	Basalt Hill Borrow Area; Construction Impact Area – West of Goosehead Point; Haul Road/Highway 152 Impact Area	Historic period road segment	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended

Resource Designation	APE Location	Description	NRHP/CRHR Status/ Recommendation	Additional Evaluation Measures Recommended
CA-MER-495H[1] P-24-001989 PL-SLLP-A-016	Construction Impact Area – West of Goosehead Point	Historic period road segment	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-509H P-24-002154 PL-SLLPIP-16-01	Basalt Hill Borrow Area; Haul Road/Highway 152 Impact Area	Historic period Basalt Hill Quarry, part of the industrial complex used in construction of B.F. Sisk Dam system	Recommended not eligible for listing in the NRHP/CRHR and a non-contributing element of the B.F. Sisk Dam/San Luis Reservoir Historic District (JRP 2018)	No additional evaluation efforts recommended
CA-MER-510H P-24-002155 PL-SLLPIP-16-02	Borrow Area 6 - South of O'Neill Forebay	Historic period concrete equipment pad near O'Neill Forebay	Not eligible for listing in the NRHP with SHPO concurrence (Polanco 2018), recommended not eligible for listing in the CRHR	No additional evaluation efforts recommended
CA-MER-511H P-24-002156 PL-SLLPIP-16-03	Borrow Area 6 - South of O'Neill Forebay	Historic period metal water tank on railroad ties in a corral area near O'Neill Forebay	Not eligible for listing in the NRHP with SHPO concurrence (Polanco 2018), recommended not eligible for listing in the CRHR	No additional evaluation efforts recommended
CA-MER-512H P-24-002157 PL-SLLPIP-16-05	Potential construction staging areas – block east of B.F. Sisk Dam	Historic period helicopter pad located east of the BF Sisk Dam	Not eligible for listing in the NRHP with SHPO concurrence (Polanco 2018), recommended not eligible for listing in the CRHR	No additional evaluation efforts recommended
CA-MER-513H P-24-002158 PL-SLLPIP-16-06	Potential construction staging areas – block east of B.F. Sisk Dam	Historic period asphalt road segment	Not eligible for listing in the NRHP with SHPO concurrence (Polanco 2018), recommended not eligible for listing in the CRHR	No additional evaluation efforts recommended
CA-MER-514H P-24-002159 PL-SLLPIP-16-07	**Potential construction staging areas – block east of B.F. Sisk Dam**	**Historic period ditch segment**	**Not eligible for listing in the NRHP with SHPO concurrence (Polanco 2018), recommended not eligible for listing in the CRHR**	**No additional evaluation efforts recommended**
CA-MER-515H P-24-002160 PL-SLLPIP-16-09	Reservoir Shoreline – South Highway 152	Historic period earthen dam with impound pond	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-516H P-24-002161 PL-SLLPIP-16-10	Reservoir Shoreline – South of SR 152	Historic period e	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended

Resource Designation	APE Location	Description	NRHP/CRHR Status/ Recommendation	Additional Evaluation Measures Recommended
CA-MER-517 P-24-002162 PL-SLLPIP-16-11	Reservoir Shoreline – South of Dinosaur Point Boat Ramp	Prehistoric lithic scatter with midden and groundstone	Pending evaluation for listing in the NRHP/CRHR under Criterion D/4	If resource cannot be avoided, subsurface testing is recommended to further evaluate the site
CA-MER-518H P-24-002163 PL-SLLPIP-16-12	Reservoir Shoreline – South side of San Luis Creek Inlet	Historic period earthen dam with impound pond	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-519H P-24-002164 PL-SLLPIP-16-13	Reservoir Shoreline –San Luis Creek Inlet	Historic period dirt road segments	Recommended not eligible for listing in the NRHP/CRHR	No additional evaluation efforts recommended
CA-MER-520H P-24-002165 PL-SLLPIP-16-14	Basalt Hill Borrow Area; Construction Impact Area; Downstream and Upstream Fill Impact Areas; Potential Construction Staging Areas	Historic period survey markers and monitoring wells associated with construction and maintenance of the B.F. Sisk Dam	Not eligible for listing in the NRHP with SHPO concurrence (Polanco 2018), recommended not eligible for listing in the CRHR	No additional evaluation efforts recommended

[1] Resource also occurs within the Lower San Felipe Intake Alternative APE

Cultural resource evaluations completed for this investigation focused on archaeological sites and built environment resources that were relocated or newly identified in 2012 and 2016 within the APE for two main action alternatives. No evaluations could be offered for resources that were not relocated or that featured no physical traces within the areas examined (*see* Table 6-3, Section 6.2.2, and Table 6-8). Limited subsurface testing at the reported locations of resources that were not relocated, particularly along the reservoir shoreline, may assist in confirming their presence or absence in advance of ground disturbing activities associated with the SLLPIP.

As was noted in Section 2.2.3, Late Holocene landforms in and around the San Luis Reservoir are highly sensitive for buried cultural resources that may become exposed during drought years or periods of significant drawdown. Mechanical and biochemical impacts associated with a fluctuating reservoir shoreline also can have a pronounced effect on cultural resources and can act to cover, expose, erode, or alter both archaeological sites and built environment resources (*see* Section 6.4). If the maximum pool level of the San Luis Reservoir is increased under the San Luis Reservoir Expansion Alternative, two known resources (CA-MER-130 and CA-MER-484H) and one resource that could not be revisited (CA-MER-136) may be newly affected. Other resources

located along the existing shoreline that have been subject to prior mechanical and biochemical impacts also may be affected in new ways. For instance, additional resource areas may become inundated, subject to wave action, or buried by redeposited sediment. Based on field observations and controlled experiments, Ware (1989) formulated a model for the management of cultural resources in reservoir environments based on three major impact zones. If the SLLPIP is authorized and the San Luis Reservoir Expansion Alternative is selected, that model might provide an effective tool in managing historic properties affected by an increase in reservoir storage capacity. Given the level of prior disturbance within the Treatment Alternative APE, subsurface cultural deposits are not anticipated.

An EIS/EIR, which is currently being prepared by Reclamation and the SCVWD, addresses potential impacts of SLLPIP action alternatives to cultural resources under CEQA. Given the information available to date, the Treatment Alternative likely is expected to result in no significant impacts to cultural resources. Conversely, adverse effects to significant cultural resources (i.e., historic properties) may result from implementation of the Lower San Felipe Intake Alternative and the San Luis Reservoir Expansion Alternative.

Mitigation measures to resolve adverse effects on historic properties, pursuant to Section 106 of the NHPA, cannot be determined until all cultural resources in the APE for the undertaking have been fully evaluated for NRHP eligibility and consultations are conducted under Section 106 of the NHPA. This will not occur until after the submission of a SLLPIP Feasibility Report and EIS/EIR to the Office of Management and Budget and the authorization of a Project by Congress. When a Project is authorized, efforts to identify and evaluate historic properties would continue, a Section 106 finding of effect for the undertaking would be made, and any adverse effects on historic properties would be resolved through the Section 106 consultation process.

The resolution of adverse effects on historic properties occurs through the implementation of measures agreed to through consultation with the SHPO, ACHP, and other Section 106 consulting parties as stipulated in a formal agreement document (i.e., Memorandum of Agreement or Programmatic Agreement). Generally, significant impacts to cultural resources under NEPA would also be mitigated through the measures agreed to through the Section 106 process.

Cultural resources that are formally determined not eligible for inclusion in the NRHP or the CRHR would require no further management prior to Project implementation. It should be noted that some cultural resources may not meet NRHP eligibility criteria, but still may be CRHR eligible. Such resources would be managed per CEQA requirements.

Chapter 8
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Appendix L1: Fish Resources in the Area of Analysis

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Appendix L1
Fish Resources in the Area of Analysis

Aquatic habitats throughout the area of analysis provide vital fish spawning, rearing, and/or migratory habitat for a diverse assemblage of native and nonnative species. Key life stages and needs of the species of primary management concern with the greatest potential to be affected by the San Luis Low Point Improvement Project (SLLPIP) alternatives are discussed below. These species collectively represent a diversity of life histories and environmental/habitat requirements, and they are among the most sensitive to environmental perturbation; therefore, findings from assessments of these species can be effectively used to make inferences about other fish species in the project area.

L1.1 Special-status Fish Species

Several native anadromous and resident species have been listed as threatened or endangered under the Federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA) or are candidates for listing. Seven fish species listed under ESA or CESA have the potential to occur in the watercourses in the area of analysis, as shown in Table L1-1. One of these species, longfin smelt, is a candidate for federal listing in addition to its current CESA listing. Additionally, three species have the potential to occur in the watercourses in the area of analysis that are listed as either federal or State species of concern (Table L1-1).

Table L1-1. Special-Status Fish Species with the Potential to Occur within the Area of Analysis.

Common Name	Scientific Name	Status (Federal/ State)	Primary Habitat and Critical Seasonal Periods	Occurrence in Area of Analysis
Central Valley Steelhead	*Oncorhynchus mykiss*	FT/—	Anadromous species using riverine, estuarine, and saltwater habitat. Migration potentially occurs year-round.	Sacramento River, American River, San Joaquin Valley, Delta

Table L1-1. Special-Status Fish Species with the Potential to Occur within the Area of Analysis.

Common Name	Scientific Name	Status (Federal/ State)	Primary Habitat and Critical Seasonal Periods	Occurrence in Area of Analysis
California Central Coast/South-Central Coast Steelhead	*Oncorhynchus mykiss*	FT/—	Anadromous species using riverine, estuarine, and saltwater habitat. Migration potentially occurs year-round.	Coastal Mountains, San Francisco Bay Area; documented in SCVWD Service Area in Upper Penitencia, Pacheco, and Coyote creeks and Guadalupe River and Pajaro River
Central Valley Chinook salmon, fall/late fall-run	*Oncorhynchus tshawytscha*	SC/CSC	Anadromous species using riverine, estuarine, and saltwater habitat. Adult migration occurs mainly from September through December but has been observed as late as June. Primary juvenile outmigration occurs from January through June.	Sacramento River, American River, Delta, San Francisco Bay Area, San Joaquin Valley
Central Valley spring-run Chinook salmon	*Oncorhynchus tshawytscha*	FT/ST	Anadromous species using riverine, estuarine, and saltwater habitat. Adult migration potentially occurs from March through May. Juvenile outmigration occurs from November through April.	Sacramento River, Delta, San Joaquin Valley
Sacramento River winter-run Chinook salmon	*Oncorhynchus tshawytscha*	FE/SE	Anadromous species using riverine, estuarine, and saltwater habitat. Adult migration potentially occurs from January through May. Juvenile outmigration occurs from November through mid-March.	Sacramento River, Delta
Green sturgeon	*Acipenser medirostris*	FT/CSC	Green sturgeon are an anadromous species, migrating from the ocean to freshwater to spawn. They exist in the Sacramento River system, as well as in the Eel, Mad, Klamath, and Smith rivers in the northwest portion of California.	Sacramento River, American River, San Francisco Bay Area, Delta, San Joaquin Valley
Delta smelt	*Hypomesus transpacificus*	FT/SE	Spends most of its life in the Sacramento–San Joaquin estuary. Spawns in shallow, fresh or slightly brackish water upriver from the mixing zone, including in the Sacramento River, Mokelumne River system, Cache Slough region, San Francisco Bay Delta, and Montezuma Slough area.	Sacramento River, American River, Delta

Table L1-1. Special-Status Fish Species with the Potential to Occur within the Area of Analysis.

Common Name	Scientific Name	Status (Federal/ State)	Primary Habitat and Critical Seasonal Periods	Occurrence in Area of Analysis
Longfin smelt	*Spirinchus thaleichthys*	—/ST	The longfin smelt is an anadromous species that spawns in the Delta and rears in the brackish areas of the San Francisco Bay and Delta.	Delta, San Francisco Bay Area
California / San Joaquin Roach	*Lavinia symmetricus* ssp. 1	—/CSC	Occurs in small, warm tributaries, to larger streams that flowed through open foothill woodlands of oak and foothill pine. Located in the foothills in much of the same region that contains the pikeminnow-hardhead-sucker assemblage.	Occurs upstream of large reservoirs or in tributary streams that would not be affected by the project.
Sacramento perch	*Archoplites interruptus*	—/CSC	Historically found in the sloughs, slow moving rivers, and lakes of the central valley. Prefer warm water. Aquatic vegetation is essential for young. (Within native range only)	Found in isolated quarry lakes in the Livermore Valley and has been found in San Luis Reservoir.
Pacific Lamprey	*Lampetra tridentata*	—/CSC	An anadromous species that, like steelhead, migrate into freshwater to spawn and juveniles return to the ocean to mature.	Pajaro River
Monterey roach	*Lavinia symmetricus subditus*	—/CSC	Generally found in small streams and are adapted to life in intermittent watercourses where dense populations are frequently observed in isolated pools.	Pajaro RIver
Monterey hitch	*Lavinia exilicauda harengus*	—/CSC	Can occupy a wide variety of habitats, but are most abundant in lowland areas with large pools or in small reservoirs.	Pajaro River

Sources: CDFW 2016; Moyle 2002
Key to Status Codes:

Federal Status:	State Status:
SC: Species of Concern	SE: Endangered
FE: Endangered	ST: Threatened
FT: Threatened	CSC: Species of Special Concern

L1.1.1 Central Valley Steelhead

National Marine Fisheries Service (NMFS) has divided steelhead into six distinct groups, called DPS, based on genetic testing and life history patterns. Recognition of these groups helps conserve diversity in the various life history adaptations. The Central Valley DPS includes all naturally spawned populations of steelhead in the Sacramento and San Joaquin rivers and their tributaries, excluding steelhead from the San Francisco and San Pablo Bays and their tributaries. Designated critical habitat includes 2,308 miles of stream habitat

within the Central Valley as well as estuary habitat within the San Francisco-San Pablo-Suisun Bay complex (NMFS 2007).

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

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

Central Valley steelhead are listed as a threatened species under the ESA. Steelhead are not listed for protection under the CESA but are identified as a species of concern.

L1.1.2 South-Central and Central California Coast Steelhead

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

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

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

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

Steelhead habitat in Pacheco Creek is almost completely dependent upon releases from North Fork Pacheco Reservoir (Smith 2007). The stream is generally sparsely shaded and percolation rates are high, so stream flows decrease and temperatures increase rapidly downstream (Smith 2007). Even with good summer reservoir releases, conditions are rarely suitable for significant juvenile steelhead rearing (Smith 2007). Adult steelhead access through the lower portion of Pacheco Creek is also restricted in dry years (Smith 2007).

L1.1.3 Central Valley Fall-/Late Fall-Run Chinook Salmon

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

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

Fall-run and late fall-run Chinook salmon have a similar life history as described for other Pacific salmon (above). Adult fall-run Chinook salmon migrate from the coastal marine waters upstream through San Francisco Bay, Suisun Bay, and the Delta during late summer and early fall (approximately late July to early December). Fall-run Chinook salmon spawning occurs between October and December with the greatest spawning activity occurring typically in November and early December. The success of fall-run Chinook salmon

spawning is dependent, in part, on seasonal water temperatures. After incubating and hatching, the young salmon emerge from the gravel redd as fry. A portion of the fry population migrate downstream soon after emergence, where they rear within the lower river channels, Delta, and estuary, during the spring months. The remaining portion of juvenile salmon continue to rear in the upstream stream systems through the spring months, until they are physiologically adapted to migration into saltwater (smolting), which typically takes place between April and early June. A small proportion of the fall-run Chinook salmon juveniles may, in some systems, rear through the summer and fall months migrating downstream during the fall, winter, or early spring as yearlings. Adult Chinook salmon spawn at ages ranging from approximately two to five-years-old with the majority of adult fall-run Chinook salmon returning at age three. Chinook salmon, unlike steelhead, die after spawning.

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

L1.1.4 Central Valley Spring-Run Chinook Salmon

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

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

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

A variety of environmental and biological factors have been identified that affect the abundance, mortality, and population dynamics of spring-run Chinook salmon. One of the primary factors that have affected population abundance of spring-run Chinook salmon has been the loss of access to historic spawning and juvenile rearing habitat within the upper reaches of the Sacramento River and its tributaries and San Joaquin River as a result of the migration barriers caused by construction of major dams and reservoirs. Operation of the Red Bluff Diversion Dam, which impedes adult upstream migration and vulnerability of juvenile spring-run Chinook salmon to predation mortality, has been identified as a factor affecting mortality within the river. Water temperatures within the rivers and creeks have also been identified as a factor affecting incubating eggs, holding adults, and growth and survival of juvenile spring-run Chinook salmon. Juvenile spring-run Chinook salmon are also vulnerable to entrainment at a large number of unscreened water diversions located along the Sacramento River and within the Delta in addition to entrainment and salvage mortality at the State Water Project (SWP) and Central Valley Project (CVP) export facilities. In recent years a number of changes have been made to improve the survival and habitat conditions for spring-run Chinook salmon. Several large previously unscreened water diversions have been equipped with positive

barrier fish screens. Changes to ocean salmon fishing regulations, and modifications to SWP and CVP export operations have also been made to improve the survival of both adult and juvenile spring-run Chinook salmon. Improvements in fish passage facilities have also been made to improve migration and access to Butte Creek. These changes and management actions, in combination with favorable hydrologic and oceanographic conditions in recent years, are thought to have contributed to the trend of increasing abundance of adult spring-run Chinook salmon returning to spawn in Butte Creek and other habitats within the upper Sacramento River system in recent years.

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

L1.1.5 Sacramento River Winter-Run Chinook Salmon

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

Winter-run Chinook salmon historically migrated into the upper tributaries of the Sacramento River for spawning and juvenile rearing. With the construction of Shasta and Keswick dams, winter-run salmon no longer had access to historic spawning habitat within the upper watersheds. As a result of migration blockage, spawning and juvenile rearing habitat for winter-run Chinook is limited to the mainstem Sacramento River downstream of Keswick Dam. During the mid-1960s, adult winter-run Chinook salmon returns to the Sacramento River were relatively high (approximately 80,000 returning adults). However, the population declined substantially during the 1970s and 1980s. The population decline continued until 1991 when the adult winter-run Chinook salmon population returning to the Sacramento River was estimated to be less than 200 fish. As a result of the substantial decline in abundance, the species was listed as endangered under both the CESA and ESA. During the mid- and late- 1990s the numbers of adult winter-run salmon returning to the Sacramento River gradually increased and the trend of increasing abundance continues to be present.

Winter-run Chinook salmon have a similar life history as described for other Pacific salmon (above). Adult winter-run salmon migrate upstream through San

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

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

L1.1.6 North American Green Sturgeon

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

Habitat requirements of green sturgeon are poorly understood, but spawning and larval ecologies are probably similar to those of white sturgeon. Indirect evidence indicates that green sturgeon spawn mainly in the upper reaches of

Sacramento River (e.g., Colusa to Keswick Dam). They are slow growing and late maturing, spawning every three to five years between March and July. Adult fish spawn in fresh water and then return to estuarine or marine environments. Preferred spawning habitat occurs in large rivers that contain large cobble in deep and cool pools with turbulent water (Moyle 2002; Adams et al. 2002). Larval and juvenile green sturgeon may rear for up to 2 years in fresh water and then migrate to an estuarine environment, primarily during summer and fall. They remain near estuaries at first, but may migrate considerable distances as they grow larger (Moyle 2002).

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

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

L1.1.7 Delta Smelt

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

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

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

L1.1.8 Longfin Smelt

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

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

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

L1.1.9 California/San Joaquin Roach

California roach are small, thick-bodied fish found throughout the Sacramento-San Joaquin river drainage, including the Pit River and tributaries to Goose Lake in Oregon. In coastal drainages, they are native to the Navarro, Gualala, and Russian rivers; streams tributary to Tomales Bay, Pescadero Creek and, in

the Monterey Bay drainage, San Lorenzo, Pajaro, and Salinas rivers (Moyle 2002). The Sacramento-San Joaquin roach, a distinct population within the California roach "complex" (Moyle 2002), is found within the Sacramento and San-Joaquin River drainages, except Pit River, as well as tributaries to San Francisco Bay. They are commonly found in small to medium sized foothill rivers and their present distribution is confined to rivers upstream of large Central Valley reservoirs or tributaries that are not affected by the CVP or SWP operations. Consequently, California roach are not included in the analysis of effects.

L1.1.10 Sacramento Perch

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

L1.1.11 Pacific Lamprey

The Pacific lamprey are anadromous, beginning their migration into freshwater towards upstream spawning areas primarily between early March and late June (Moyle 2002). Most upstream migration occurs at night and occurs in pulses. Spawning habitat requirements are thought to be similar to those of salmonids. There is some evidence that lamprey in larger river systems, such as the Klamath and Eel Rivers, have distinct runs similar to Chinook salmon (Moyle 2002). Both sexes contribute to nest construction by removing larger stones from a gravelly substrate, creating a shallow depression. These simple nests occur in gravelly substrata with moderately swift current, water temperatures typically of 12-18 degrees Celsius, and at a depth of 30-150 centimeters (Moyle 2002). External fertilization of eggs occurs just in front of the nest and are then washed into the nest. Fecundity is unknown. Spawning is repeated until both individuals are spent. Adults typically die after spawning. The eggs hatch into ammocoetes after approximately 19 days at 15 degrees Celsius, spend a short time in the nest, and then drift downstream to suitable area in sand or mud (Moyle 2002).

Ammocoetes remain in freshwater for approximately 5 to 7 years, where they bury into silt and mud and feedon algae, organic material, and microorganisms. Ammocoetes change locations during this stage. Ammocoetes begin metamorphosis into macropthalmia (juveniles) when they reach 14-16 centimeters TL. Downstream migration begins upon completion of this

metamorphosis, generally coinciding with high flow events in winter and spring (Moyle 2002).

Adults spend 3-4 years in the ocean in British Columbia, but this length is thought to be shorter in more southern areas (Moyle 2002). Adult remain close to the mouths of the rivers from which they came, likely because their prey is most abundant in estuaries and other coastal areas (Moyle 2002). Pacific lamprey are thought to be preyed upon in the ocean by sharks, other fish, otters, seals, and sea lions (Moyle 2002).

L1.1.12 Monterey Roach

Monterey roach, a subspecies of California roach and a California species of special concern, have similar habitat requirements to California roach in other areas where they are generally found in small streams and are adapted to life in intermittent watercourses where dense populations are frequently observed in isolated pools. Roach can tolerate a relatively wide range of temperatures and dissolved oxygen levels and are found in habitats ranging from cold, clear, well-aerated salmonid streams to intermittent streams where they can survive extremely high temperatures (30-35℃) and low dissolved oxygen levels (1-2 ppm) (Moyle et al. 2015).

L1.1.13 Monterey Hitch

Monterey hitch, a subspecies of hitch and a California species of special concern, can occupy a wide variety of habitats, but are most abundant in lowland areas with large pools or in small reservoirs. Monterey hitch were found to be most abundant in low-gradient sites in the Pajaro River basin that had permanent water and large pools in summer (Moyle et al. 2015. The water at these sites tended to be clear, warm in late summer, and moderately deep. Bottom substrates were mostly a mixture of sand and gravel and the presence of cover (e.g., fallen trees, overhanging bushes) was an important factor.

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Appendix L2: Operational Impacts on Aquatic Resources

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Appendix L2
Operational Impacts on Aquatic Resources

This section analyzes the impacts to special-status aquatic resources due to changes in hydrologic operations associated with each alternative.

L2.1 Methods

Operational impacts to special-status fishes in the Delta were evaluated for Alternatives 2 through 5. In addition to impacts to Delta fishes, operational impacts to South-Central California Coast Steelhead in Pacheco Creek were also evaluated for Alternative 5.

L2.1.1 Operational Impacts to Delta Fishes

Extensive modeling of hydrologic conditions was performed using CalSim II to provide a quantitative basis from which to assess potential operational effects of the project alternatives on fisheries resources and aquatic habitats in the Delta. Hydrologic indicators (or parameters) for habitat quality in the Delta that were used in this analysis include Sacramento River flow, Delta outflow, Delta inflow, low salinity zone location (X2), Old and Middle River flows, and Delta exports.

Operational impacts would be triggered by changes in hydrology associated with changes in operations. Extensive modeling of hydrologic conditions was performed using CalSim II to provide a quantitative basis from which to assess potential operational effects of the project alternatives on fisheries resources and aquatic habitats in the Delta. CalSim II is a water resources simulation model that simulates the Central Valley Project (CVP) and State Water Project (SWP) operations, as well as other major water supply operations in the Central Valley through optimization. It provides a systemwide hydrologic and operational approach for planning and impact analyses for the Sacramento River, San Joaquin River, and the Delta. CalSim II is widely used to determine the reliability of CVP and SWP water deliveries, as well as to support water resources studies, such as water-right applications for the State Water Resources Control Board (SWRCB), California Environmental Quality Act (CEQA) compliance, and National Environmental Policy Act (NEPA) compliance, to estimate potential changes in surface water resources.

Because the San Luis Reservoir is part of the CVP/SWP, protection would be provided in all action alternatives through operations consistent with applicable laws, regulations, biological opinions (BOs), and court orders in place at the

time the intake would become operational and long-term operations of equipment would remain subject to applicable permitting processes.

Hydrologic indicators (or parameters) for habitat quality that were used in this analysis include Sacramento River flow, Delta outflow, Delta inflow, X2, Old and Middle River flows, and Delta exports.

L2.1.1.1 Sacramento River Flow

Flow within the Sacramento River has been identified as an important factor affecting the survival of emigrating juvenile Chinook salmon, important to the downstream transport of planktonic fish eggs and larvae, such as delta smelt and longfin smelt, striped bass, and shad, and important for seasonal floodplain inundation that has been identified as important habitat for successful spawning and larval rearing by species, such as splittail, and as seasonal foraging habitat for juvenile Chinook salmon and steelhead. Sacramento River flows are also important in the transport of organic material and nutrients from the upper regions of the watershed downstream into the Delta. A reduction in Sacramento River flow as a result of water operations, depending on the season and magnitude of change, could adversely affect habitat conditions for both resident and migratory fish species.

The potential effect of flow changes in the Sacramento River at Hood on fish habitat within the Bay-Delta as a result of the proposed project were evaluated. It was assumed that model-predicted changes in the average monthly flows less than 5 percent (plus or minus) relative to the basis-of-comparison would not be expected to result in a significant effect on habitat quality or availability, or the transport mechanisms provided by Sacramento River flow, on resident or migratory fish or the zooplankton and phytoplankton that they rely on for a food resource. A change of 5 percent was used because it is corresponds to a small magnitude of change and also accounts for model error (or noise).

L2.1.1.2 Delta Outflow

Water development has changed the volume and timing of freshwater flows through the Bay-Delta. Over the past several decades, the volume of the Bay-Delta's freshwater supply has been reduced by upstream diversions, in-Delta use, and Delta exports. As a result, the proportion of Delta outflow depleted by upstream and Delta diversions has grown substantially. In wet years, diversions reduce outflow by 10 percent to 30 percent. In dry years, diversions may reduce outflow by more than 50 percent.

Water development has also altered the seasonal timing of flows passing into and through the Bay-Delta. Flows have decreased in April, May, and June and have increased slightly during the summer and fall (San Francisco Estuary Partnership 2015). Seasonal flows influence the transport of eggs and young organisms (e.g., zooplankton, fish eggs, larvae) through the Delta and into San Francisco Bay. Flows during the months of April, May, and June play an especially important role in determining the reproductive success and survival

of many estuarine species, including salmon, striped bass, American shad, delta smelt, longfin smelt, splittail, and others (Stevens et al. 1985, Meng and Moyle 1995).

It was assumed that model-predicted changes in the average monthly flows that were less than 5 percent (plus or minus) relative to the basis-of-comparison would not be expected to result in a significant effect on habitat quality or availability. It would also not be expected to result in a significant effect on the transport mechanisms provided by Delta outflow, on resident or migratory fish or the zooplankton and phytoplankton on which they rely for a food resource.

L2.1.1.3 Low Salinity Zone and X2

The transition area between saline waters and fresh water, frequently referred to as the low salinity zone (LSZ), is located within Suisun Bay and the western Delta. The LSZ has also been associated with the entrapment zone, a region of the Bay-Delta characterized by higher levels of particulates, higher abundances of several types of organisms, and a turbidity maximum. It is commonly associated with the position of X2, but actually occurs over a broader range of salinities (Kimmerer 2002). Originally, the primary mechanism responsible for this region was thought to be gravitational circulation, a circulation pattern formed when freshwater flows seaward over a more dense, landward-flowing marine tidal current. However, studies have shown that gravitational circulation does not occur in the entrapment zone in all years, nor is it always associated with X2 (Burau et al. 1998).

Delta outflow establishes the location of the LSZ in the Delta, an area that historically has had high prey densities and other favorable habitat conditions for rearing juvenile delta smelt, striped bass, and other fish species (Kimmerer 2004). The LSZ is often referenced by X2, which is the distance upstream, in kilometers, from the Golden Gate Bridge where tidally averaged salinity is equal to 2 ppt. X2 is largely determined by Delta outflow (Kimmerer 2004). The best combination of habitat factors are believed to occur when X2 is located downstream from the confluence of the Sacramento and San Joaquin rivers. When Delta outflow is low, X2 moves eastward and is located in the relatively narrow channel of these rivers, and at higher outflows, it moves downstream (westward) into more open waters with larger area.

X2 is an index representing the center of the LSZ and has been commonly used to develop relationships with fish and aquatic species abundances by X2 position. Historically, X2 has varied between San Pablo Bay (River kilometer (km) 50) during high Delta outflow and Rio Vista (River km 100) during low Delta outflow. In recent years, it has typically been located between approximately Honker Bay and Sherman Island (River km 70 to 85). X2 is controlled directly by the volume of Delta outflow, although changes in X2 lag behind changes in outflow. Minor modifications in outflow do not greatly alter X2.

Jassby et al. (1995) showed that when X2 is in the vicinity of Suisun Bay, several estuarine organisms tend to show increased abundance. However, it is by no means certain that X2 has a direct effect on any of the species. The observed correlations may result from a close relationship between X2 and other factors that affect these species.

Operations of upstream storage reservoirs have the potential to affect the location of X2 as a result of changes in freshwater flows from the upstream tributaries through the Delta. To evaluate changes in habitat quantity and quality for estuarine species, a significance criterion of a model-predicted upstream change in X2 location within 1 km of the basis-of-comparison condition was considered to be less than significant. The criterion was applied to a comparison of hydrologic model results for basis-of-comparison conditions and project alternative, by month and water year, for the months from February through May and September through November. As specified in the United States Fish and Wildlife Service (USFWS) BO, spring months are important to longfin smelt and striped bass population dynamics, and there is evidence that X2 in the fall may influence delta smelt population dynamics (USFWS 2008).

L2.1.1.4 Old and Middle River Flows

Reverse flows in the central and south Delta occur when Delta exports and agricultural demands exceed San Joaquin River inflow plus Sacramento River inflow through the Delta-Mendota Canal (DMC), Georgiana Slough, and Threemile Slough. The reverse flow condition occurs within Old and Middle rivers as the rate of water diverted at the CVP and SWP export facilities exceeds tidal and downstream flows within the central region of the Delta.

Reverse flows in Old and Middle rivers, resulting from low San Joaquin River inflows and increased exports to the CVP and SWP, have been identified as a potential cause of increased delta smelt mortality at the CVP and SWP fish facilities within recent years (Simi and Ruhl 2005, Ruhl et al. 2006). Results of analyses of the relationship between the magnitude of reverse flows in Old and Middle rivers and salvage of adult delta smelt in the late winter shows a substantial increase in salvage as reverse flows exceed approximately -5,000 cubic feet per second (cfs). Concerns regarding reverse flows in Old and Middle rivers have also focused on planktonic egg and larval stages of striped bass, splittail, and on Chinook salmon smolts, in addition to delta smelt, and while these species do not spawn to a significant extent in the south Delta, eggs and larvae may be transported into the area by reverse flows in Old and Middle rivers. As discussed previously, these early life stages are more vulnerable to entrainment, because they are too small and have poor swimming capabilities to be effectively screened from export waters.

For most fish species, habitat quality in the south Delta is believed to be poor (Feyrer 2004, Feyrer and Healey 2003, Feyrer et al. 2007, Monsen et al. 2007). Nobriga et al. (2008) showed that very low summer abundances of delta smelt in the south Delta are related to significantly higher water temperatures and

water clarity in the south Delta than other areas of the Delta. Increased water clarity may increase predation risks and reduce feeding success of planktivorous fish such as delta smelt. Entrainment risk is also much higher in the south Delta because of the large volumes of water exported by the Jones and Banks pumping plants (Kimmerer 2004). In experimental releases, survival of fall-run Chinook salmon smolts migrating from the San Joaquin River was lower for smolts moving through the Delta via the channels south of the San Joaquin River than for those remaining in the river channel (Brandes and McLain 2001). However, the consistent trend is that when the fish have an increased travel time, they have a lower probability of reaching Chipps Island (San Joaquin River Group Authority 2010).

Old and Middle river reverse flows were calculated for project action alternatives. The most biologically sensate period when the potential effects of reverse flows could affect delta smelt, Chinook salmon, and many other species extends from the late winter through early summer. It was assumed that model-predicted changes in the average monthly Old and Middle river reverse flows that were less than 5 percent (plus or minus) relative to the basis-of-comparison would not be expected to result in a significant effect on entrainment vulnerabilities on resident or migratory fish or the zooplankton and phytoplankton on which they rely for a food resource.

L2.1.1.5 Delta Exports

Increased exports could increase the risk of entrainment (fish lost from diversions or exports) and salvage (fish collected at the pumping facilities for release back into the Delta) of resident and migratory fish present in the south Delta, which may include adult delta smelt, juvenile Chinook salmon, steelhead, striped bass, and other species of fish as well as macroinvertebrates and nutrients. Increased exports during drier water years in the summer could result in an increased risk of entrainment and salvage for juvenile delta smelt and salmon (June) and resident warm-water fish such as striped bass, threadfin shad, catfish, and others during the warmer summer months (July through August). Increased exports could also increase the entrainment and removal of phytoplankton, zooplankton, macroinvertebrates, organic material, and nutrients from the Delta.

Changes in the volume of water exported at the CVP and SWP facilities are assumed to result in a direct proportional increase or decrease in the risk of fish being entrained and salvaged at the facilities. It was assumed that model-predicted changes in the average monthly Delta exports that were less than 5 percent (plus or minus) relative to the basis-of-comparison would not be expected to result in a significant (detectable increase in take) effect on entrainment on resident or migratory fish or the zooplankton and phytoplankton on which they rely for a food resource.

L2.1.2 Operational Impacts to Pacheco Creek Steelhead

Habitat suitability modeling was performed by Santa Clara Valley Water District (SCVWD) to evaluate the impact of the New Pacheco Reservoir operations on South-Central California Coast Steelhead critical habitat located in Pacheco Creek (SCVWD 2018). Suitability modeling evaluated the impact of New Pacheco Dam flow releases on steelhead habitat quality for all life stages (adult migration to juvenile outmigration) present in Pacheco Creek. The model considered a range of environmental factors important for steelhead, including flow, temperature, and macro-habitat features.

Changes to suitable habitat for South-Central California Coast Steelhead in Pacheco Creek were directly evaluated through the use of the Pacheco Creek Steelhead Habitat Suitability Model. The model was used to simulate with- and without-Project conditions. Pacheco Reservoir storage levels, and releases to Pacheco Creek from the SCVWD's Water Evaluation and Planning (WEAP) model, were used as inputs into the Pacheco Creek Steelhead Habitat Suitability Model.

An output of the Pacheco Creek Steelhead Habitat Suitability Model is a Steelhead Cohort Score. This Score provides an index of Pacheco Creek's ability to support steelhead through all life stages, based on the 14-month period in which a cohort is expected to remain in the creek (i.e., from adult migration through juvenile outmigration), and considers a range of environmental factors that improve or degrade habitats including water operations, water flow and temperature, surface and groundwater interaction, and ratings of pools, runs, and riffles from field surveys. The Steelhead Cohort Score reflects habitat suitability in Pacheco Creek over the entire cohort lifecycle. For example, if habitat conditions for early life stages during winter/spring months are good, but Pacheco Creek has no flow during summer months, the resultant Steelhead Cohort Score for that cohort would be poor.

L2.1.3 Other Hydrologic Considerations

Operational influences of the project alternatives were also considered for upstream reservoir operations (i.e., Folsom, Shasta, Oroville, and Trinity), American River flows, Feather River flows, and San Joaquin River flows. Hydrologic modeling results predict that the project action alternatives would not result in any appreciable effects for these hydrologic indicators. As a result, they are not discussed further in this section. See Chapter 4, Water Quality, Chapter 5, Surface Water Supply, and Appendix B for additional details on this modeling and the modeling assumptions used in the analysis, and the detailed results of the modeling analyses.

L2.2 Results

L2.2.1 Operational Impacts to Delta Fishes

L2.2.1.1 Alternative 2

Operations of the reservoir would be generally the same as under the No Project. CalSim II modeling results indicate that, on average, there are very slight changes (<1%) to Delta hydrology, hydrodynamics, and water quality resulting from changes in Delta operations of the CVP and SWP compared to the No Action Alternative, which could impact delta fisheries and habitats.

L2.2.1.2 Alternative 3

Operation of the Treatment Alternative would be similar to the Lower San Felipe Intake Alternative. CalSim II modeling results indicate that, on average, there are very slight changes (<1%) to Delta hydrology, hydrodynamics, and water quality resulting from changes in Delta operations of the CVP and SWP compared to the No Action/No Project Alternative, which could impact delta fisheries and habitats.

L2.2.1.3 Alternative 4

L2.2.1.3.1 Sacramento River Flow

As described above, flow within the Sacramento River has been identified as an important factor affecting the survival of emigrating juvenile Chinook salmon, important to the downstream transport of planktonic fish eggs and larvae, such as delta smelt and longfin smelt, striped bass, and shad, and important for seasonal floodplain inundation that has been identified as important habitat for successful spawning and larval rearing by species, such as splittail, and as seasonal foraging habitat for juvenile Chinook salmon and steelhead. Sacramento River flows are also important in the transport of organic material and nutrients from the upper regions of the watershed downstream into the Delta.

Simulated Sacramento River flow at Hood would decrease by less than one percent on average in all months of all water-year types (Table L2-1) for Alternative 4 compared to the No Action/No Project Alternative. During most years Sacramento River flows would be unchanged.

Table L2-1. Modeled Difference in Sacramento River Flow between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative (% change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
AN	0.8%	-0.5%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%
BN	0.1%	-0.3%	0.2%	0.1%	-0.2%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.2%
D	0.8%	-0.3%	-0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	-0.2%	-0.2%	0.2%	-0.2%
C	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%

– Notes: Data results from CalSim modeling presented in Appendix B

– Key: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

L2.2.1.3.2 Low Salinity Zone Location (X2)

As discussed above, the linkage between river inflow and the LSZ is referred to as X2, the distance along the main channel (usually in km) from the Golden Gate Bridge to the point where the salinity on the bottom is 2 ppt (Nobriga et al. 2008). Delta outflow largely determines the location of X2 and the LSZ, an area that historically had high prey densities and other favorable habitat conditions for rearing delta smelt (Kimmerer 2004). The LSZ is believed to provide the best combination of habitat conditions when X2 is located downstream from the confluence of the Sacramento and San Joaquin rivers (Kimmerer 2004). Delta outflow and the position of the X2, among other factors, is believed to influence the availability and quality of habitat for several Delta fish species (Feyrer et al. 2007; Feyrer et al. 2011), even though the exact mechanisms for these relationships are not clearly understood. When Delta outflow is low for sustained periods of time, the position of X2 has the potential to move eastward to areas where there is reduced habitat volume (e.g., areas with relatively narrow channels), whereas under periods of sustained higher outflows, it moves downstream into more open waters and associated increased habitat volume (Kimmerer 2004).

Modeling simulations predict that operation of the proposed project would result in small changes to the X2 position (Table L2-2). X2 would not change by more than 0.02 km during February through May or September through November, periods when special-status fish species utilize the LSZ for rearing. During most months of most years, the position of the LSZ would be unchanged.

Table L2-2. Modeled Difference in Position of LSZ (X2) between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative (km change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.01	0.00	0.00	0.00	0.00	0.00	0.04	0.01	0.00	0.00	0.00	0.00
AN	0.00	0.00	0.03	-0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
BN	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00
D	0.00	0.00	-0.02	0.00	0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.01
C	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

– Notes: Data results from CalSim modeling presented in Appendix B.
– Key: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

L2.2.1.3.3 Delta Outflow

Seasonal flows represented by Delta outflow influence the transport of eggs and young organisms (e.g., zooplankton, fish eggs, larvae) through the Delta and into San Francisco Bay. Flows during the months of April, May, and June play an especially important role in determining the reproductive success and survival of many estuarine species, including several special-status species (Stevens et al. 1985, Meng and Moyle 1995).

Simulated Delta outflow would decrease by less than one percent in all months of all water-year types (Table L2-3). During most months of most years Delta outflows would be unchanged.

Table L2-3. Modeled Difference in Delta Outflow between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative (% change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	0.0%	-0.6%	0.1%	-0.3%	-0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BN	0.0%	-0.1%	0.4%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
D	0.0%	0.3%	-0.2%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%
C	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%

– Notes: Data results from CalSim modeling presented in Appendix B.
– Key: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

L2.2.1.3.4 Old and Middle River Flows

As discussed above, reverse flows in Old and Middle rivers, resulting from low San Joaquin River inflows and increased exports to the CVP and SWP, have been identified as a potential cause of increased delta smelt mortality at the CVP and SWP fish facilities within recent years (Simi and Ruhl 2005, Ruhl et al. 2006). Results of analyses of the relationship between the magnitude of reverse flows in Old and Middle rivers and salvage of adult delta smelt in the late winter shows a substantial increase in salvage as reverse flows exceed approximately -5,000 cfs. Concerns regarding reverse flows in Old and Middle rivers have also focused on planktonic egg and larval stages of striped bass,

splittail, and on Chinook salmon and steelhead smolts, in addition to delta smelt, and while these species do not spawn to a large extent in the south Delta, eggs and larvae may be transported into the area by reverse flows in Old and Middle rivers. As discussed previously, these early life stages are generally entrained, because they are too small to be effectively screened from export waters.

Modeling simulations predict that operation of the San Luis Reservoir Expansion Alternative would result in small changes to Old and Middle rivers reverse flows for most months of most year types (Table L2-4). The greatest changes occur in Wet (February and March) and Above Normal (January and February) water year types. All changes in other years were less than 2 percent. As discussed above, results of analyses of the relationship between the magnitude of reverse flows in Old and Middle rivers and salvage of adult delta smelt in the late winter shows a substantial increase in salvage as reverse flows exceed approximately -5,000 cfs. Reverse flows during months and years with the greatest changes were well below the -5,000 cfs threshold for Alternative 4 (Table L2-5) and the No Action/No Project Alternative (Table L2-6).

Table L2-4. Modeled Difference in Old and Middle River Flows between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative (% change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.2%	-0.2%	0.0%	1.8%	3.3%	9.5%	-0.5%	0.0%	0.0%	0.0%	0.0%	-0.2%
AN	1.3%	0.0%	0.0%	2.7%	5.3%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.4%
BN	0.1%	-0.5%	0.3%	0.0%	-1.3%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.3%
D	1.2%	-0.9%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	-0.6%	-0.3%	0.4%	-0.2%
C	0.0%	0.0%	-0.1%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	1.2%	-0.1%	0.0%

– Notes: Data results from CalSim modeling presented in Appendix B.
– Key: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table L2-5. Modeled Old and Middle River Flows under the San Luis Reservoir Expansion Alternative (cfs)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	-6520	-7397	-5734	-2210	-2993	-2285	2925	1718	-4434	-8962	-10425	-9398
AN	-6046	-6361	-7043	-3639	-3256	-4187	1325	402	-4837	-9806	-10755	-9869
BN	-6343	-7039	-7168	-4240	-3759	-4073	813	25	-4238	-10664	-10699	-9665
D	-5818	-6130	-7267	-4779	-4152	-3179	-425	-748	-3154	-8275	-6589	-6314
C	-5279	-4805	-5055	-4333	-3682	-2322	-1058	-1135	-1426	-3666	-2440	-3823

– Notes: Data results from CalSim modeling presented in Appendix B.
– Key: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table L2-6. Modeled Old and Middle River Flows under the No Action/No Project Alternative (cfs)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	-6,509	-7,413	-5,734	-2,170	-2,897	-2,086	2,941	1,718	-4,434	-8,961	-10,421	-9,416
AN	-5,967	-6,363	-7,046	-3,544	-3,091	-4,177	1,325	402	-4,837	-9,809	-10,755	-9,905
BN	-6,335	-7,072	-7,149	-4,240	-3,808	-4,070	813	25	-4,238	-10,663	-10,699	-9,638
D	-5,747	-6,189	-7,270	-4,784	-4,152	-3,179	-425	-748	-3,173	-8,300	-6,562	-6,328
C	-5,276	-4,806	-5,059	-4,333	-3,675	-2,322	-1,058	-1,135	-1,426	-3,624	-2,441	-3,822

– Notes: Data results from CalSim modeling presented in Appendix B.
– Key: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

L2.2.1.3.5 Delta Exports

Operation of the San Luis Reservoir Expansion Alternative could result in an increase in CVP and SWP exports during certain periods; this increase is assumed to result in a direct proportional increase in the risk of fish being entrained and salvaged at the Delta facilities.

Except for two model periods, simulated Delta exports would increase by less than two percent in all months of all water-year types (Table L2-7). In March of Wet water years and of February of Above Normal water years, there would be a 2.2 and 2.6 percent increase in Delta exports, respectively. During most years, Delta exports would be unchanged.

Table L2-7. Modeled Difference in Delta Exports between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative (% change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.2%	-0.2%	0.0%	0.5%	1.1%	2.2%	0.5%	0.0%	0.0%	0.0%	0.0%	-0.2%
AN	1.3%	0.0%	0.0%	1.6%	2.6%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.4%
BN	0.1%	-0.5%	0.2%	0.0%	-0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%
D	1.2%	-0.9%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	-0.7%	-0.3%	0.4%	-0.2%
C	0.0%	0.0%	-0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	1.6%	-0.1%	0.0%

– Notes: Data results from CalSim modeling presented in Appendix B.
– Key: AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

L2.2.1.4 Alternative 5

Operations of the reservoir would be generally the same for Alternative 5 as under the No Project. CalSim II modeling results indicate that, on average, there are very slight changes (<1%) to Delta hydrology, hydrodynamics, and water quality resulting from changes in Delta operations of the CVP and SWP compared to the No Action Alternative, which could impact delta fisheries and habitats.

L2.3 Operational Impacts to Pacheco Creek Steelhead

L2.3.1 Alternative 5

Table L2-8 presents Alternative 5 versus No Action Alternative average steelhead cohort scores summarized by water year type. The Pacheco Creek Habitat Suitability Model predicted improved viability of steelhead populations through improved habitat conditions in Pacheco Creek in all water year types for Alternative 5 versus the No Action Alternative. The model predicted the most significant improvement in steelhead cohort scores in critical years, where steelhead cohort scores increased from 0.8 to 20.6, a 2,728% increase.

Table L2-8. Average Pacheco Creek Steelhead Cohort Scores for Alternative 5 and the No Action Alternative for all water year types for 1922 to 2003 Simulation Period.

Water Year Type	No Action	Alternative 5	% Difference
W	13.2	28.9	219%
AN	8.2	22.9	281%
BN	13.1	25.6	195%
D	7.5	24.6	327%
C	0.8	20.6	2728%

Table L2-9 presents Alternative 5 versus No Action Alternative annual steelhead cohort scores for the full model record. Table L2-10 presents the monthly modeled river flows in Pacheco Creek for the No Action/ No Project Alternative 1 mile downstream of the Expanded Pacheco Reservoir utilized in the Pacheco Creek Habitat Suitability Model, Table L2-11 presents flows for Alternative 5 at this location, and Table L2-12 presents the change between the alternatives in river flow for each month of the model period.

Table L2-9. Pacheco Creek Steelhead Cohort Scores for Alternative 5 and the No Action Alternative for all water year types for 1922 to 2003 Simulation Period.

Outmigration Year	Water Year Type	Cohort Score		Difference
		No Action/No Project	Alternative 5	
1923	BN	17.1	25.4	8.3
1924	C	0.0	27.6	27.6
1925	D	0.0	19.4	19.4
1926	D	0.5	23.9	23.4
1927	W	4.0	28.2	24.2
1928	AN	7.4	24.4	17.0
1929	C	0.0	24.3	24.3
1930	D	0.0	23.4	23.4
1931	C	0.0	18.5	18.5
1932	D	0.0	18.2	18.2
1933	C	0.0	28.2	28.2
1934	C	0.0	23.5	23.5
1935	BN	0.0	15.4	15.4
1936	BN	1.5	21.8	20.3
1937	BN	17.6	33.2	15.6
1938	W	4.7	31.5	26.8
1939	D	2.2	29.7	27.5
1940	AN	0.0	18.4	18.4
1941	W	0.0	23.7	23.7
1942	W	0.2	27.9	27.7
1943	W	12.6	35.9	23.3
1944	D	15.2	29.3	14.1
1945	BN	8.1	34.4	26.3
1946	BN	10.6	28.3	17.7
1947	D	6.4	31.4	25.0
1948	BN	1.3	19.5	18.2
1949	D	10.2	19.0	8.8
1950	BN	4.5	28.0	23.4
1951	AN	0.4	34.7	34.3
1952	W	11.5	36.1	24.7
1953	W	0.0	29.6	29.6
1954	AN	0.8	32.4	31.6
1955	D	0.0	27.6	27.6
1956	W	1.1	29.9	28.9
1957	AN	2.7	28.7	26.0
1958	W	5.0	23.9	19.0
1959	BN	0.0	28.0	28.0

Outmigration Year	Water Year Type	Cohort Score		Difference
		No Action/No Project	Alternative 5	
1960	D	0.0	25.5	25.5
1961	D	0.0	23.7	23.7
1962	BN	0.0	18.7	18.7
1963	W	0.7	26.1	25.4
1964	D	0.0	30.6	30.6
1965	W	0.2	24.4	24.2
1966	BN	0.0	30.4	30.4
1967	W	0.0	19.4	19.4
1968	BN	0.0	29.1	29.1
1969	W	0.0	21.9	21.9
1970	W	14.0	28.0	14.0
1971	W	9.3	35.4	26.1
1972	BN	0.0	23.7	23.7
1973	AN	0.0	22.9	22.9
1974	W	11.2	35.2	24.0
1975	W	8.9	28.0	19.0
1976	C	0.0	23.0	23.0
1977	C	0.0	18.2	18.2
1978	AN	0.0	18.2	18.2
1979	BN	6.2	28.0	21.8
1980	AN	1.2	27.9	26.7
1981	D	7.2	28.0	20.7
1982	W	0.9	34.2	33.3
1983	W	30.5	35.8	5.3
1984	W	2.9	30.3	27.4
1985	D	0.0	34.4	34.4
1986	W	0.0	29.7	29.7
1987	D	5.1	29.1	24.1
1988	C	0.0	19.4	19.4
1989	D	0.0	18.4	18.4
1990	C	0.0	18.6	18.6
1991	C	0.0	18.5	18.5
1992	C	0.6	18.7	18.1
1993	AN	1.0	25.8	24.8
1994	C	0.0	29.2	29.2
1995	W	0.0	25.3	25.3
1996	W	12.4	30.0	17.6
1997	W	28.1	35.8	7.7
1998	W	1.8	29.0	27.2

Outmigration Year	Water Year Type	Cohort Score		Difference
		No Action/No Project	Alternative 5	
1999	W	14.9	30.9	16.0
2000	AN	12.2	35.8	23.5
2001	D	8.4	25.6	17.1
2002	D	0.6	25.0	24.4
2003	AN	1.3	34.7	33.4

Table L2-10. Pacheco Creek Simulated Average Monthly Flow (cfs) under the No Action Alternative for the 1922 to 2015 Simulation Period 1 Mile Downstream of Pacheco Dam.

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1922	9.6	328.6	72.1	33.5	8.5	15.9	13.2	12.6	12.5	12.5	7.6	43.8
1923	146.2	64.4	15.8	51.3	7.1	14.8	13.1	12.7	12.6	12.5	7.3	2.3
1924	2.3	2.5	1.9	1.3	0.1	0.4	0.3	0.2	0.3	0.3	0.3	0.3
1925	0.9	23.8	3.7	8.5	1.9	6.3	5.6	5.4	5.3	5.4	3.1	1.0
1926	1.0	147.6	8.2	84.5	5.8	13.2	12.6	12.5	12.5	12.5	9.3	3.0
1927	5.2	251.4	46.8	54.4	7.2	14.5	13.0	12.6	12.5	12.5	7.4	5.6
1928	4.0	11.1	47.2	18.9	2.3	11.9	11.4	11.2	11.2	11.3	6.6	2.4
1929	2.9	8.1	7.0	4.6	1.1	2.5	2.2	2.0	2.0	2.0	1.2	0.4
1930	2.9	4.8	55.7	2.3	1.0	10.7	10.4	10.3	10.3	10.4	6.0	3.3
1931	2.2	2.6	1.7	1.1	0.1	0.3	0.2	0.2	0.2	0.2	0.0	134.1
1932	105.0	253.6	17.5	7.0	3.5	13.4	12.7	12.5	12.4	12.4	7.3	4.5
1933	12.2	7.1	4.6	3.8	0.7	2.4	2.2	2.1	2.0	2.0	1.2	2.2
1934	8.5	14.8	4.8	1.4	0.4	4.4	4.2	4.2	4.2	4.3	2.4	1.1
1935	1.2	2.3	29.9	32.0	1.5	11.5	11.4	12.8	12.0	13.7	7.8	11.6
1936	29.3	107.2	20.6	29.7	11.9	15.0	14.2	14.2	14.4	14.3	8.2	37.7
1937	27.6	127.6	147.9	9.2	2.5	15.0	14.1	14.2	14.3	14.6	16.8	67.3
1938	81.1	291.3	107.2	36.8	4.1	15.0	14.2	14.2	14.5	17.0	14.6	14.5
1939	2.2	8.0	25.0	2.1	0.0	8.7	9.0	9.1	9.1	9.2	5.3	2.1
1940	4.3	263.5	204.5	62.2	0.0	11.9	12.2	12.2	12.3	12.4	7.2	24.8
1941	79.4	420.9	252.6	236.1	0.2	12.1	12.4	12.4	12.5	12.6	7.3	20.8
1942	105.7	207.5	83.8	154.0	28.7	19.6	13.0	12.6	12.5	12.7	10.1	5.1
1943	259.9	90.9	224.2	31.6	13.4	17.0	13.1	12.4	12.4	12.4	7.5	6.1
1944	10.3	187.4	172.9	12.8	4.2	13.6	12.9	12.2	12.3	12.7	11.1	6.6
1945	6.5	316.0	119.0	22.1	5.2	16.2	14.7	12.2	12.3	12.8	8.3	74.2
1946	64.6	25.3	27.3	31.1	12.3	19.1	18.9	19.0	18.1	13.6	11.9	8.4
1947	14.2	16.0	36.6	4.0	1.0	12.1	11.9	11.9	11.9	12.4	7.2	4.3
1948	3.7	12.2	31.2	78.5	14.9	17.8	12.9	12.5	12.4	12.5	7.4	6.1
1949	9.9	39.5	89.0	11.9	3.4	13.4	12.8	12.7	12.4	12.4	7.2	4.4
1950	17.5	27.5	4.8	18.8	0.6	9.3	9.3	8.8	8.8	8.9	130.4	199.9

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1951	61.8	37.7	55.9	9.5	4.8	13.3	15.8	12.3	12.3	12.8	9.6	41.2
1952	428.7	52.9	166.7	22.2	10.8	16.4	15.7	12.5	12.5	12.5	7.5	22.6
1953	32.8	6.2	7.5	5.6	1.2	12.4	12.2	12.1	12.0	12.1	7.9	5.5
1954	4.4	9.7	14.3	7.5	1.1	3.8	3.5	3.4	3.3	3.2	2.6	2.1
1955	24.0	7.6	7.6	3.7	1.2	7.3	6.9	6.8	6.8	6.6	4.1	313.9
1956	280.4	87.7	28.2	16.9	6.6	14.7	13.3	12.6	12.6	12.5	7.3	2.3
1957	3.2	32.0	16.1	5.8	3.5	7.6	7.0	6.9	6.8	6.8	3.9	2.9
1958	33.7	287.1	260.1	490.8	19.0	19.1	13.7	12.7	12.7	12.8	7.5	3.6
1959	4.7	136.2	10.1	4.8	0.6	11.9	11.8	11.8	15.7	12.3	7.3	2.4
1960	3.7	69.0	2.4	4.6	0.5	10.7	10.7	10.6	10.7	10.8	6.3	3.0
1961	2.0	1.9	1.5	1.0	0.2	0.8	0.5	0.3	0.3	0.2	0.2	0.1
1962	0.6	134.4	105.1	5.2	0.6	12.4	12.2	12.4	12.3	14.4	7.6	2.8
1963	10.2	292.3	69.5	195.0	26.8	17.1	13.5	13.2	12.9	13.3	8.6	2.5
1964	28.5	5.4	4.9	4.3	0.4	5.2	5.9	5.7	5.5	5.4	3.1	3.5
1965	167.7	21.6	8.4	104.9	3.3	13.3	13.1	12.5	12.4	13.5	10.6	30.0
1966	12.0	12.0	5.0	3.6	1.1	9.5	9.5	9.4	9.4	9.6	5.7	36.1
1967	251.5	41.1	193.3	227.8	31.0	20.8	13.0	12.8	12.9	12.7	7.5	4.8
1968	5.9	8.1	10.0	3.7	0.3	1.8	1.7	1.7	1.7	1.7	1.9	2.4
1969	483.4	557.4	156.3	30.8	7.6	14.5	12.6	12.3	12.3	12.4	7.2	5.7
1970	192.0	59.2	162.7	12.1	4.2	12.9	12.4	12.2	12.3	12.4	9.7	56.4
1971	74.3	12.1	35.4	15.5	5.5	13.4	12.5	12.2	12.3	12.4	7.2	4.1
1972	3.7	5.1	2.3	1.8	0.2	0.4	0.4	0.3	0.3	0.3	18.3	3.0
1973	139.0	428.4	119.2	25.4	4.8	12.9	12.2	12.2	12.3	12.4	11.9	43.6
1974	129.4	15.5	229.6	104.5	9.2	14.4	12.7	12.3	12.4	12.5	7.3	5.0
1975	4.1	91.3	216.2	50.3	9.5	13.4	12.6	12.4	12.4	12.4	7.2	4.9
1976	2.6	1.6	1.2	0.7	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0
1977	0.2	0.2	0.2	0.1	0.1	0.4	0.1	0.1	0.1	0.1	0.0	0.8
1978	161.7	244.0	242.3	51.4	12.3	16.7	12.5	12.3	12.3	12.4	7.2	4.1
1979	8.3	11.5	14.8	7.5	1.4	4.2	4.1	4.0	4.0	4.1	2.3	6.2
1980	182.6	573.2	108.0	25.5	5.7	16.0	13.0	12.4	12.4	12.4	7.2	4.5
1981	36.6	9.9	30.4	6.6	0.8	11.6	11.5	11.5	11.5	11.6	13.7	2.9
1982	173.6	205.4	175.4	340.4	23.8	19.1	13.2	12.7	12.7	12.7	20.1	58.0
1983	288.9	328.1	379.8	93.0	43.4	12.7	12.2	12.3	12.4	12.9	8.3	4.5
1984	12.0	17.9	18.1	2.3	0.1	5.0	5.2	5.2	5.3	5.3	5.9	4.1
1985	1.9	17.7	15.8	1.0	0.0	4.7	5.0	5.0	5.0	5.1	6.9	3.5
1986	8.4	641.4	271.4	24.3	8.1	13.2	12.9	12.4	12.4	12.5	7.4	4.6
1987	3.7	12.1	12.1	4.4	0.4	2.6	2.7	2.7	2.8	2.8	1.7	1.3
1988	1.9	1.4	0.8	2.4	0.6	1.0	0.8	0.7	0.6	0.4	0.3	0.2
1989	0.9	1.3	2.7	1.0	0.7	2.2	2.1	2.0	1.4	1.2	0.8	0.2
1990	0.3	3.9	0.7	0.2	0.0	1.1	1.0	1.1	1.1	1.2	0.5	0.4

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1991	0.3	0.3	78.8	10.7	0.9	12.4	12.2	12.2	12.3	12.5	7.3	4.1
1992	2.6	57.3	18.9	3.1	0.9	11.5	11.0	10.7	10.7	11.0	6.7	10.3
1993	338.5	346.6	103.2	32.5	8.7	16.1	12.4	12.5	12.3	12.5	7.4	4.5
1994	2.9	10.0	2.5	2.5	0.7	1.1	1.0	1.1	1.1	1.1	0.9	0.5
1995	217.7	50.3	487.4	40.0	5.2	12.2	13.5	12.5	12.3	12.4	7.6	6.5
1996	51.1	439.7	146.6	12.1	12.8	15.3	12.6	12.5	12.5	12.4	9.4	165.1
1997	871.3	73.1	21.8	12.4	1.3	12.5	12.2	12.3	11.9	12.0	7.2	10.6
1998	146.4	1018.5	120.7	114.6	24.6	16.7	13.8	12.3	12.4	12.5	7.8	6.0
1999	49.9	438.3	146.6	12.1	12.8	15.3	12.6	12.5	12.5	12.4	9.4	5.0
2000	15.0	190.8	107.2	22.6	17.7	13.1	12.4	12.3	12.3	12.6	8.6	4.9
2001	4.7	36.7	15.2	5.0	0.7	8.1	8.5	8.5	8.4	8.4	5.1	17.2
2002	20.0	7.2	14.7	4.6	1.1	8.8	8.2	8.3	8.4	8.5	7.6	61.3
2003	36.8	13.3	16.7	14.6	17.4	13.4	12.2	12.2	12.3	12.4	7.2	7.8
2004	16.7	61.7	9.5	4.6	0.0	11.5	11.8	11.8	11.9	12.0	7.3	26.6
2005	143.8	271.3	212.7	46.9	13.1	14.1	12.7	12.2	12.3	12.8	8.2	36.2
2006	82.9	21.0	189.0	300.5	23.5	17.1	12.6	12.5	12.5	12.6	7.4	3.5
2007	2.4	10.7	5.3	3.1	0.2	1.5	1.5	1.5	1.5	1.5	0.9	0.3
2008	46.7	90.3	16.3	3.4	0.2	12.0	12.1	12.1	12.2	12.3	7.2	3.3
2009	2.1	23.3	36.9	4.7	0.3	8.7	8.8	8.8	8.9	11.9	5.3	5.4
2010	122.6	91.9	74.9	74.6	9.0	14.6	12.5	12.3	12.3	12.4	7.3	29.9
2011	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4
2012	24.4	189.2	189.2	189.2	189.2	189.2	189.2	189.2	189.2	2.6	1.7	54.1
2013	6.1	2.4	1.7	1.0	0.2	9.1	9.3	9.4	9.4	9.5	5.5	2.3
2014	1.3	3.2	3.3	2.2	0.1	0.8	0.8	0.8	0.8	0.8	0.3	29.5
2015	1.6	22.9	2.0	1.3	0.5	8.3	8.4	8.2	8.3	8.3	8.3	8.3

Table L2-11. Pacheco Creek Simulated Average Monthly Flow (cfs) under Alternative 5 for the 1922 to 2015 Simulation Period 1 Mile Downstream of Pacheco Dam.

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1922	9.8	198.3	34.4	35.9	16.1	15.6	14.1	13.5	13.5	13.4	9.7	44.7
1923	83.1	30.4	27.4	24.7	15.4	15.1	14.1	13.6	13.5	13.4	9.5	9.6
1924	9.6	9.5	19.5	19.6	11.4	13.3	13.1	13.1	13.3	13.4	9.7	9.7
1925	10.6	24.9	23.7	28.7	13.6	14.2	13.5	13.3	13.3	13.3	9.4	9.5
1926	9.6	115.3	24.1	40.7	14.6	14.1	13.5	13.3	13.3	13.4	11.5	10.4
1927	12.6	160.3	23.1	26.1	15.5	14.9	13.9	13.5	13.4	13.4	9.5	10.6
1928	10.6	18.5	45.4	39.3	14.1	14.0	13.5	13.3	13.3	13.3	9.5	10.0
1929	10.5	15.6	24.7	22.2	12.6	13.8	13.4	13.2	13.2	13.3	9.4	9.5
1930	12.6	14.4	56.7	22.2	12.5	13.8	13.4	13.3	13.3	13.3	9.4	9.5
1931	9.8	10.8	20.0	19.6	11.3	13.2	13.1	13.1	13.2	13.3	9.4	107.8

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1932	50.2	121.6	27.6	23.3	13.7	14.3	13.7	13.4	13.4	13.4	9.5	9.6
1933	19.4	14.6	22.0	21.1	12.2	13.7	13.3	13.2	13.3	13.3	9.4	11.8
1934	15.7	14.6	19.4	15.7	8.8	10.0	9.7	9.6	9.7	9.8	6.9	7.0
1935	10.2	11.5	29.7	32.6	13.2	15.2	15.1	16.5	15.7	17.4	11.6	9.8
1936	29.9	62.9	29.6	34.2	17.8	15.2	15.1	15.2	15.3	15.2	10.4	35.7
1937	28.1	61.5	70.8	24.0	13.2	15.2	15.1	15.2	15.3	15.6	9.2	60.6
1938	38.8	139.9	50.7	37.4	14.0	15.2	15.1	15.2	15.5	18.0	16.9	12.2
1939	9.4	15.5	25.5	19.2	11.2	13.1	13.1	13.1	13.2	13.3	9.4	9.4
1940	12.9	170.3	98.5	29.3	11.2	13.1	13.1	13.1	13.2	13.3	9.4	21.5
1941	66.8	202.4	131.8	230.2	11.2	13.1	13.1	13.1	13.2	13.3	9.4	17.6
1942	81.6	178.7	78.2	148.1	18.8	17.3	13.9	13.4	13.3	13.5	12.3	12.5
1943	227.2	87.2	221.1	34.6	18.5	16.1	14.0	13.4	13.3	13.3	9.6	11.0
1944	16.7	130.5	151.7	25.7	14.1	14.5	13.8	13.2	13.2	13.6	13.3	14.1
1945	14.0	288.6	113.3	30.3	14.6	15.8	15.7	13.1	13.2	13.7	10.5	71.1
1946	30.9	11.8	33.0	34.9	18.0	17.1	19.9	20.0	19.1	14.5	14.2	15.9
1947	11.9	13.6	29.2	20.5	12.6	13.5	13.2	13.2	13.2	13.7	9.7	9.9
1948	10.9	9.9	31.8	57.6	19.0	16.5	13.8	13.3	13.3	13.4	9.5	11.3
1949	16.4	36.1	63.7	25.4	13.7	14.4	13.7	13.6	13.4	13.3	9.4	9.4
1950	14.9	25.4	22.2	39.2	12.0	13.9	13.7	13.2	13.3	13.3	100.1	95.9
1951	29.0	17.8	26.7	23.5	15.3	14.5	17.1	13.5	13.5	14.1	12.0	42.0
1952	216.8	23.9	83.9	30.2	17.3	15.8	16.7	13.4	13.4	13.4	9.7	20.4
1953	33.4	16.4	27.7	21.8	12.8	13.8	13.5	13.4	13.3	13.4	10.3	10.5
1954	10.9	16.8	31.8	25.1	12.6	14.0	13.5	13.4	13.4	13.4	10.3	11.3
1955	23.7	17.0	27.0	23.0	12.8	14.0	13.6	13.6	13.6	13.4	9.8	190.0
1956	134.1	41.2	33.3	28.1	15.3	15.1	14.2	13.5	13.5	13.5	9.5	9.6
1957	10.6	29.6	33.8	23.2	15.5	14.2	13.5	13.5	13.4	13.4	9.4	11.4
1958	32.8	161.2	124.4	391.9	19.9	16.9	14.2	13.2	13.2	13.3	9.4	9.4
1959	12.3	108.1	25.7	20.9	12.0	13.4	13.1	13.1	17.1	13.6	9.7	9.7
1960	11.2	67.4	22.3	22.1	11.9	13.3	13.2	13.1	13.2	13.3	9.4	9.5
1961	9.8	10.3	20.1	19.6	11.5	14.0	13.5	13.4	13.4	13.4	9.5	9.5
1962	10.2	111.3	50.2	22.1	12.1	13.5	13.2	13.3	13.2	15.4	9.8	10.1
1963	17.8	178.8	32.6	93.7	12.5	16.1	14.3	14.0	13.7	14.1	10.7	9.8
1964	26.4	12.8	22.3	21.7	11.8	13.5	14.0	13.8	13.6	13.5	9.5	12.4
1965	119.7	9.8	23.3	51.1	13.3	14.2	13.9	13.4	13.2	14.4	12.8	27.9
1966	12.3	12.3	22.4	20.9	12.8	13.3	13.2	13.2	13.2	13.4	9.6	33.2
1967	143.7	18.9	92.9	109.2	14.4	17.8	13.7	13.6	13.7	13.5	9.6	9.9
1968	12.9	14.8	27.1	21.0	11.6	13.4	13.2	13.1	13.2	13.3	10.5	11.9
1969	273.4	455.6	149.6	34.4	15.7	14.9	13.5	13.2	13.2	13.3	9.4	11.0
1970	129.5	54.7	159.0	25.4	14.1	13.9	13.3	13.2	13.2	13.4	11.9	57.4
1971	41.6	15.5	36.9	27.4	14.7	14.4	13.5	13.2	13.2	13.3	9.4	9.4

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1972	10.9	12.7	19.9	19.6	11.4	13.2	13.1	13.1	13.2	13.3	19.3	12.9
1973	97.9	205.8	56.1	31.9	14.3	13.8	13.2	13.1	13.2	13.3	14.1	44.4
1974	74.0	16.9	203.7	96.9	16.3	14.9	13.6	13.2	13.2	13.3	9.4	10.4
1975	10.9	86.6	154.3	42.1	16.6	14.3	13.5	13.3	13.3	13.3	9.4	10.3
1976	9.4	9.4	19.9	19.3	11.2	13.1	13.1	13.1	13.2	13.3	9.4	9.5
1977	9.8	9.6	19.6	19.4	11.4	13.5	13.1	13.1	13.2	13.3	9.4	10.5
1978	120.4	117.0	116.0	24.0	17.9	16.0	13.4	13.2	13.2	13.3	9.4	9.4
1979	15.7	18.6	32.5	25.0	13.1	13.4	13.2	13.2	13.2	13.3	9.4	14.5
1980	126.8	275.4	50.4	32.0	14.8	15.7	13.9	13.3	13.3	13.3	9.4	9.5
1981	34.2	17.5	31.0	24.1	12.3	13.4	13.2	13.1	13.2	13.3	16.4	10.5
1982	118.9	98.3	88.9	336.3	22.6	17.0	13.9	13.3	13.3	13.3	12.4	58.9
1983	264.2	327.1	377.5	84.3	34.0	13.6	13.1	13.1	13.2	13.8	10.4	9.8
1984	19.2	15.6	35.8	19.5	11.4	13.1	13.1	13.1	13.2	13.3	12.4	13.0
1985	10.6	16.9	34.9	19.4	11.2	13.1	13.1	13.1	13.2	13.3	13.5	12.4
1986	17.4	347.4	184.6	30.9	16.0	14.1	13.8	13.3	13.3	13.4	9.6	9.7
1987	10.7	9.8	29.7	21.8	11.8	13.2	13.2	13.2	13.4	13.4	9.6	10.2
1988	11.0	10.2	19.6	21.5	12.0	14.0	13.7	13.6	13.5	13.4	9.4	9.6
1989	10.5	11.0	22.8	20.6	12.2	14.6	14.3	14.2	13.7	13.5	9.5	9.4
1990	9.6	14.1	20.1	19.2	11.2	13.1	13.1	13.1	13.2	13.5	9.5	9.6
1991	9.6	9.6	80.6	25.0	12.3	13.4	13.1	13.2	13.3	13.5	9.5	9.8
1992	9.9	56.3	39.3	20.4	12.4	14.1	13.5	13.2	13.2	13.5	9.8	16.1
1993	199.2	165.8	48.7	35.4	16.2	15.7	13.3	13.4	13.2	13.4	9.6	9.7
1994	9.9	18.1	20.5	20.3	12.2	13.1	13.1	13.1	13.2	13.3	9.7	9.8
1995	147.1	23.5	234.5	37.8	14.5	13.1	14.4	13.4	13.2	13.3	9.8	11.8
1996	48.1	227.8	69.4	25.4	18.3	15.3	13.6	13.4	13.4	13.3	11.6	115.3
1997	501.3	64.6	30.2	24.6	13.0	13.8	13.5	13.7	13.3	13.3	9.6	15.8
1998	106.5	970.0	110.9	107.9	15.0	15.9	14.6	13.1	13.2	13.3	10.0	10.8
1999	47.1	405.5	140.6	25.4	18.3	15.3	13.6	13.4	13.4	13.3	11.6	12.4
2000	12.7	124.9	88.8	30.6	20.7	14.1	13.3	13.2	13.3	13.5	10.8	9.7
2001	11.6	34.2	35.6	25.1	12.1	13.2	13.5	13.4	13.3	13.3	9.6	14.4
2002	18.5	15.6	35.0	22.8	12.7	13.7	13.1	13.1	13.2	13.3	12.2	62.4
2003	22.4	16.2	27.9	27.0	20.5	14.3	13.1	13.1	13.2	13.3	9.4	13.4
2004	12.5	62.9	27.2	20.9	11.2	13.2	13.1	13.1	13.2	13.3	9.7	23.4
2005	96.9	130.2	101.6	22.0	18.3	14.7	13.6	13.1	13.2	13.7	10.4	34.2
2006	59.5	9.8	90.9	253.0	22.6	16.0	13.3	13.1	13.2	13.3	9.4	9.4
2007	9.9	19.1	23.8	20.3	11.4	13.2	13.1	13.1	13.2	13.3	9.4	9.4
2008	47.7	62.6	27.5	21.3	11.5	13.3	13.1	13.1	13.2	13.3	9.4	9.5
2009	9.7	22.1	37.7	22.1	11.6	13.3	13.1	13.1	13.2	16.2	9.5	13.6
2010	95.9	43.8	35.7	35.7	16.3	14.9	13.4	13.2	13.2	13.3	9.4	25.8
2011	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	24.9	104.8	104.8	104.8	104.8	104.8	104.8	104.8	104.8	13.3	9.7	54.2
2013	16.2	11.7	20.9	19.9	11.4	13.2	13.1	13.1	13.2	13.3	9.4	9.4
2014	9.4	12.2	22.3	21.0	11.3	13.2	13.1	13.1	13.3	13.3	9.4	30.5
2015	11.3	23.4	21.6	20.7	11.9	13.4	13.3	13.1	13.2	13.2	13.2	13.2

Table L2-12. Difference in Pacheco Creek Simulated Average Monthly Flow (cfs) between the No Action/No Project and Alternative 5 for the 1922 to 2015 Simulation Period 1 Mile Downstream of Pacheco Dam.

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1922	0.2	-130.3	-37.7	2.4	7.7	-0.3	0.9	0.9	0.9	0.9	2.2	0.8
1923	-63.1	-34.0	11.5	-26.6	8.3	0.3	0.9	0.9	0.9	0.9	2.2	7.3
1924	7.3	7.0	17.6	18.3	11.3	12.9	12.9	12.9	13.0	13.1	9.3	9.5
1925	9.7	1.1	20.0	20.2	11.7	8.0	7.9	7.9	7.9	8.0	6.3	8.5
1926	8.5	-32.4	15.9	-43.8	8.9	0.9	0.9	0.9	0.9	0.9	2.2	7.4
1927	7.5	-91.1	-23.7	-28.3	8.2	0.4	0.9	0.9	0.9	0.9	2.2	5.0
1928	6.5	7.4	-1.7	20.4	11.8	2.1	2.1	2.1	2.1	2.1	2.9	7.6
1929	7.6	7.5	17.7	17.6	11.6	11.3	11.2	11.2	11.3	11.4	8.2	9.1
1930	9.7	9.6	1.0	19.9	11.6	3.1	3.0	3.0	3.0	3.0	3.4	6.1
1931	7.6	8.2	18.4	18.5	11.2	12.9	12.9	12.9	13.0	13.1	9.4	-26.3
1932	-54.8	-131.9	10.2	16.3	10.3	1.0	1.0	0.9	1.0	0.9	2.2	5.1
1933	7.2	7.5	17.4	17.3	11.5	11.3	11.2	11.2	11.2	11.3	8.2	9.5
1934	7.2	-0.2	14.6	14.2	8.4	5.6	5.5	5.5	5.5	5.6	4.5	5.9
1935	9.0	9.1	-0.2	0.6	11.7	3.7	3.7	3.7	3.7	3.7	3.8	-1.8
1936	0.6	-44.3	9.0	4.6	5.9	0.2	0.9	0.9	1.0	0.9	2.2	-2.0
1937	0.6	-66.0	-77.1	14.8	10.7	0.2	1.0	1.0	1.0	1.0	-7.7	-6.7
1938	-42.2	-151.4	-56.4	0.6	9.8	0.2	0.9	0.9	0.9	1.0	2.3	-2.4
1939	7.3	7.5	0.5	17.1	11.2	4.4	4.1	4.1	4.1	4.1	4.0	7.4
1940	8.6	-93.2	-106.0	-32.8	11.2	1.2	0.9	0.9	0.9	0.9	2.2	-3.2
1941	-12.6	-218.5	-120.8	-6.0	10.9	1.0	0.7	0.7	0.7	0.7	2.1	-3.2
1942	-24.0	-28.7	-5.6	-5.9	-9.9	-2.3	0.8	0.8	0.8	0.8	2.2	7.4
1943	-32.6	-3.7	-3.1	2.9	5.1	-0.9	0.9	0.9	0.9	0.9	2.2	5.0
1944	6.5	-56.9	-21.1	12.8	9.8	0.9	0.9	0.9	0.9	0.9	2.3	7.5
1945	7.5	-27.4	-5.7	8.2	9.4	-0.4	1.0	0.9	0.9	0.9	2.2	-3.1
1946	-33.7	-13.5	5.7	3.8	5.7	-2.0	1.0	1.0	1.0	0.9	2.3	7.5
1947	-2.4	-2.3	-7.4	16.5	11.6	1.4	1.3	1.3	1.3	1.3	2.4	5.6
1948	7.2	-2.3	0.6	-21.0	4.1	-1.3	0.9	0.8	0.9	0.9	2.1	5.2
1949	6.5	-3.4	-25.2	13.6	10.3	1.0	0.9	0.9	0.9	0.9	2.2	5.0
1950	-2.7	-2.1	17.4	20.4	11.4	4.6	4.4	4.4	4.4	4.4	-30.3	-104.0
1951	-32.8	-19.9	-29.2	14.0	10.5	1.2	1.3	1.2	1.2	1.2	2.4	0.8

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1952	-212.0	-28.9	-82.9	8.0	6.5	-0.5	1.0	0.9	0.9	0.9	2.2	-2.2
1953	0.6	10.2	20.2	16.1	11.6	1.4	1.3	1.3	1.3	1.3	2.4	5.0
1954	6.6	7.2	17.6	17.6	11.6	10.2	10.1	10.1	10.1	10.2	7.7	9.2
1955	-0.3	9.4	19.4	19.2	11.6	6.8	6.7	6.7	6.7	6.8	5.7	-123.8
1956	-146.3	-46.5	5.0	11.2	8.6	0.3	1.0	0.9	0.9	0.9	2.2	7.3
1957	7.4	-2.3	17.7	17.4	11.9	6.6	6.5	6.5	6.5	6.6	5.5	8.5
1958	-0.9	-125.9	-135.6	-98.9	0.9	-2.2	0.5	0.5	0.5	0.5	1.9	5.9
1959	7.6	-28.2	15.5	16.1	11.4	1.5	1.3	1.3	1.4	1.3	2.4	7.4
1960	7.5	-1.6	19.9	17.5	11.4	2.7	2.5	2.5	2.5	2.5	3.1	6.5
1961	7.8	8.3	18.7	18.6	11.3	13.2	13.0	13.0	13.1	13.1	9.3	9.4
1962	9.6	-23.1	-54.9	17.0	11.4	1.1	0.9	0.9	0.9	1.0	2.2	7.3
1963	7.6	-113.5	-36.8	-101.3	-14.3	-1.1	0.8	0.8	0.8	0.8	2.1	7.3
1964	-2.1	7.4	17.4	17.3	11.4	8.2	8.0	8.0	8.1	8.1	6.4	8.9
1965	-48.0	-11.8	14.9	-53.8	10.1	0.9	0.9	0.8	0.9	0.9	2.2	-2.1
1966	0.3	0.3	17.4	17.3	11.6	3.8	3.8	3.8	3.8	3.8	3.9	-2.9
1967	-107.8	-22.2	-100.4	-118.7	-16.6	-3.0	0.7	0.7	0.8	0.7	2.1	5.2
1968	7.0	6.7	17.1	17.3	11.3	11.5	11.5	11.5	11.5	11.6	8.6	9.5
1969	-210.0	-101.7	-6.7	3.6	8.1	0.4	0.9	0.9	0.9	0.9	2.2	5.3
1970	-62.6	-4.5	-3.7	13.2	9.9	0.9	0.9	0.9	0.9	0.9	2.2	1.0
1971	-32.7	3.4	1.5	11.8	9.2	0.9	0.9	0.9	0.9	0.9	2.2	5.4
1972	7.3	7.5	17.6	17.8	11.3	12.8	12.8	12.8	12.9	13.0	1.0	9.9
1973	-41.2	-222.5	-63.0	6.5	9.5	0.9	0.9	0.9	0.9	0.9	2.3	0.8
1974	-55.4	1.4	-25.9	-7.6	7.1	0.5	0.9	0.9	0.9	0.9	2.1	5.4
1975	6.9	-4.6	-61.9	-8.2	7.1	0.9	0.9	0.9	0.9	0.9	2.2	5.4
1976	6.8	7.8	18.6	18.6	11.2	13.0	13.0	13.0	13.1	13.3	9.4	9.4
1977	9.6	9.4	19.4	19.3	11.3	13.2	13.0	13.1	13.1	13.2	9.4	9.7
1978	-41.2	-127.0	-126.4	-27.4	5.6	-0.7	0.9	0.9	0.9	0.9	2.2	5.4
1979	7.4	7.2	17.7	17.5	11.7	9.2	9.2	9.2	9.2	9.3	7.1	8.3
1980	-55.8	-297.7	-57.7	6.4	9.1	-0.3	0.9	0.9	0.9	0.9	2.2	5.0
1981	-2.4	7.6	0.6	17.5	11.5	1.8	1.7	1.7	1.7	1.7	2.8	7.5
1982	-54.8	-107.1	-86.5	-4.1	-1.2	-2.1	0.6	0.6	0.6	0.6	-7.8	0.9
1983	-24.7	-1.0	-2.4	-8.7	-9.3	0.9	0.9	0.9	0.9	0.9	2.2	5.3
1984	7.3	-2.3	17.7	17.2	11.3	8.1	7.9	7.9	8.0	8.0	6.5	8.9
1985	8.7	-0.8	19.1	18.4	11.2	8.4	8.1	8.1	8.2	8.2	6.6	8.9
1986	9.0	-294.1	-86.9	6.6	7.9	0.9	0.9	0.9	0.9	0.9	2.2	5.1
1987	7.0	-2.4	17.6	17.4	11.4	10.6	10.5	10.5	10.6	10.6	7.9	8.9
1988	9.0	8.8	18.7	19.0	11.4	13.0	12.9	12.9	12.9	12.9	9.2	9.4
1989	9.6	9.7	20.1	19.5	11.5	12.4	12.3	12.3	12.3	12.3	8.8	9.2
1990	9.3	10.2	19.3	19.0	11.2	12.0	12.0	12.1	12.2	12.3	9.1	9.2
1991	9.3	9.3	1.9	14.3	11.4	1.0	0.9	0.9	0.9	0.9	2.2	5.8

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1992	7.3	-0.9	20.4	17.3	11.5	2.7	2.5	2.5	2.5	2.5	3.1	5.8
1993	-139.2	-180.8	-54.5	2.8	7.6	-0.4	0.9	0.9	0.9	0.9	2.2	5.2
1994	7.0	8.0	17.9	17.8	11.5	12.0	12.0	12.1	12.2	12.3	8.8	9.3
1995	-70.6	-26.8	-252.8	-2.2	9.3	0.9	0.9	0.9	0.9	0.9	2.2	5.3
1996	-3.0	-211.9	-77.3	13.3	5.5	0.0	0.9	0.9	0.9	0.9	2.2	-49.8
1997	-370.1	-8.5	8.4	12.3	11.7	1.3	1.3	1.3	1.3	1.3	2.4	5.2
1998	-39.9	-48.5	-9.8	-6.7	-9.7	-0.8	0.9	0.8	0.8	0.8	2.1	4.8
1999	-2.9	-32.7	-6.0	13.3	5.5	0.0	0.9	0.9	0.9	0.9	2.2	7.5
2000	-2.3	-65.9	-18.5	7.9	2.9	0.9	0.9	0.9	0.9	0.9	2.2	4.8
2001	6.9	-2.5	20.3	20.1	11.4	5.1	5.0	5.0	5.0	5.0	4.6	-2.7
2002	-1.4	8.3	20.3	18.2	11.6	4.9	4.9	4.9	4.9	4.9	4.6	1.1
2003	-14.5	2.8	11.2	12.4	3.1	1.0	0.9	0.9	0.9	0.9	2.2	5.6
2004	-4.1	1.1	17.7	16.3	11.2	1.6	1.3	1.3	1.3	1.3	2.4	-3.2
2005	-46.9	-141.2	-111.1	-25.0	5.3	0.6	0.9	0.9	0.9	0.9	2.2	-2.0
2006	-23.5	-11.2	-98.1	-47.5	-0.9	-1.1	0.7	0.7	0.7	0.7	2.0	5.9
2007	7.5	8.4	18.4	17.2	11.3	11.7	11.6	11.7	11.7	11.8	8.5	9.2
2008	1.1	-27.7	11.3	17.9	11.3	1.2	1.0	1.0	1.0	1.0	2.2	6.2
2009	7.6	-1.2	0.7	17.4	11.3	4.5	4.3	4.3	4.3	4.4	4.2	8.2
2010	-26.7	-48.1	-39.2	-38.9	7.3	0.4	0.9	0.9	0.9	0.9	2.1	-4.1
2011	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
2012	0.5	-84.4	-84.4	-84.4	-84.4	-84.4	-84.4	-84.4	-84.4	10.7	8.0	0.1
2013	10.2	9.3	19.2	19.0	11.3	4.1	3.8	3.8	3.8	3.8	3.9	7.2
2014	8.2	9.0	19.0	18.8	11.2	12.3	12.3	12.3	12.4	12.5	9.1	0.9
2015	9.7	0.5	19.7	19.5	11.4	5.1	4.9	4.9	4.9	4.9	4.9	4.9

Table L2-13 presents the monthly modeled river flows in Pacheco Creek for the No Action/ No Project Alternative 1 mile downstream of the Expanded Pacheco Reservoir utilized in the Pacheco Creek Habitat Suitability Model, Table L2-14 presents flows for Alternative 5 at this location, and Table L2-15 presents the change between the alternatives in river flow for each month of the model period.

Table L2-13. Pacheco Creek Simulated Average Monthly Flow (cfs) under the No Action Alternative for the 1922 to 2015 Simulation Period 5 Mile Downstream of Pacheco Dam.

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1922	7.6	326.4	70.1	31.4	6.5	13.8	11.2	10.6	10.5	10.5	5.5	41.8
1923	144.3	62.2	13.8	49.2	5.1	12.8	11.2	10.7	10.5	10.4	5.2	0.6
1924	0.7	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1925	0.0	19.0	1.8	6.4	0.4	4.2	3.6	3.3	3.1	3.2	1.2	0.0
1926	0.0	144.8	6.2	82.4	3.8	11.2	10.6	10.4	10.3	10.4	7.2	1.2
1927	3.2	249.2	44.8	52.3	5.2	12.5	11.0	10.6	10.4	10.4	5.2	3.6
1928	2.0	8.9	45.2	16.8	0.7	9.9	9.4	9.2	9.0	9.1	4.5	0.8
1929	1.1	5.8	5.0	2.5	0.0	0.6	0.6	0.4	0.3	0.3	0.0	0.0
1930	0.4	2.5	53.7	0.7	0.0	8.3	8.4	8.2	8.2	8.2	3.8	1.4
1931	0.6	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	129.0
1932	103.0	251.4	15.5	5.0	1.6	11.3	10.7	10.5	10.3	10.3	5.1	2.4
1933	10.2	4.8	2.6	1.8	0.0	0.4	0.6	0.4	0.4	0.4	0.0	0.4
1934	6.5	12.6	2.8	0.0	0.0	1.7	2.1	2.0	2.0	2.1	0.7	0.0
1935	0.0	0.3	27.9	29.9	0.1	9.4	9.4	10.8	9.9	11.7	5.7	9.7
1936	27.3	105.0	18.6	27.6	9.9	13.0	12.2	12.2	12.3	12.3	6.1	35.7
1937	25.6	125.3	145.9	7.1	0.9	12.9	12.2	12.2	12.3	12.6	14.8	65.3
1938	79.1	289.1	105.2	34.8	2.1	12.9	12.2	12.2	12.5	15.0	12.5	12.5
1939	0.5	5.8	23.0	0.4	0.0	5.4	6.9	6.9	6.9	7.1	3.1	0.4
1940	2.3	261.3	202.5	60.1	0.0	8.5	10.1	10.1	10.1	10.3	5.0	22.8
1941	77.4	418.7	250.6	234.0	0.0	8.9	10.2	10.3	10.3	10.4	5.1	18.8
1942	103.7	205.2	81.8	151.9	26.7	17.6	11.0	10.6	10.4	10.6	8.1	3.1
1943	257.9	88.7	222.2	29.6	11.4	14.9	11.1	10.5	10.2	10.3	5.4	4.1
1944	8.3	185.2	170.9	10.8	2.3	11.5	10.9	10.1	10.1	10.7	9.0	4.6
1945	4.5	313.8	117.0	20.0	3.2	14.2	12.7	10.1	10.1	10.8	6.2	72.2
1946	62.6	23.1	25.4	29.0	10.3	17.0	16.9	17.0	16.1	11.6	9.9	6.4
1947	12.2	13.7	34.6	1.9	0.0	9.7	9.8	9.8	9.7	10.4	5.2	2.3
1948	1.8	10.0	29.2	76.5	12.9	15.8	10.9	10.5	10.3	10.5	5.3	4.1
1949	7.9	37.3	87.0	9.8	1.5	11.3	10.8	10.7	10.3	10.2	5.0	2.3
1950	15.5	25.3	2.8	16.7	0.0	6.7	7.3	6.7	6.7	6.8	128.3	197.9
1951	59.8	35.5	53.9	7.4	2.8	11.2	13.9	10.3	10.2	10.8	7.6	39.2
1952	426.8	50.6	164.7	20.1	8.8	14.3	13.7	10.5	10.5	10.4	5.4	20.6
1953	30.8	4.0	5.5	3.6	0.0	10.2	10.2	10.1	9.8	9.9	5.8	3.5
1954	2.4	7.4	12.3	5.4	0.0	1.6	1.6	1.5	1.4	1.3	0.9	0.5
1955	22.0	5.4	5.6	1.7	0.0	5.0	4.9	4.8	4.7	4.6	2.0	311.9
1956	278.4	85.5	26.2	14.9	4.7	12.7	11.3	10.6	10.5	10.5	5.2	0.6
1957	1.4	29.8	14.1	3.7	1.6	5.6	5.0	4.9	4.7	4.7	1.8	1.1
1958	31.7	284.9	258.1	488.8	17.0	17.1	11.7	10.7	10.5	10.7	5.3	1.6
1959	2.7	134.0	8.1	2.7	0.0	9.2	9.6	9.7	13.6	10.3	5.2	0.7

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1960	1.7	66.8	0.8	2.6	0.0	7.9	8.6	8.5	8.5	8.7	4.1	1.2
1961	0.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1962	0.0	129.2	103.2	3.1	0.0	9.8	10.2	10.3	10.1	12.4	5.6	1.1
1963	8.3	290.1	67.5	192.9	24.8	15.1	11.5	11.2	10.8	11.3	6.5	0.9
1964	26.5	3.2	3.0	2.3	0.0	2.5	3.9	3.7	3.4	3.3	1.2	1.6
1965	165.7	19.3	6.4	102.8	1.4	11.3	11.1	10.5	10.2	11.5	8.6	28.0
1966	10.0	9.8	3.0	1.7	0.0	7.3	7.4	7.3	7.2	7.5	3.7	34.1
1967	249.5	38.9	191.3	225.8	29.0	18.7	11.0	10.8	10.8	10.7	5.4	2.8
1968	3.9	5.9	8.0	1.7	0.0	0.0	0.0	0.0	0.1	0.1	0.4	0.8
1969	481.4	555.1	154.3	28.7	5.6	12.4	10.6	10.3	10.1	10.3	5.0	3.7
1970	190.0	57.0	160.7	10.1	2.2	10.9	10.4	10.1	10.1	10.3	7.6	54.4
1971	72.3	9.9	33.4	13.5	3.5	11.4	10.5	10.1	10.1	10.2	5.0	1.9
1972	1.7	2.9	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	13.5	1.2
1973	137.1	426.1	117.2	23.3	2.8	10.8	10.2	10.1	10.1	10.3	9.8	41.6
1974	127.4	13.3	227.6	102.5	7.2	12.3	10.8	10.2	10.2	10.3	5.1	3.0
1975	2.1	89.0	214.2	48.3	7.5	11.3	10.6	10.3	10.2	10.3	5.0	2.9
1976	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1977	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1978	156.7	241.8	240.3	49.3	10.3	14.7	10.5	10.2	10.1	10.3	5.0	1.9
1979	6.4	9.3	12.8	5.5	0.0	2.2	2.0	1.9	1.8	1.9	0.6	4.2
1980	180.6	570.9	106.0	23.5	3.7	13.9	11.0	10.4	10.3	10.3	5.0	2.4
1981	34.6	7.7	28.4	4.5	0.0	9.1	9.4	9.3	9.3	9.5	11.6	1.2
1982	171.7	203.2	173.4	338.3	21.8	17.0	11.2	10.7	10.6	10.5	18.1	56.0
1983	286.9	325.9	377.8	90.9	41.4	10.7	10.1	10.1	10.1	10.9	6.2	2.5
1984	10.0	15.6	16.1	0.7	0.0	1.9	3.1	3.1	3.1	3.2	3.8	2.1
1985	0.4	15.5	13.8	0.0	0.0	1.3	2.8	2.9	2.8	3.0	4.8	1.6
1986	6.4	639.2	269.4	22.2	6.1	11.1	10.9	10.3	10.3	10.5	5.3	2.6
1987	1.8	9.9	10.1	2.4	0.0	0.3	0.9	0.9	1.0	1.0	0.2	0.0
1988	0.4	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0
1990	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	74.4	8.6	0.0	9.9	10.1	10.1	10.1	10.5	5.2	2.1
1992	0.9	55.0	16.9	1.3	0.0	9.0	9.0	8.6	8.5	9.0	4.6	8.3
1993	336.5	344.4	101.2	30.5	6.7	14.0	10.4	10.5	10.1	10.4	5.3	2.5
1994	1.2	7.8	0.9	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	214.2	48.1	485.4	37.9	3.2	10.0	11.5	10.5	10.1	10.3	5.5	4.5
1996	49.1	437.5	144.6	10.1	10.8	13.3	10.6	10.5	10.4	10.2	7.3	163.1
1997	869.4	70.9	19.8	10.3	0.0	10.4	10.2	10.3	9.7	9.9	5.1	8.6
1998	144.4	1016.3	118.7	112.5	22.6	14.7	11.8	10.2	10.2	10.3	5.8	4.0
1999	47.9	436.0	144.6	10.1	10.8	13.3	10.6	10.5	10.4	10.2	7.3	3.0

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	13.0	188.6	105.2	20.6	15.7	11.1	10.4	10.2	10.2	10.5	6.6	2.9
2001	2.7	34.5	13.2	2.9	0.0	5.4	6.5	6.5	6.2	6.2	3.0	15.2
2002	18.0	5.0	12.7	2.6	0.0	6.5	6.1	6.1	6.1	6.3	5.5	59.3
2003	34.9	11.1	14.7	12.6	15.4	11.3	10.0	10.1	10.1	10.2	5.0	5.8
2004	14.7	59.5	7.5	2.5	0.0	8.2	9.6	9.7	9.7	9.9	5.2	24.6
2005	141.9	269.1	210.7	44.9	11.1	12.1	10.7	10.1	10.1	10.8	6.1	34.2
2006	80.9	18.8	187.0	298.4	21.5	15.0	10.6	10.3	10.3	10.5	5.2	1.5
2007	0.8	8.4	3.3	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2008	43.3	88.1	14.3	1.5	0.0	9.1	10.0	10.0	10.0	10.2	5.0	1.4
2009	0.5	21.1	35.0	2.6	0.0	5.8	6.7	6.7	6.7	9.9	3.1	3.4
2010	120.6	89.7	72.9	72.6	7.0	12.5	10.5	10.3	10.1	10.3	5.0	28.0
2011	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4
2012	22.4	187.0	187.0	187.0	187.0	187.0	187.0	187.0	187.0	0.8	0.2	52.1
2013	4.1	0.7	0.2	0.0	0.0	5.8	7.2	7.2	7.2	7.4	3.3	0.6
2014	0.0	1.1	1.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.5
2015	0.2	20.7	0.4	0.0	0.0	5.5	6.4	6.1	6.1	6.1	6.1	6.1

Table L2-14. Pacheco Creek Simulated Average Monthly Flow (cfs) under Alternative 5 for the 1922 to 2015 Simulation Period 5 Mile Downstream of Pacheco Dam.

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1922	7.8	196.0	32.3	33.8	14.1	13.5	12.0	11.5	11.3	11.3	7.6	42.6
1923	81.0	28.1	25.3	22.5	13.3	13.0	12.0	11.5	11.4	11.3	7.3	7.4
1924	7.5	7.2	17.4	17.4	9.3	11.2	11.0	10.9	11.0	11.2	7.5	7.7
1925	8.5	22.6	21.6	26.5	11.6	12.1	11.5	11.2	11.0	11.1	7.2	7.3
1926	7.4	113.0	22.0	38.6	12.6	12.0	11.4	11.2	11.1	11.2	9.4	8.3
1927	10.6	158.0	21.0	23.9	13.4	12.8	11.8	11.5	11.2	11.2	7.3	8.5
1928	8.5	16.2	43.3	37.2	12.0	11.9	11.4	11.2	11.0	11.1	7.3	7.9
1929	8.4	13.3	22.6	20.0	10.6	11.7	11.3	11.1	11.0	11.1	7.1	7.3
1930	10.5	12.1	54.7	20.0	10.5	11.6	11.3	11.1	11.0	11.1	7.1	7.3
1931	7.7	8.5	18.0	17.4	9.2	11.0	10.9	10.9	10.9	11.1	7.1	105.7
1932	48.1	119.3	25.6	21.2	11.7	12.2	11.6	11.4	11.2	11.2	7.2	7.4
1933	17.3	12.3	19.9	19.0	10.1	11.6	11.3	11.0	11.0	11.1	7.1	9.7
1934	13.6	12.3	17.3	13.5	6.8	7.8	7.5	7.4	7.4	7.6	4.6	4.9
1935	8.1	9.2	27.6	30.5	11.2	13.0	13.0	14.5	13.5	15.3	9.5	7.7
1936	27.8	60.6	27.5	32.1	15.8	13.0	13.0	13.1	13.2	13.2	8.2	33.7
1937	26.1	59.2	68.7	21.9	11.1	13.0	13.0	13.1	13.2	13.5	7.0	58.5
1938	36.8	137.6	48.7	35.3	11.9	13.0	13.0	13.1	13.3	15.9	14.8	10.1
1939	7.2	13.2	23.4	17.0	9.0	10.8	10.9	10.9	10.9	11.1	7.1	7.2
1940	10.8	168.0	96.4	27.2	9.0	10.8	10.9	10.9	10.9	11.1	7.1	19.5

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1941	64.8	200.1	129.7	228.0	9.0	10.8	10.9	10.9	10.9	11.1	7.1	15.5
1942	79.6	176.4	76.1	145.9	16.7	15.1	11.8	11.3	11.1	11.3	10.2	10.5
1943	225.2	84.9	219.0	32.4	16.5	14.0	11.9	11.3	11.0	11.1	7.5	8.9
1944	14.6	128.2	149.7	23.5	12.0	12.4	11.8	11.0	11.0	11.6	11.2	12.0
1945	12.0	286.3	111.2	28.2	12.5	13.7	13.6	10.9	10.9	11.6	8.3	69.0
1946	28.8	9.5	30.9	32.7	15.9	15.0	17.9	17.9	17.0	12.5	12.1	13.9
1947	9.8	11.3	27.1	18.4	10.5	11.3	11.0	11.0	11.0	11.7	7.5	7.8
1948	8.9	7.6	29.7	55.4	17.0	14.4	11.7	11.3	11.0	11.3	7.3	9.2
1949	14.3	33.8	61.7	23.3	11.6	12.2	11.7	11.5	11.2	11.1	7.1	7.2
1950	12.8	23.1	20.2	37.0	10.0	11.8	11.6	11.0	11.0	11.1	97.9	93.9
1951	27.0	15.5	24.6	21.4	13.2	12.3	15.1	11.4	11.4	12.0	9.9	39.9
1952	214.7	21.6	81.8	28.1	15.2	13.7	14.7	11.4	11.3	11.3	7.5	18.3
1953	31.3	14.1	25.6	19.6	10.7	11.7	11.4	11.3	11.1	11.2	8.2	8.5
1954	8.9	14.5	29.7	22.9	10.6	11.9	11.5	11.4	11.3	11.3	8.2	9.2
1955	21.6	14.7	24.9	20.8	10.7	11.9	11.6	11.5	11.4	11.3	7.6	187.9
1956	132.0	38.9	31.2	25.9	13.2	12.9	12.2	11.5	11.4	11.3	7.3	7.4
1957	8.5	27.3	31.7	21.1	13.4	12.1	11.5	11.4	11.2	11.2	7.2	9.3
1958	30.7	158.9	122.4	389.8	17.8	14.8	12.1	11.1	10.9	11.1	7.1	7.2
1959	10.2	105.8	23.6	18.8	10.0	11.2	10.9	10.9	15.0	11.6	7.6	7.7
1960	9.1	65.1	20.2	19.9	9.8	11.2	11.0	10.9	10.9	11.1	7.1	7.4
1961	7.7	7.9	18.1	17.5	9.4	11.8	11.5	11.3	11.3	11.2	7.3	7.3
1962	8.1	108.9	48.2	20.0	10.0	11.4	11.0	11.2	10.9	13.3	7.7	8.1
1963	15.8	176.5	30.6	91.6	10.4	13.9	12.3	11.9	11.5	12.0	8.5	7.8
1964	24.3	10.5	20.3	19.5	9.7	11.3	11.9	11.7	11.4	11.3	7.3	10.3
1965	117.6	7.5	21.3	48.9	11.3	12.1	11.9	11.3	10.9	12.3	10.7	25.8
1966	10.2	10.0	20.3	18.8	10.7	11.2	11.1	11.0	10.9	11.3	7.5	31.1
1967	141.7	16.6	90.9	107.0	12.4	15.7	11.6	11.5	11.5	11.4	7.4	7.8
1968	10.9	12.5	25.0	18.9	9.5	11.2	11.0	10.9	10.9	11.1	8.4	9.9
1969	271.3	453.3	147.5	32.2	13.7	12.8	11.4	11.1	11.0	11.1	7.1	8.9
1970	127.4	52.4	156.9	23.2	12.0	11.7	11.3	11.0	10.9	11.2	9.8	55.3
1971	39.5	13.2	34.9	25.3	12.6	12.3	11.4	11.0	10.9	11.1	7.1	7.2
1972	8.9	10.4	17.8	17.4	9.4	10.9	10.9	10.9	10.9	11.1	17.1	10.8
1973	95.8	203.5	54.1	29.7	12.3	11.7	11.0	10.9	10.9	11.1	12.0	42.3
1974	71.9	14.6	201.6	94.8	14.2	12.7	11.5	11.0	10.9	11.1	7.1	8.3
1975	8.9	84.3	152.3	40.0	14.5	12.1	11.4	11.2	11.0	11.1	7.1	8.2
1976	7.2	7.0	17.8	17.1	9.0	10.8	10.9	10.9	10.9	11.1	7.1	7.3
1977	7.7	7.3	17.5	17.2	9.3	11.4	10.9	10.9	10.9	11.1	7.1	8.4
1978	118.4	114.7	113.9	21.9	15.9	13.9	11.4	11.0	10.9	11.1	7.1	7.2
1979	13.7	16.3	30.4	22.9	11.0	11.3	11.1	11.0	10.9	11.1	7.1	12.4
1980	124.8	273.1	48.3	29.8	12.7	13.5	11.8	11.2	11.1	11.1	7.1	7.3

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	32.1	15.2	28.9	21.9	10.2	11.3	11.1	10.9	10.9	11.1	14.3	8.4
1982	116.8	96.0	86.8	334.2	20.6	14.8	11.8	11.2	11.1	11.1	10.2	56.8
1983	262.1	324.8	375.4	82.1	32.0	11.5	10.9	10.9	10.9	11.7	8.3	7.7
1984	17.2	13.3	33.7	17.4	9.3	10.8	10.9	10.9	10.9	11.1	10.2	11.0
1985	8.6	14.6	32.8	17.2	9.0	10.8	10.9	10.9	10.9	11.1	11.4	10.4
1986	15.3	345.1	182.5	28.7	13.9	12.0	11.8	11.2	11.1	11.3	7.4	7.6
1987	8.7	7.5	27.6	19.7	9.8	11.0	11.0	11.1	11.2	11.3	7.5	8.1
1988	8.9	7.9	17.5	19.3	9.9	11.9	11.6	11.5	11.4	11.2	7.1	7.4
1989	8.5	8.7	20.7	18.4	10.1	12.5	12.3	12.2	11.6	11.3	7.3	7.2
1990	7.5	11.8	18.0	17.0	9.0	10.8	10.9	10.9	10.9	11.4	7.3	7.5
1991	7.5	7.3	78.6	22.8	10.2	11.3	10.9	10.9	11.0	11.4	7.3	7.8
1992	7.8	54.0	37.3	18.2	10.3	12.0	11.4	11.0	10.9	11.5	7.7	14.1
1993	197.2	163.5	46.6	33.2	14.2	13.6	11.3	11.3	10.9	11.2	7.4	7.7
1994	7.9	15.8	18.4	18.1	10.2	10.8	10.9	10.9	10.9	11.1	7.6	7.7
1995	145.0	21.2	232.5	35.6	12.4	10.8	12.3	11.3	10.9	11.1	7.6	9.7
1996	46.0	225.5	67.3	23.3	16.2	13.2	11.5	11.3	11.3	11.1	9.5	113.2
1997	499.2	62.3	28.1	22.5	10.9	11.7	11.5	11.6	11.0	11.1	7.4	13.7
1998	104.4	967.7	108.8	105.7	12.9	13.8	12.5	10.9	10.9	11.1	7.8	8.7
1999	45.0	403.2	138.5	23.3	16.2	13.2	11.5	11.3	11.3	11.1	9.5	10.4
2000	10.6	122.6	86.7	28.5	18.6	11.9	11.3	11.1	11.0	11.4	8.7	7.7
2001	9.5	31.9	33.5	22.9	10.1	10.9	11.5	11.4	11.1	11.1	7.5	12.4
2002	16.5	13.3	33.0	20.7	10.6	11.6	10.9	10.9	10.9	11.1	10.0	60.4
2003	20.3	13.9	25.8	24.9	18.5	12.2	10.9	10.9	10.9	11.1	7.1	11.3
2004	10.4	60.6	25.2	18.7	9.0	10.9	10.9	10.9	10.9	11.1	7.5	21.4
2005	94.9	127.9	99.6	19.8	16.3	12.6	11.6	10.9	10.9	11.6	8.2	32.1
2006	57.4	7.5	88.8	250.9	20.6	13.9	11.2	10.9	10.9	11.1	7.1	7.2
2007	7.9	16.8	21.7	18.1	9.4	11.0	10.9	10.9	10.9	11.1	7.1	7.2
2008	45.7	60.3	25.5	19.2	9.5	11.1	10.9	10.9	10.9	11.1	7.1	7.3
2009	7.6	19.8	35.6	20.0	9.6	11.1	10.9	10.9	10.9	14.1	7.3	11.5
2010	93.8	41.5	33.7	33.6	14.2	12.8	11.4	11.1	10.9	11.1	7.1	23.8
2011	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8
2012	22.8	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5	11.1	7.5	52.1
2013	14.2	9.4	18.9	17.8	9.4	11.0	10.9	10.9	10.9	11.1	7.1	7.2
2014	7.2	9.9	20.3	18.8	9.2	10.9	10.9	10.9	11.0	11.1	7.2	28.4
2015	9.3	21.1	19.6	18.6	9.8	11.3	11.3	10.9	10.9	10.9	10.9	10.9

Table L2-15. Difference in Pacheco Creek Simulated Average Monthly Flow (cfs) between the No Action/No Project and Alternative 5 for the 1922 to 2015 Simulation Period 5 Mile Downstream of Pacheco Dam.

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1922	0.2	-130.4	-37.8	2.4	7.6	-0.4	0.9	0.8	0.8	0.8	2.1	0.7
1923	-63.2	-34.0	11.5	-26.7	8.3	0.2	0.8	0.8	0.8	0.8	2.1	6.8
1924	6.8	6.5	17.1	17.4	9.3	11.2	11.0	10.9	11.0	11.2	7.5	7.7
1925	8.5	3.6	19.9	20.1	11.2	7.9	7.8	7.8	7.9	7.9	6.0	7.3
1926	7.4	-31.8	15.8	-43.9	8.8	0.8	0.8	0.8	0.8	0.8	2.1	7.1
1927	7.4	-91.1	-23.8	-28.4	8.2	0.3	0.8	0.8	0.8	0.8	2.1	4.9
1928	6.5	7.3	-1.8	20.3	11.3	2.0	2.0	2.0	2.0	2.0	2.8	7.1
1929	7.3	7.4	17.7	17.5	10.6	11.1	10.7	10.7	10.7	10.8	7.1	7.3
1930	10.2	9.5	0.9	19.4	10.5	3.3	2.9	2.9	2.9	2.9	3.3	5.9
1931	7.1	7.7	17.8	17.4	9.2	11.0	10.9	10.9	10.9	11.1	7.1	-23.2
1932	-54.9	-132.0	10.1	16.2	10.1	0.9	0.9	0.9	0.9	0.9	2.1	5.0
1933	7.2	7.4	17.4	17.2	10.1	11.2	10.7	10.6	10.6	10.7	7.1	9.3
1934	7.1	-0.3	14.5	13.5	6.8	6.2	5.4	5.4	5.4	5.5	4.0	4.9
1935	8.1	8.9	-0.3	0.6	11.1	3.6	3.6	3.6	3.6	3.6	3.8	-1.9
1936	0.5	-44.4	8.9	4.5	5.8	0.1	0.9	0.9	0.9	0.9	2.1	-2.0
1937	0.5	-66.1	-77.2	14.7	10.3	0.2	0.9	0.9	0.9	0.9	-7.7	-6.8
1938	-42.3	-151.5	-56.5	0.5	9.8	0.1	0.9	0.9	0.9	0.9	2.2	-2.4
1939	6.8	7.5	0.4	16.6	9.0	5.4	4.0	4.0	4.0	4.0	4.0	6.8
1940	8.5	-93.3	-106.1	-32.9	9.0	2.3	0.8	0.8	0.8	0.8	2.1	-3.3
1941	-12.6	-218.6	-120.9	-6.0	9.0	1.9	0.7	0.7	0.7	0.7	2.0	-3.3
1942	-24.1	-28.8	-5.7	-6.0	-9.9	-2.4	0.7	0.7	0.7	0.7	2.1	7.4
1943	-32.7	-3.8	-3.2	2.9	5.0	-0.9	0.9	0.8	0.8	0.9	2.1	4.9
1944	6.4	-57.0	-21.2	12.8	9.8	0.9	0.9	0.9	0.9	0.9	2.2	7.4
1945	7.4	-27.5	-5.7	8.1	9.3	-0.5	0.9	0.8	0.8	0.9	2.1	-3.2
1946	-33.8	-13.6	5.6	3.8	5.6	-2.0	1.0	1.0	0.9	0.9	2.2	7.5
1947	-2.4	-2.4	-7.4	16.4	10.5	1.6	1.2	1.3	1.2	1.3	2.3	5.5
1948	7.1	-2.4	0.5	-21.0	4.1	-1.4	0.8	0.8	0.8	0.8	2.1	5.1
1949	6.4	-3.5	-25.3	13.5	10.1	0.9	0.9	0.9	0.9	0.9	2.1	4.9
1950	-2.7	-2.2	17.3	20.3	10.0	5.1	4.4	4.4	4.4	4.4	-30.4	-104.1
1951	-32.8	-20.0	-29.2	13.9	10.4	1.1	1.2	1.1	1.1	1.1	2.3	0.7
1952	-212.0	-29.0	-82.9	7.9	6.4	-0.6	0.9	0.9	0.8	0.9	2.1	-2.3
1953	0.6	10.1	20.1	16.0	10.7	1.5	1.2	1.2	1.2	1.2	2.3	4.9
1954	6.5	7.1	17.5	17.5	10.6	10.2	9.9	9.9	9.9	9.9	7.3	8.7
1955	-0.4	9.3	19.3	19.1	10.7	6.9	6.7	6.7	6.7	6.7	5.6	-123.9
1956	-146.3	-46.6	5.0	11.1	8.6	0.3	0.9	0.9	0.9	0.9	2.1	6.8
1957	7.1	-2.4	17.6	17.4	11.8	6.5	6.5	6.5	6.5	6.5	5.4	8.2
1958	-0.9	-126.0	-135.7	-99.0	0.8	-2.3	0.4	0.4	0.4	0.4	1.8	5.7

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1959	7.5	-28.2	15.5	16.1	10.0	2.0	1.3	1.3	1.3	1.3	2.3	6.9
1960	7.4	-1.7	19.5	17.4	9.8	3.3	2.4	2.4	2.4	2.4	3.0	6.2
1961	7.3	7.7	18.0	17.5	9.4	11.8	11.5	11.3	11.3	11.2	7.3	7.3
1962	8.1	-20.3	-55.0	16.9	10.0	1.6	0.9	0.9	0.9	0.9	2.1	7.0
1963	7.5	-113.6	-36.9	-101.3	-14.4	-1.1	0.7	0.7	0.7	0.7	2.0	6.9
1964	-2.2	7.4	17.3	17.3	9.7	8.8	8.0	8.0	8.0	8.0	6.1	8.7
1965	-48.1	-11.8	14.8	-53.8	9.8	0.8	0.8	0.8	0.8	0.8	2.1	-2.2
1966	0.2	0.2	17.3	17.1	10.7	3.9	3.7	3.7	3.7	3.7	3.8	-3.0
1967	-107.9	-22.3	-100.5	-118.8	-16.7	-3.0	0.7	0.7	0.7	0.7	2.0	5.1
1968	6.9	6.6	17.0	17.1	9.5	11.2	11.0	10.9	10.9	11.0	8.0	9.1
1969	-210.1	-101.8	-6.8	3.5	8.1	0.4	0.8	0.8	0.8	0.8	2.1	5.3
1970	-62.7	-4.6	-3.8	13.2	9.8	0.9	0.9	0.9	0.9	0.9	2.2	1.0
1971	-32.8	3.3	1.4	11.8	9.1	0.9	0.9	0.9	0.9	0.9	2.1	5.3
1972	7.1	7.5	17.1	17.2	9.4	10.9	10.9	10.9	10.9	11.1	3.6	9.6
1973	-41.3	-222.6	-63.1	6.4	9.5	0.9	0.8	0.8	0.8	0.8	2.2	0.7
1974	-55.5	1.4	-26.0	-7.7	7.0	0.4	0.8	0.8	0.8	0.8	2.0	5.4
1975	6.8	-4.7	-61.9	-8.3	7.0	0.8	0.8	0.8	0.8	0.8	2.1	5.3
1976	6.4	7.0	17.8	17.1	9.0	10.8	10.9	10.9	10.9	11.1	7.1	7.3
1977	7.7	7.3	17.5	17.2	9.3	11.4	10.9	10.9	10.9	11.1	7.1	8.4
1978	-38.3	-127.1	-126.5	-27.5	5.6	-0.8	0.8	0.8	0.8	0.8	2.1	5.3
1979	7.3	7.1	17.6	17.4	11.0	9.1	9.1	9.1	9.1	9.2	6.5	8.3
1980	-55.9	-297.8	-57.7	6.4	9.0	-0.4	0.9	0.9	0.8	0.8	2.1	5.0
1981	-2.4	7.5	0.5	17.4	10.2	2.2	1.6	1.6	1.6	1.6	2.7	7.2
1982	-54.8	-107.2	-86.6	-4.1	-1.2	-2.2	0.6	0.6	0.6	0.6	-7.8	0.9
1983	-24.8	-1.1	-2.5	-8.8	-9.4	0.8	0.8	0.8	0.8	0.8	2.1	5.2
1984	7.2	-2.4	17.6	16.7	9.3	9.0	7.8	7.8	7.9	7.9	6.4	8.8
1985	8.2	-0.9	19.0	17.2	9.0	9.5	8.0	8.1	8.1	8.1	6.6	8.7
1986	9.0	-294.1	-87.0	6.5	7.8	0.9	0.9	0.9	0.8	0.9	2.1	5.0
1987	6.9	-2.4	17.5	17.3	9.8	10.7	10.1	10.1	10.2	10.3	7.3	8.1
1988	8.6	7.9	17.5	18.9	9.9	11.9	11.6	11.5	11.4	11.2	7.1	7.4
1989	8.5	8.7	20.7	18.4	10.1	12.5	11.9	11.7	11.6	11.3	7.3	7.2
1990	7.5	11.5	18.0	17.0	9.0	10.8	10.9	10.9	10.9	11.4	7.3	7.5
1991	7.5	7.3	4.1	14.2	10.2	1.3	0.9	0.9	0.9	0.9	2.1	5.7
1992	6.9	-1.0	20.3	17.0	10.3	3.0	2.5	2.4	2.5	2.5	3.1	5.7
1993	-139.3	-180.9	-54.6	2.8	7.5	-0.5	0.8	0.8	0.8	0.8	2.1	5.1
1994	6.7	8.0	17.5	17.3	10.2	10.8	10.9	10.9	10.9	11.1	7.6	7.7
1995	-69.2	-26.9	-252.9	-2.3	9.2	0.8	0.9	0.8	0.8	0.8	2.1	5.3
1996	-3.1	-212.0	-77.3	13.2	5.4	-0.1	0.9	0.9	0.9	0.9	2.1	-49.8
1997	-370.1	-8.6	8.3	12.2	10.9	1.3	1.2	1.2	1.2	1.2	2.3	5.1
1998	-40.0	-48.6	-9.9	-6.8	-9.8	-0.9	0.8	0.8	0.8	0.8	2.1	4.8

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999	-2.9	-32.8	-6.1	13.2	5.4	-0.1	0.9	0.9	0.9	0.9	2.1	7.4
2000	-2.4	-65.9	-18.5	7.9	2.8	0.9	0.8	0.8	0.9	0.8	2.1	4.8
2001	6.8	-2.6	20.3	20.0	10.1	5.6	4.9	4.9	4.9	4.9	4.5	-2.8
2002	-1.5	8.3	20.3	18.1	10.6	5.1	4.8	4.8	4.8	4.8	4.5	1.0
2003	-14.6	2.8	11.2	12.3	3.0	0.9	0.9	0.9	0.9	0.9	2.1	5.5
2004	-4.2	1.0	17.6	16.2	9.0	2.7	1.2	1.2	1.2	1.2	2.3	-3.2
2005	-47.0	-141.2	-111.2	-25.0	5.2	0.5	0.8	0.8	0.8	0.8	2.1	-2.1
2006	-23.5	-11.3	-98.2	-47.5	-1.0	-1.1	0.6	0.6	0.6	0.6	1.9	5.7
2007	7.1	8.3	18.4	16.9	9.4	11.0	10.9	10.9	10.9	11.1	7.1	7.2
2008	2.4	-27.8	11.2	17.7	9.5	2.0	0.9	0.9	0.9	0.9	2.1	6.0
2009	7.1	-1.2	0.6	17.3	9.6	5.2	4.2	4.2	4.2	4.3	4.1	8.1
2010	-26.8	-48.1	-39.2	-39.0	7.2	0.3	0.8	0.8	0.8	0.8	2.1	-4.2
2011	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2012	0.4	-84.5	-84.5	-84.5	-84.5	-84.5	-84.5	-84.5	-84.5	10.3	7.3	0.0
2013	10.1	8.8	18.6	17.8	9.4	5.2	3.7	3.7	3.7	3.7	3.8	6.7
2014	7.2	8.8	18.8	18.3	9.2	10.9	10.9	10.9	11.0	11.1	7.2	2.9
2015	9.1	0.4	19.1	18.6	9.8	5.8	4.8	4.8	4.8	4.8	4.8	4.8

L2.3 References

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San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix M1: Terrestrial Resources Figures

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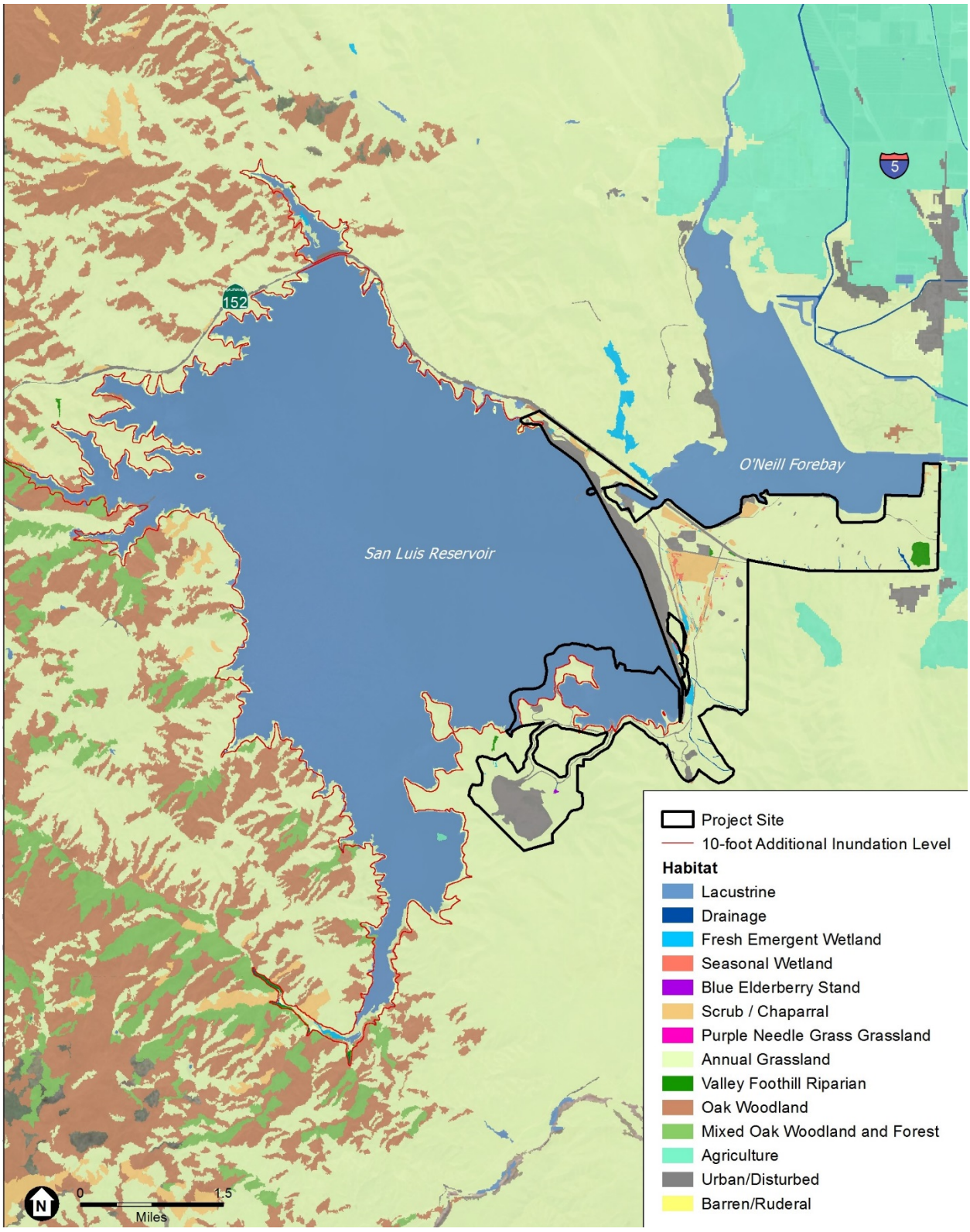


Figure M1-1a. Habitats within the San Luis Reservoir Region

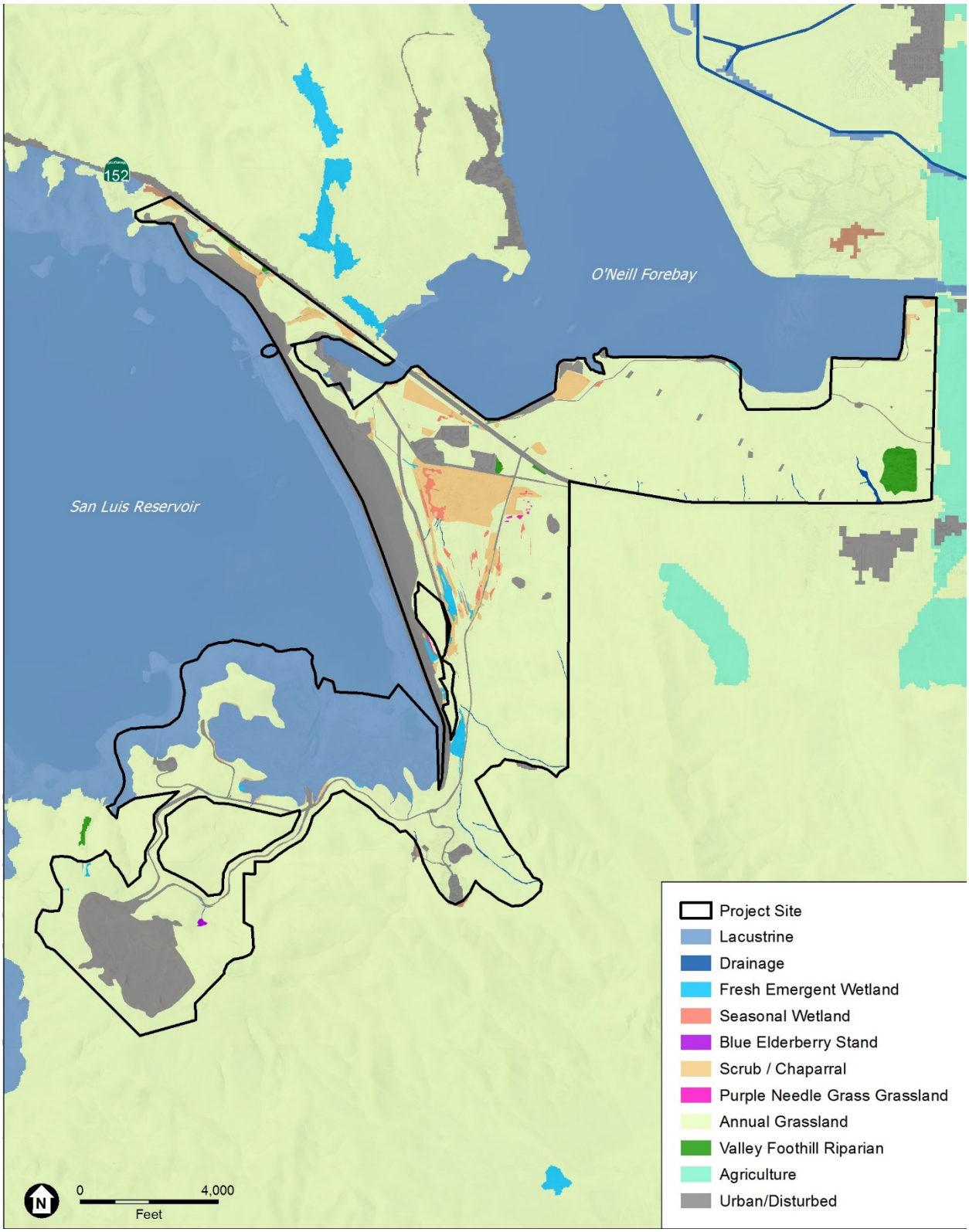
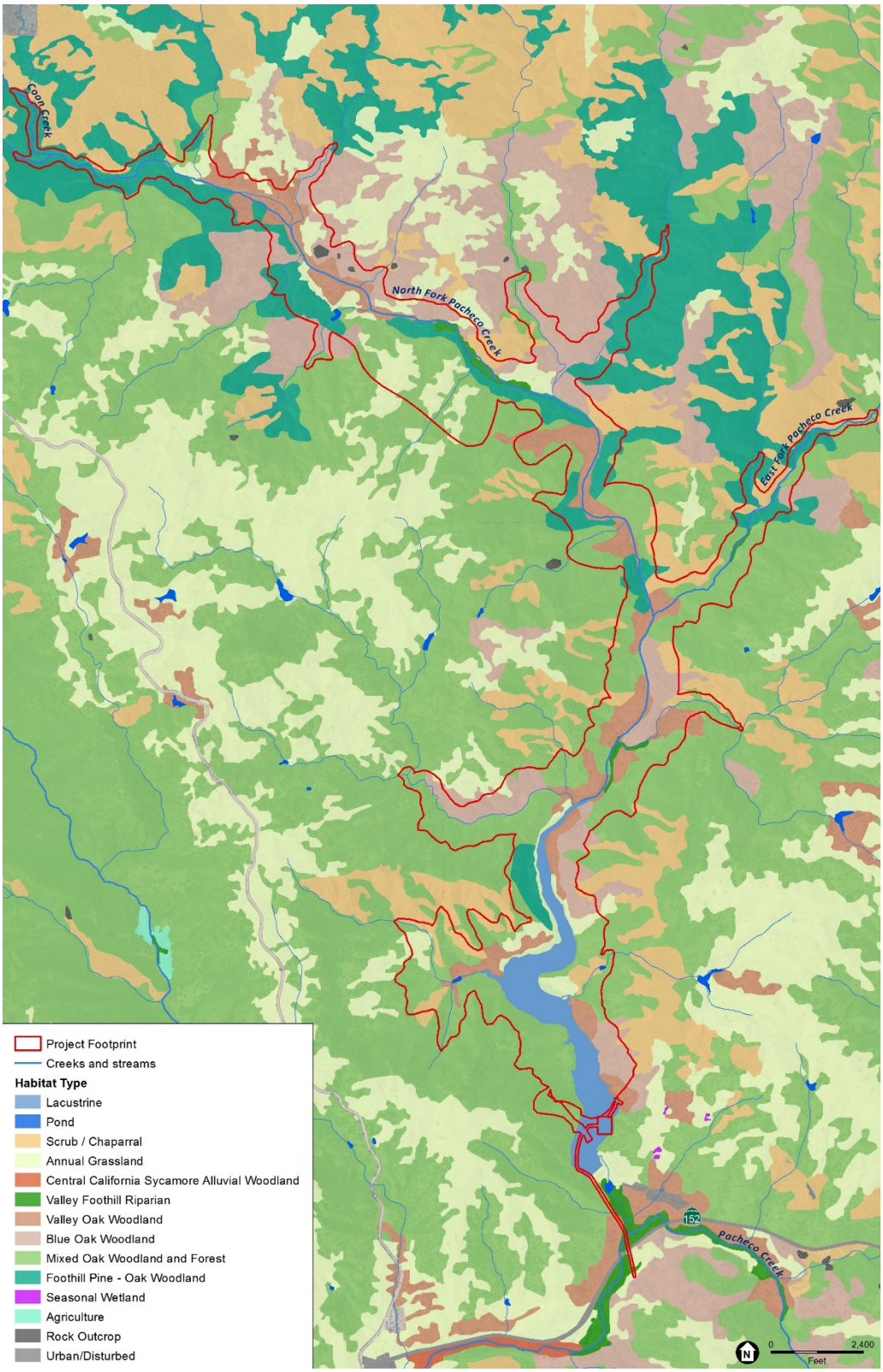


Figure M1-1b. Close-up of Habitats in B.F. Sisk Project Area within the San Luis Reservoir Region



Note: Habitat types from Santa Clara County (2012), with the following terminology adjustment: Reservoir = Lacustrine, Northern Coastal Scrub + Northern Mixed Chaparral = Scrub/Chaparral, California Annual Grassland = Annual Grassland, Willow Riparian Forest + Mixed Riparian Forest = Valley Foothill Riparian, Urban/Suburban = Urban/Disturbed

Figure M1-2a. Habitats in Pacheco Reservoir Region

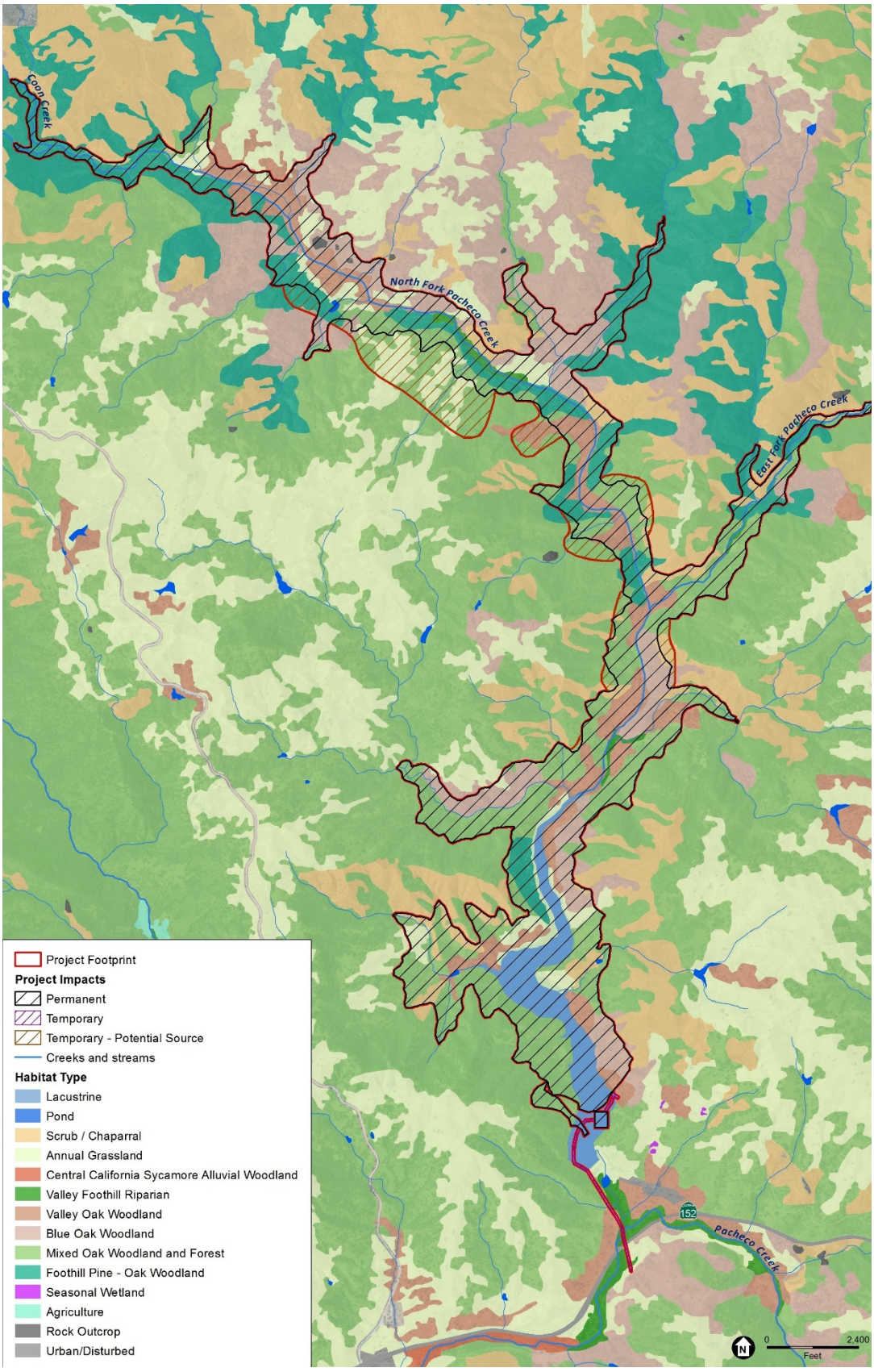


Figure M1-2b. Impact Area by Vegetation Type for Pacheco Reservoir Region

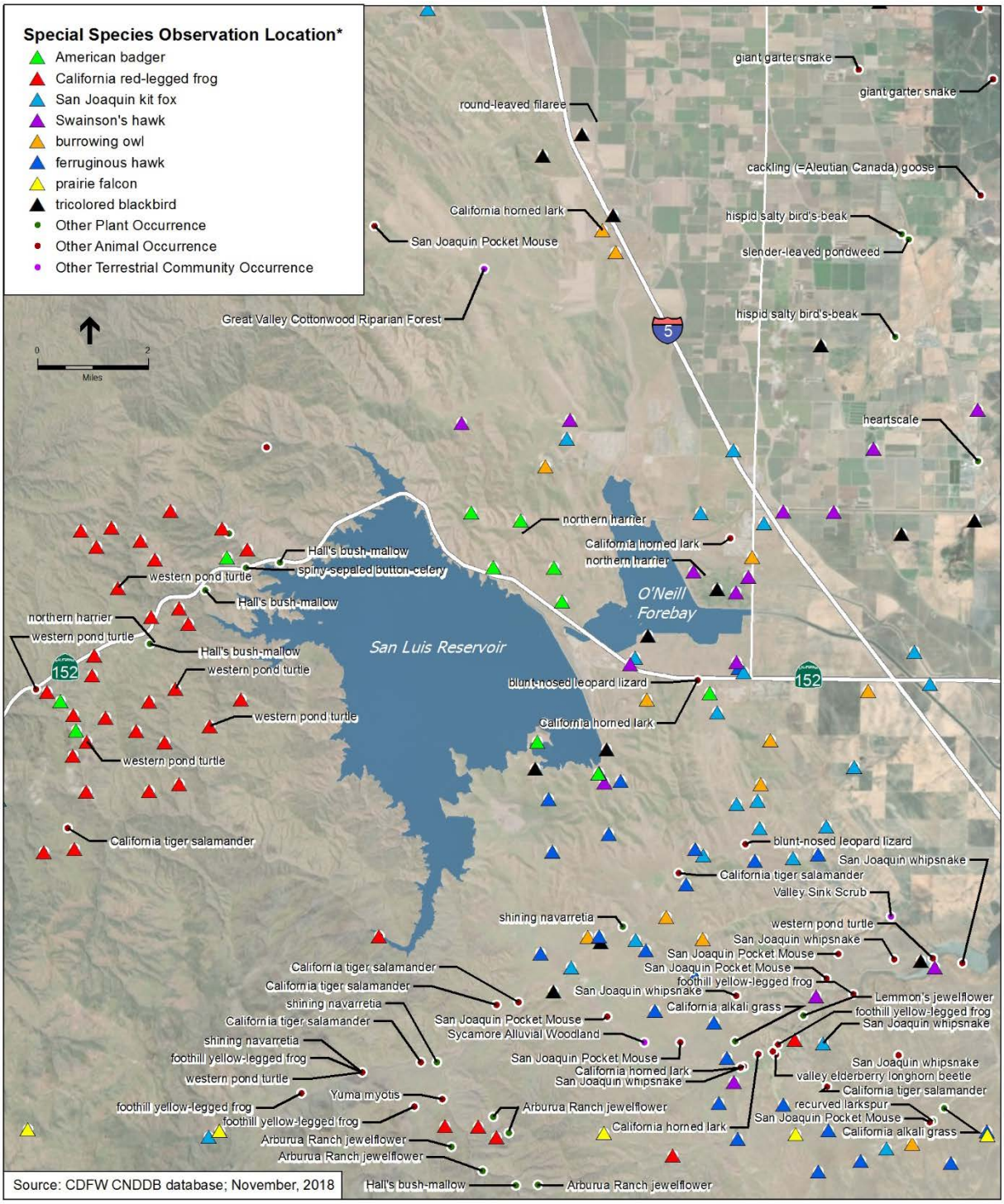


Figure M1-3. Occurrences of Special-Status Species in the San Luis Reservoir Region.

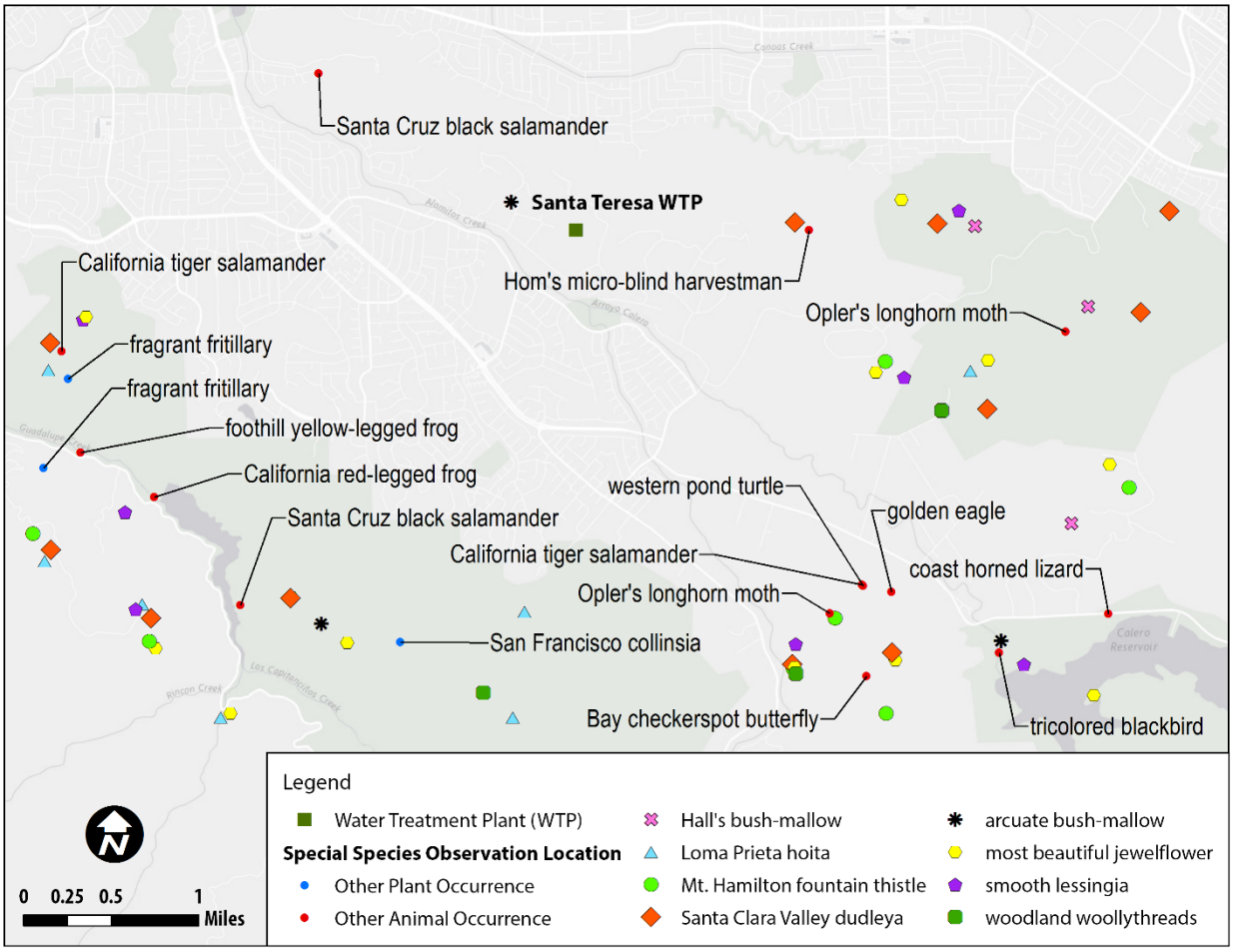


Figure M1-4. Occurrences of Special-Status Species in the Santa Teresa WTP Area.

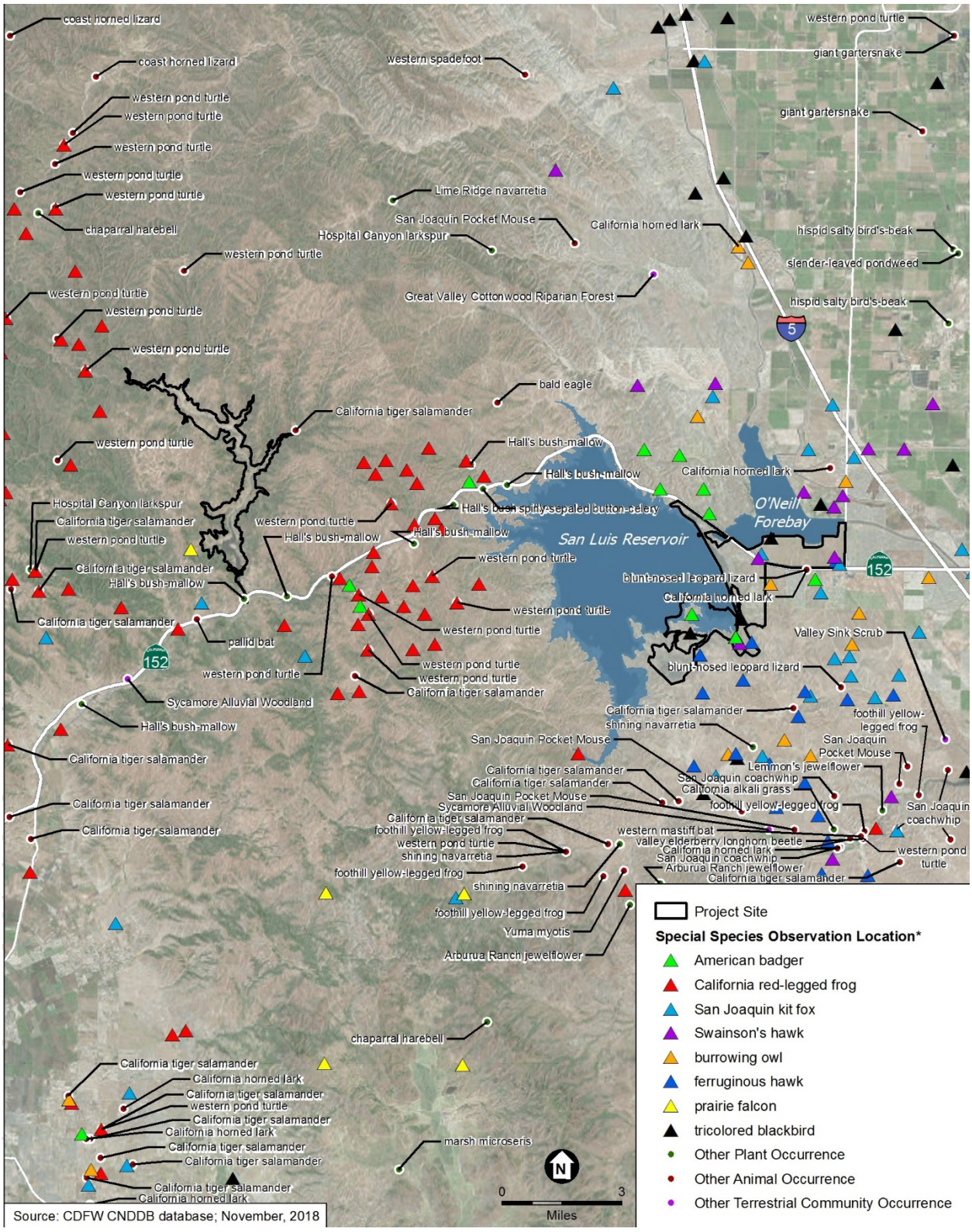
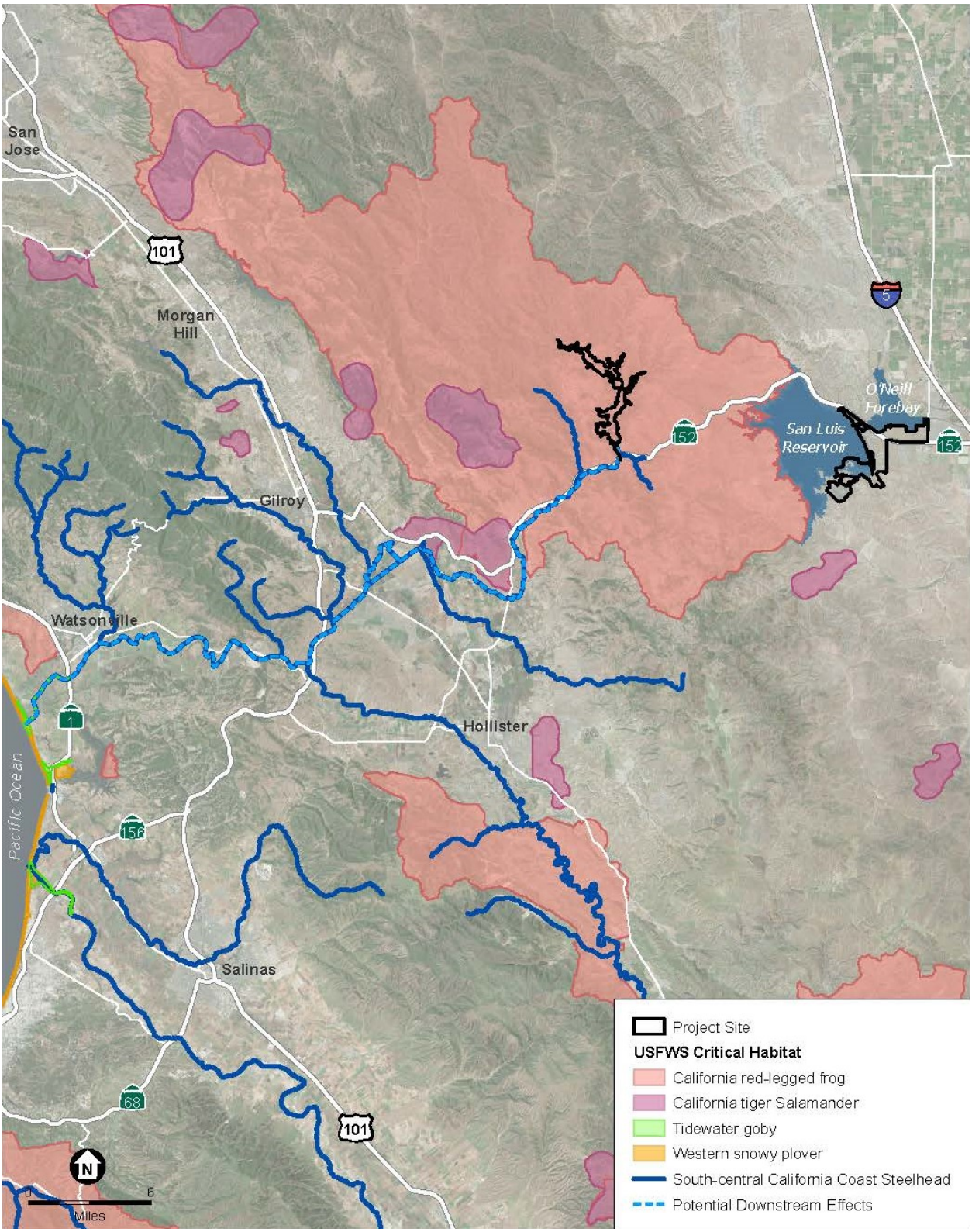


Figure M1-5. Occurrences of Special-Status Species in the San Luis and Pacheco Reservoir Areas.



Source: USFWS 2010

Figure M1-6. Critical Habitat in the San Luis Reservoir Area.



Source: Photograph taken by Brian Pittman, ESA

Figure M1-7. California Red-legged Frog Breeding Site at Willow Spring Pond, north of Basalt Quarry.

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Appendix M2: Terrestrial Resources Detailed Affected Environment

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Appendix M2
Terrestrial Resources Detailed Affected Environment

M2.1 Terrestrial Natural Communities and Wildlife

The following section describes the potentially affected common and special status natural communities and associated wildlife species.

M2.1.1 San Luis Reservoir Region

M2.1.1.1 Common Natural Communities

Annual grassland. Annual grassland comprises the majority of terrestrial habitat in the San Luis Reservoir Region. Most grassland areas have not been grazed recently and are dominated by tall non-native annual grasses interspersed with shrubs and forbs. Small mammal burrows occur within the annual grassland. Dominant plants observed within the annual grassland during the September 2018 biological surveys include wild oat (*Avena fatua*), ripgut brome, foxtail chess (*Bromus madritensis*), Mediterranean barley (*Hordeum marinum* ssp. *gussoneum*), perennial pepperweed (*Lepidium latifolia*), stinkwort (*Dittrichia graveolens*), and alkali heliotrope (*Heliotropium curassavicum* var. *oculatum*). Isolated or small clusters of oak (*Quercus* sp.), coyote brush (*Baccharis pilularis*), and silverscale saltbush (*Atriplex argentea*) are interspersed throughout the annual grassland.

Purple needlegrass (*Stipa pulchra*) grassland has limited distribution in the project area, occurring in various densities (e.g., up to an acre in size) within annual grasslands (see Section M21.3.2 Sensitive Natural Communities).

Urban/Disturbed. Urban/disturbed areas include campgrounds, picnic areas, boat ramps, facilities, roads, driveways, and roadsides. The majority of urban/disturbed areas observed during the September 2018 biological surveys contained minimal vegetation. Ruderal vegetation observed includes isolated, self-established mullein (*Verbascum* sp.), turkey mullein (*Croton setigerus*), radish (*Raphanus sativa*), and stinkwort.

In the wetter areas around the reservoir species include broad-leaved pepper-grass, spiny cocklebur (*Xanthium spinosum*), and bristly ox-tongue (*Helminthotheca echioides*). In the drier areas dominant species include yellow star-thistle (*Centaurea solstitialis*), Italian thistle (*Carduus pycnocephalus*), and short-pod mustard (*Hirschfeldia incana*) (Reclamation and California

Department of Pesticide Regulation [CDPR] 2013). At the Basalt Campground and Basalt Day Use Area non-native shade trees (e.g., *Eucalyptus* spp. and *Pinus* spp.) have been planted around the camp sites.

M2.1.1.2 Special-Status Natural Communities

Woodlands. Three types of woodland occur within the San Luis Reservoir Region: coast live oak, blue oak, and savanna. Coast live oak woodland occurs in San Luis Wildlife Area at the northwestern corner of the reservoir. Coast live oak woodland includes primarily coast live oak with blue oak, California bay (*Umbellularia californica*), valley oak (*Quercus lobata*), and California buckeye (*Aesculus californica*) intermixed throughout.

Blue oak woodland and savanna occur in the San Luis Wildlife Area and along the western edge of the San Luis Reservoir. Blue oak woodland occurs on the tops and sides of the ridges in small clumps. Blue oak (*Quercus douglasii*) is the dominant tree of this woodland with an occasional coast live oak (*Quercus agrifolia*). Blue oak woodland transitions to blue oak savanna, which consists of a sparse cover of trees growing within grassland.

The understory of the blue oak woodland mostly consists primarily of non-native grass as identified under the grassland vegetation community. Native forbs interspersed within the grassland include blue dicks (*Dichelostemma capitatum*) and clarkia (*Clarkia* spp.). Understory shrubs include California sagebrush (*Artemesia californica*), redberry buckthorn (*Rhamnus crocea*), and golden yarrow (*Eriophyllum confertiflorum*) (Reclamation and CDPR 2013).

Understory vegetation includes woodland sanicle (*Sanicula crassicaule*), blue wildrye (*Elymus glaucus*), miner's lettuce (*Claytonia perfoliata*), fiesta flower (*Pholistoma auritum*), chickweed (*Stellaria media*), sweet pea (*Lathyrus* spp.), bedstraw (*Galium apairne*), western poison oak (*Toxicodendron diversilobum*), toyon (*Heteromeles arbutifolia*), and redberry buckthorn.

Scrub/Chaparral. Coyote brush scrub occurs in patches around the reservoir on shaded slopes and in drainage depressions. California sagebrush scrub occurs on the shallow soils of slopes along the reservoir's northwestern drainages. Dominant vegetation includes California sagebrush and California buckwheat (*Eriogonum fasciculatum*). Understory vegetation includes grassland between the shrubs. Dominant shrubs include chamise (*Adenestoma fasciculatum*), manzanita (*Arctostaphylos* spp.).

In the San Luis Region, chaparral and scrub vegetation is interspersed throughout the annual grassland. Dominant plants observed within the chaparral-scrub include coyote brush, mule fat (*Baccharis salicifolia* ssp. *salicifolia*), black sage (*Salvia mellifera*), tree tobacco (*Nicotiana glauca*), and honey mesquite (*Prosopis glandulosa* var. *torreyana*) (Environmental Science Associates [ESA] 2018).

Purple Needlegrass Grassland. Purple needlegrass (*Nasella pulchra*) grassland occurs in various densities within small to moderate-sized areas (e.g., up to an acre) in limited locations within annual grasslands. Patches with a minimum cover of ten-percent purple needlegrass were identified as this community.

Valley Foothill Riparian. Riparian occurs at the edges of San Luis Reservoir, with a canopy of black willow (*Salix goodingii*), Fremont cottonwood (*Populus fremontii*), and western sycamore (*Platanus racemosa*), and a shrub understory of mulefat (*Baccharis salicifolia*) and sandbar willow (*Salix exigua*). Herbaceous understory plants include crabgrass (*Cynodon dactylon*), spiny cockleburr, and Italian thistle (Reclamation and CDPR 2013). Dominant plants observed within the valley foothill riparian during the September 2018 biological surveys include those identified above, in addition to western goldenrod (*Euthamia occidentalis*), narrow-leaved cattail (*Typha angustifolia*), Mexican rush (*Juncus mexicanus*), and rabbit's foot grass (*Polypogon monspeliensis*).

Freshwater Emergent Wetland. Wetland vegetation occurs in wet areas along the edges of the San Luis Reservoir below the high water mark. Dominant species include broadleaf cattail (*Typha latifolia*), tule (*Schoenoplectus acutus* ssp. *occidentalis*), crabgrass, knotgrass (*Paspalum distichum*), Mexican rush, water parsley (*Oenanthe sarmentosa*), and water smartweed (*Polygonum punctatum*). Meadow barley (*Hordeum brachyantherum*) and creeping wildrye (*Leymus triticoides*) occur in in adjacent drier areas (Reclamation and CDPR 2013). Dominant vegetation observed in small pools during September 2018 biological surveys included eryngium (*Eryngium* sp.) and pillwort (*Pilularia americana*) (ESA 2018). Seasonal wetlands and vernal pools may occur within the grassland to the south and east of the San Luis Reservoir.

Seasonal Wetland and Ephemeral Drainage. Seasonal wetlands occur within the grassland around the reservoir in areas of relatively poor drainage (Reclamation 2018). These areas have saturated soil during the wet season and spring, but are dry in summer, and are dominated by plant species adapted to life in saturated soils (i.e., hydrophytes). Dominant vegetation observed within the seasonal wetlands include rabbit's foot grass, curly dock (*Rumex crispus*), alkali bulrush (*Bolboschoenus maritimus* ssp. *paludosus*), sedge (*Carex* spp.), and narrow-leaved cattail. Dominant plant species may also include hydrophytic grasses such as Mediterranean barley, and squirreltail fescue (*Festuca bromoides*), and herbaceous species such as broad-leaved pepperweed, heliotrope, and white horehound (*Marrubium vulgare*). Seasonal wetland is a sensitive natural community because of its important ecological functions and is subject to regulation by United States Army Corps of Engineers (USACE) and California Department of Fish and Wildlife (CDFW).

Ephemeral drainages which convey water during the wet season, but are dry during most of the year are typically not vegetated with hydrophytic vegetation,

but may be considered jurisdictional waters by the USACE and are therefore special-status communities.

M2.1.1.3 Wildlife

Grassland habitats support many species of migratory birds and raptors including western meadowlark (*Sturnella neglecta*), savannah sparrow (*Passerculus sandwichensis*), and red-tailed hawk (*Buteo jamaicensis*). Amphibians an reptiles including western fence lizard (*Sceloporus occidentalis*) and common garter snake (*Thamnophis sirtalis*) and mammals including California ground squirrel (*Otospermophilis beecheyi*), bobcat (*Felis rufus*) and coyote (*Canis latrans*) inhabit grassland.

Scrub/chaparral provides cover for wildlife including desert cottontail (*Sylvilagus audubonii*), western rattlesnake (*Crotalus viridis*) and coyote.

Riparian areas support common wildlife species including: amphibians such as Sierran treefrog (*Pseudacris sierra*); birds including Wilson's warbler (*Wilsonia pusilla*), Swainson's thrush (*Catharus ustulatus*), yellow warbler (*Dendroica petechia brewsteri*), green heron (*Butorides striatus*), and red-shouldered hawk (*Buteo lineatus*); and mammals including raccoon (*Procyon lotor*) and striped skunk (*Mephitis mephitis*), and gray fox (*Urocyon cinereoargenteus*).

Emergent wetlands are important for foraging and breeding habitat for many species of water birds including: wading birds such as great egret (*Ardea alba*); waterfowl including green-winged teal (*Anas crecca*), mallard, and American coot; shorebirds including killdeer, black-necked stilt (*Himantopus mexicanus*), greater yellowlegs (*Tringa melanoleuca*), and American avocet (*Recurvirostra americana*); and passerines including Brewer's blackbird (*Euphagus cyanocephalus*), red-winged blackbird, brown-headed cowbird (*Molothrus ater*), and American pipit (*Anthus rubescens*) (Santa Clara County 2012).

Developed areas provide limited habitat for wildlife. However, typical bird species that are found in developed areas include American robin (*Turdus migratorius*), mockingbird (*Mimus polyglottos*), American crow (*Corvus brachyrhynchos*), house sparrow (*Passer domesticus*), European starling (*Sturnus vulgaris*), and rock pigeon (*Columba livia*). Other wildlife adapted to living in developed areas include Norway rat (*Rattus norvegicus*), western gray squirrel (*Sciurus niger*), opossum (*Didelphis virginiana*), and raccoon.

M2.1.2 SCVWD Service Area

M2.1.2.1 Common Natural Communities

Major natural communities found in the Santa Clara Valley Water District (SCVWD) Service Area include grassland, chaparral, coastal scrub, oak woodland, riparian forest and scrub, wetland, and open water (Santa Clara County 2012). The Santa Teresa water treatment plant (WTP) is located primarily within developed areas. However, grassland, oak woodland, and

riparian forest and scrub vegetation communities do occur at or near proposed construction areas. These natural communities are described in more detail below. Further description of the Santa Teresa WTP Area natural communities is also provided below.

Annual Grassland. Grassland is a predominant vegetation community in the SCVWD Service Area. The grassland communities are dominated by non-native annuals, interspersed with small patches of native perennial grasses (Santa Clara County 2012).

Oak Woodland. Oak woodland is the dominant vegetation community type in the SCVWD Service Area and includes several sub-types such as valley oak woodland, mixed oak woodland and forest (the most common subtype), blue oak woodland, and coast live oak woodland. Other species that occur in this community include California buckeye and foothill pine (*Pinus sabiniana*). Oak woodland in the SCVWD Service Area are often located next to streams and creeks and have associated riparian vegetation (Santa Clara County 2012).

Riparian Forest and Scrub. Riparian forests are dominated by trees such as willow (*Salix* spp.) and Fremont cottonwood (*Populus fremontii*). Other commonly occurring trees include white alder (*Alnus rhombifolia*), bigleaf maple (*Acer macrophyllum*), California sycamore (*Platanus racemosa*), and coast live oak. Riparian woodland contain an understory of shrubs and forbs. Riparian scrub is dominated by young willow trees and shrubs such as mulefat typically representing an early successional stage of riparian woodland (Santa Clara County 2012).

These vegetation communities occur along several creeks that traverse the SCVWD Service Area, including Penitencia Creek, Los Gatos Creek, Guadalupe Creek, and Guadalupe River, described in more detail below.

Wetlands and Open Water Habitat. Freshwater marsh wetlands may occur in association with creeks and rivers in the SCVWD Service Area. Wetlands are dominated by emergent herbaceous plants such as bulrush (*Bolboschoenus* spp.), sedge (*Carex* spp.), and cattail (*Typha* spp.) with either intermittently flooded or perennially saturated soils. These communities are found throughout the coastal drainages of California wherever water slows down and accumulates, even on a temporary or seasonal basis (Santa Clara County 2012). In addition, vernal pools and seasonal wetlands may occur in the SCVWD Service Area.

Open water habitat includes lakes, reservoirs, and groundwater recharge ponds within the SCVWD Service Area. Wetlands can also occur around the margins of these water bodies.

Chaparral. Chaparral includes mixed chaparral and mixed serpentine chaparral. Mixed chaparral is found on rocky, porous, nutrient-deficient soils

and on steep slopes. Mixed serpentine chaparral consists of fire-adapted shrubs found on serpentine soils and is generally more open than other chaparral types (Santa Clara County 2012). Dominant shrubs include chamise (*Adenestoma fasciculatum*), manzanita (*Arctostaphylos* spp.), scrub oak (*Quercus berberidifolia*), and ceanothus (*Ceanothus* sp.). Other species include toyon (*Heteromeles arbutifolia*), coffeeberry (*Rhamnus californica*), madrone (*Arbutus menziesii*), California bay (*Umbellularia californica*), birchleaf mountain-mahogany (*Cercocarpus betuloides*), western poison-oak, bush monkey flower (*Mimulus aurantiacus*), and California yerba santa (*Eriodictyon californicum*) (Santa Clara County 2012).

Developed. Developed areas include residential, commercial, industrial, transportation, landfill, landscaping, and recreational uses. Some developed areas contain ornamental vegetation, landscaped lawns.

M2.1.2.2 Wildlife

Given similarities in vegetation communities, many of the wildlife species that occur in the SCVWD Service Area are similar to those found in the San Luis Reservoir Region, such as grassland, riparian, and wetlands, as described above. Common wildlife associated with the vegetation communities not found in the San Luis Reservoir Region, including chaparral.

Chaparral communities in the SCVWD Service Area support many species of birds including Anna's hummingbird (*Calypte anna*), western scrub-jay (*Aphelocoma californica*), Bewick's wren (*Thryomanes bewickii*), California towhee (*Pipilo crissalis*), and California quail (*Callipepla californica*). Reptiles that utilize chaparral include gopher snake (*Pituophis melanoleucus*) and western rattlesnake (*Crotalus oreganus*). Mammals that utilize chaparral include California pocket mouse (*Perognathus californicus*), California ground squirrel, bobcat, and coyote.

M2.1.2.3 Santa Teresa WTP

A reconnaissance-level field survey was conducted at SCVWD's Santa Teresa WTP on June 11-12, 2012.

The Santa Teresa WTP is located near the Santa Teresa Hills in the City of San Jose. Surrounding land uses are primarily residential, with adjacent small patches of oak woodland and annual grassland. Trees and other vegetation around the site provide habitat for migratory birds and other wildlife adapted to living near residential areas.

Santa Teresa County Park is located east of the WTP and consists of 1,627 acres of annual grassland, oak woodland, and developed areas that supports many wildlife species.

M2.1.3 Pacheco Reservoir

Natural communities found in the vicinity of the Pacheco Reservoir are primarily comprised of oak woodlands. Other natural communities in the area include riparian woodland, annual grassland, and chaparral (including serpentine chaparral and northern mixed chaparral/charmise chaparral) (Santa Clara County 2012).

M2.1.3.1 Common Natural Communities

Grassland. Annual grassland communities occur throughout the lowlying valleys that would be flooded by an expanded reservoir, and are dominated by non-native annuals, interspersed with small patches of native perennial grasses (Santa Clara County 2012).

Chaparral. Both northern mixed chaparral/chamise chaparral and limited amounts of serpentine chaparral occur in the Pacheco Reservoir region. Vegetation surveys have not been performed in the Pacheco Reservoir area, however, species similar to those described for the SCVWD Service Area are expected. Small areas of serpentine soils are mapped on the east side of Pacheco Reservoir, including within the proposed expanded reservoir area (Santa Clara County 2012) within larger areas of chamise and mixed chaparral (see Figure M1-2a).

M2.1.3.2 Sensitive Natural Communities

Oak Woodland. Oak woodland is the dominant vegetation community type in the Pacheco Reservoir region and includes several sub-types such as foothill-pine oak woodland, mixed oak woodland and forest, blue oak woodland, and valley oak woodland, which are considered sensitive communities by CDFW.

Valley Foothill Riparian. Riparian habitat includes trees such as California sycamore, white alder, and black willow (Santa Clara County 2012). This vegetation community is present along Pacheco Creek upstream and downstream of the Pacheco Reservoir.

Wetlands. One large patch of freshwater emergent wetland is located along the floodplain above the confluence of the North and East Forks of Pacheco Creek. Isolated ponds are also present upstream of Pacheco Reservoir.

M2.1.3.3 Wildlife

Biological surveys have not yet been conducted in the Pacheco Reservoir region. Given similarities in vegetation communities, many of the wildlife species that occur near the Pacheco Reservoir are assumed to be similar to those found in the San Luis Reservoir Region. Common wildlife may also be associated with the vegetation communities not found in the San Luis Reservoir Region, including chaparral.

Sensitive wildlife species, including California tiger salamander, and California red-legged frog may use mixed chaparral habitat areas for movement,

aestivation, or foraging habitat, particularly when located near aquatic habitat that supports these species. Bay checkerspot butterfly may move through this community type (Santa Clara County 2012).

Numerous amphibian, reptile, bird, and mammal wildlife species use riparian habitats. Sensitive species such as California tiger salamander, California red-legged frog, foothill yellow-legged frog, western pond turtle, and least Bell's vireo use riparian habitat for movement, breeding, foraging, and/or refugia. Tricolored blackbird and San Joaquin kit fox may briefly use such habitat as well during movement and foraging.

M2.2 Special-Status Species

M2.2.1 Methods

Special-status species are protected pursuant to federal and/or state endangered species laws or have been designated as species of concern by the CDFW. In addition, Section 15380(b) of the California Environmental Quality Act (CEQA) Guidelines provides a definition of rare, endangered, or threatened species that are not included in any listing. Species recognized under these terms are collectively referred to as "special-status species." For purposes of this Environmental Impact Statement/ Environmental Impact Report (EIS/EIR), special-status species include:

- Plant and wildlife species that are identified as rare, threatened, or endangered under the federal or state endangered species acts
- Species that are candidates for listing under either federal or state law
- Species designated by CDFW as species of special concern
- Species protected by the federal Migratory Bird Treaty Act (16 United States Code [USC] Sections 703–711)
- Species identified under Fish and Game Code as fully protected (Section 3511)
- Bald and golden eagles protected by the federal Bald Eagle Protection Act (16 USC 668)
- Species such as candidate and California Rare Plant Rank (CRPR) 1A, 1B, 2A, and 2B species that may be considered rare or endangered pursuant to the criteria in Section 15380(b) of the CEQA Guidelines
- The CDFW-managed tule elk is additionally included in the analysis at San Luis Reservoir for the purposes of examining wildlife movement under CEQA

In addition to range maps, habitat assessments, and reports from field surveys, the following databases pertaining to the natural resources of the region were

reviewed to determine the determine the regional likelihood of occurrence of special-status plant and wildlife species:

- U.S. Fish and Wildlife Service (USFWS) official lists, dated December 13, 2018, of federally listed species that may occur or could potentially be affected by activities within the San Luis Reservoir Region including the San Luis Low Point Improvement Project (USFWS 2018), and the Pacheco Reservoir Region (USFWS 2018).
- CDFW California Natural Diversity Database (CNDDB) lists of documented occurrences (CDFW 2018).
- Calflora (2018) database: Information on California plants for education, research and conservation [web application]. 2018. Berkeley, California: Available: https://www.calflora.org/ (Dec 13, 2018).

M2.2.2 Special-Status Species with Potential to Occur

Table M2-1 identifies regionally occurring special-status species including common and scientific names for each species, regulatory status (federal, State, local, CRPR), habitat descriptions, and potential for occurrence for each of the alternative. Species with the potential to occur include those observed during the surveys and those with the potential to occur based on presence of habitat.

San Luis Reservoir Region: A California Natural Diversity Database (CNDDB) record search of the Mariposa Peak, Three Sisters, Los Banos Valley, San Luis Dam, Pacheco Pass, Pacheco Peak, Crevison Peak, Mustang Peak, and Howard Ranch 7.5-minute USGS quadrangles was conducted to obtain regionally occurring special-status species documented in the vicinity of the San Luis Reservoir (Figure M1-3). In addition, an official species list of federally listed species that may occur or could potentially be affected by activities within this location was obtained from the USFWS (USFWS 2018). These species are listed in Table M2-1. In September 2018 a biological resources field survey was conducted of the B.F. Sisk construction area (ESA 2018).

SCVWD Service Area: This area includes the area encompassed by the Santa Teresa WTP. A CNDDB search was conducted to identify special-status species with documented occurrences in the SCVWD Service Area. The search included the San Jose West, San Jose East, Calaveras Reservoir, Los Gatos, Santa Teresa Hills, Morgan Hill, Cupertino and Mt. Sizer 7.5-minute USGS quadrangles. The location of occurrences of special-status species surrounding Santa Teresa WTP are shown in Figure M1-4. In addition, official species lists of federally listed species that may occur or could potentially be affected by activities within the SCVWD Service Area were obtained from the USFWS (USFWS 2018). These species are provided in Table M2-1.

Pacheco Reservoir: A CNDDB search was conducted to identify special-status species with documented occurrences in the Pacheco Reservoir region. The search included the Mississippi Creek, Mustang Peak, Crevison Peak, Gilroy

Hot Springs, Pacheco Peak, Pacheco Pass, San Felipe, Three Sisters, Mariposa Peak 7.5-minute USGS quadrangles. In addition, an official species list of federally listed species that may occur or could potentially be affected by activities within this location was obtained from the USFWS (USFWS 2018). The location of occurrences of special-status species in the Pacheco Reservoir region are shown in Figure M1-5.

Table M2-1. Special-Status Terrestrial Species and Potential to Occur in the San Luis Reservoir Region, the SCVWD Service Area, and the Pacheco Reservoir Region

Common Name	Scientific Name	Status	Habitat Requirements	Potential to Occur within the San Luis Reservoir Region[1]	Potential to Occur within the SCVWD Service Area[2]	Potential to Occur within the Pacheco Reservoir Region
Invertebrates						
Bay checkerspot butterfly	*Euphydryas editha bayensis*	FT	Restricted to native grasslands on outcrops of serpentine soil in the vicinity of San Francisco Bay.	N/A	Moderate. Grasslands within the SCVWD Service Area provide habitat for this species. Nearest CNDDB occurrences are in hills above Anderson Reservoir and near Calero Reservoir.	Low. The Pacheco Reservoir Region is outside the known geographic range of this species. No CNDDB occurrences in the Pacheco Reservoir Region.
Conservancy fairy shrimp	*Branchinecta conservatio*	FE	Found in large vernal pools.	N/A	None. The SCVWD Service Area does not provide habitat for this species. No CNDDB occurrences in SCVWD Service Area.	Low. Vernal pool habitat is uncommon in the steep terrain surrounding Pacheco Reservoir. There are no known occurrences of this species within the Pacheco Reservoir Region.
San Bruno Elfin butterfly	*Callophrys mossii bayensis*	FE	Coastal mountains near San Francisco Bay with steep north facing slopes. Larval food plant is broadleaf stonecrop.	N/A	None. The SCVWD Service Area occurs outside the known geographic range for this species. No CNDDB occurrences in SCVWD Service Area	Low. Its larval food plant, broadleaf stonecrop, has been observed nearby in Henry W. Coe State Park. There are no known occurrences of this species within Santa Clara County.
Vernal pool fairy shrimp	*Branchinecta lynchi*	FT	Found in ephemeral wetland habitats and vernal pools within sandstone, alkaline soils, and alluvial fan terraces, within annual grassland.	Moderate. Observed pools and seasonal wetlands within the San Luis Region provide suitable habitat for this species. No CNDDB occurrences in the San Luis Reservoir Region.	Moderate. Potentially occurring vernal pools and seasonal wetlands within the SCVWD may provide habitat for this species. No CNDDB occurrences in SCVWD Service Area.	Low. Vernal pool habitat is uncommon in the steep terrain surrounding Pacheco Reservoir. There are no known occurrences of this species within the Pacheco Reservoir Region.

Common Name	Scientific Name	Status	Habitat Requirements	Potential to Occur within the San Luis Reservoir Region[1]	Potential to Occur within the SCVWD Service Area[2]	Potential to Occur within the Pacheco Reservoir Region
Vernal pool tadpole shrimp	*Lepidurus packardi*	FE	Found in a wide variety of ephemeral wetland habitats.	Moderate. Observed pools and seasonal wetlands within the vicinity of the San Luis Region provide suitable habitat for this species. No CNDDB occurrences in the San Luis Reservoir Region.	Moderate. Potentially occurring vernal pools and seasonal wetlands within the SCVWD may provide habitat for this species. No CNDDB occurrences in SCVWD Service Area.	Low. Vernal pool habitat is uncommon in the steep terrain surrounding Pacheco Reservoir. There are no known occurrences of this species within the Pacheco Reservoir Region.
Zayante band-winged grasshopper	*Trimerotropis infantilis*	FE	Isolated sandstone deposits in the Santa Cruz Mountains (the Zayante Sand Hills ecosystem).	N/A	Low. The SCVWD Service Area occurs outside the known geographic range for this species. No CNDDB occurrences in SCVWD Service Area.	Low. The Pacheco Reservoir region occurs outside the known geographic range for this species.
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	FT	Occurs only in the Central Valley of California, in association with blue elderberry (*Sambucus nigra* ssp. *caerulea*). Prefers to lay eggs in elderberries 2-8 inches in diameter; some preference shown for “stressed” elderberries.	High. Elderberry bushes were observed in 2002 2016, and 2018 within San Luis Reservoir Region. CNDDB occurrence along Los Banos Creek, over 5 miles southeast of San Luis Reservoir.	N/A	None. The Pacheco Reservoir Region occurs outside the geographic range of this species.

Common Name	Scientific Name	Status	Habitat Requirements	Potential to Occur within the San Luis Reservoir Region[1]	Potential to Occur within the SCVWD Service Area[2]	Potential to Occur within the Pacheco Reservoir Region
Amphibians						
California tiger salamander (Central California Distinct Population Segment)	*Ambystoma californiense*	FT, ST Critical Habitat	Need underground refuges, especially ground squirrel burrows for upland aestivation within grassland and vernal pools or other seasonal water sources for breeding.	Moderate. Grasslands provides upland aestivation habitat. CNDDB occurrence along Los Banos Creek, southeast of San Luis Reservoir. CNDDB report approximately 2.5 miles southeast of Basalt Use Area and campground. Critical habitat occurs within the western portion of the San Luis Reservoir.	Moderate. The ponds in the vicinity of the SCVWD Service Area provide breeding habitat and grasslands provides upland habitat. Critical habitat occurs within a portion of the site.	Moderate. Ponds near the Pacheco Reservoir provide potential breeding habitat for this species and grasslands provide potential upland habitat.
Foothill yellow-legged frog	*Rana boylii*	SC, Fed under review	Partly-shaded, shallow perennial and intermittent streams and riffles with a rocky substrate in a variety of habitats. Need at least some cobble-sized substrate for egg-laying. Rarely encountered far from permanent water sources.	None. Although CNDDB records occur along permanent streams to the south, no permanent streams occur within the reservoir system. CNDDB occurrences along Los Banos Creek, southeast and southwest of San Luis Reservoir.	Moderate. Permanent drainages associated with the wetlands and open water habitat provide open water habitat for this species.	Moderate. Riverine habitat upstream and downstream of the Pacheco Reservoir provide suitable habitat for this species.

Common Name	Scientific Name	Status	Habitat Requirements	Potential to Occur within the San Luis Reservoir Region[1]	Potential to Occur within the SCVWD Service Area[2]	Potential to Occur within the Pacheco Reservoir Region
California red-legged frog	*Rana draytonii*	FT, CSC	Lowlands and foothills in or near permanent sources of deep water with dense, shrubby or emergent riparian vegetation. Requires 11-20 weeks of permanent water for larval development. Must have access to aestivation habitat.	Present. Breeding population observed near quarry during 2018 field surveys. Grasslands and riparian areas provide upland and dispersal corridors. CNDDB records occur in the vicinity of San Luis Reservoir.	High. The drainages and freshwater marsh wetlands associated with the wetlands and open water habitat provide open water habitat for this species.	Moderate. The Pacheco Reservoir Region occurs within critical habitat for this species. The creeks, ponds, and riparian habitat located in vicinity of the Pacheco Reservoir provide suitable habitat for this species.
Reptiles						
Western pond turtle	*Actinemys marmorata pallida*	CSC, Fed under review	A thoroughly aquatic turtle of ponds, marshes, rivers, streams, and irrigation ditches, usually with aquatic vegetation. Need basking sites and suitable (sandy banks or grassy open fields) upland habitat up to 0.5 km from water for egg-laying.	Moderate. The San Luis Reservoir may provide aquatic habitat for this species. CNDDB occurrences in Pacheco State Park. Observed in the Portuguese Creek Area of San Luis Reservoir in 2004.	High. The drainages and freshwater marsh wetlands associated with the wetlands and open water habitat provide open water habitat for this species.	High. The aquatic habitat along the reservoir and creek provides suitable habitat for this species.

Common Name	Scientific Name	Status	Habitat Requirements	Potential to Occur within the San Luis Reservoir Region[1]	Potential to Occur within the SCVWD Service Area[2]	Potential to Occur within the Pacheco Reservoir Region
Blunt-nosed leopard lizard	*Gambelia sila*	FE, SE	Sparsely vegetated alkali and desert scrub habitats, in areas of low topographic relief. Seeks cover in mammal burrows, under shrubs or structures such as fence posts; does not excavate burrows. This species is known from the extreme northwest Santa Barbara County and western Kern County north to southern Merced County.	Low. The San Luis Reservoir Region occurs outside of the known extant geographic range for this species. The current species' range is restricted to areas south of San Luis Reservoir (1993 observation south of Los Banos Creek Reservoir). A 1930s record of a population in the vicinity of the Sisk Dam is likely extirpated.	N/A	Low. This region occurs outside known distribution range of this species.
Coast horned lizard	*Phrynosoma blainvillii*	CSC	Frequents a wide variety of habitats, most common in lowlands along sandy washes with scattered low bushes. Open areas for sunning, bushes for cover, patches of loose soil for burial, and abundant supply of ants and other insects are required.	Moderate. Grasslands provides suitable habitat for this species.	Moderate. Grasslands provides suitable habitat for this species. Nearest CNDDB occurrence is near Calero County Park.	Moderate. Grasslands and chaparral provides habitat for this species.
Alameda whipsnake	*Masticophis lateralis euryxanthus*	FT, ST	Typically found in chaparral and scrub habitats but will also use adjacent grassland, oak savanna, and woodland habitats.	N/A	Moderate. CNDDB occurrences are sensitive but species may occur in suitable habitat in the project area.	Low. This region occurs outside known distribution range of this species.

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San Joaquin whipsnake	*Masticophis flagellum ruddocki*	CSC	Open, dry habitats with little or no tree cover. Found in valley grassland and saltbush scrub in the San Joaquin Valley. Needs mammal burrows for refuge and oviposition sites.	High. Grasslands and scrub/chaparral provide habitat for this species. CNDDB occurrence southeast of San Luis Reservoir. Status unknown but expected to occur.	N/A	High. Grasslands provide habitat for this species.
Giant garter snake	*Thamnophis gigas*	FT	Found in agricultural wetlands, irrigation and drainage canals, sloughs, ponds, small lakes, low gradient streams, and adjacent uplands. Absent from large rivers and waters with large, introduced, predatory fish and from wetlands with sand, gravel, or rock substrates.	Low. The San Luis Reservoir contains predatory fish, which precludes this species from being present. CNDDB occurrence to the east of I-5.	N/A	Low. The Pacheco Reservoir Region is not within the geographic range of this species.
Birds						
American peregrine falcon	*Falco peregrinus anatum*	CFP	Nests near wetlands, lakes, rivers, or other water; on cliffs, banks, dunes, mounds; also, human-made structures. Nest consists of a scrape or a depression or ledge over an open site.	N/A	High. The wetlands and open water habitat and structures associated with developed areas provide nesting habitat. Known to nest on the San Jose City Hall building.	Moderate. Suitable nesting habitat exists in the vicinity of the existing Pacheco Reservoir.

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Bald eagle	*Haliaeetus leucocephalus*	BGEPA, SE, CFP	Requires large bodies of water, or free flowing rivers with abundant fish, and adjacent snags or other perches for nesting.	Present. Bald eagle was observed in the region during site visit (ESA 2016). May winter in small numbers and possible nesting on power line towers around reservoirs.	Present. Bald eagle have nested in the SCVWD Service Area at Calero Reservoir	Moderate. Nesting habitat is available in the vicinity of Pacheco Reservoir Region.
Black swift	*Cypseloides niger*	CSC	Coastal belt of Santa Cruz and Monterey County; central and southern Sierra Nevada; San Bernardino and San Jacinto Mountains. Breeds in small colonies on cliffs behind or adjacent to waterfalls in deep canyons and sea-bluffs above the surf.	N/A	Low. The SCVWD Service Area does not provide suitable nest habitat for this species, however eBird observations record several sightings in the area. No CNDDB occurrences in SCVWD Service Area.	Low. The Pacheco Reservoir Region occurs outside the known geographic range of this species, howevever, eBird observations record sevreal sightings in the area.No CNDDB occurrences in the Pacheco Reservoir Region.
Ridgway's rail	*Rallus longirostris obsoletus*	FE	Resides in coastal wetlands and brackish areas around San Francisco Bay.	N/A	Low. The known extant geographic range for this species occurs in the SCVWD Service Area but not near the Treatment Alternative Study Area. No CNDDB occurrences in SCVWD Service Area.	None. No suitable habitat is present for this species in the vicinity of Pacheco Reservoir Region.

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California condor	*Gymnogyps californianus*	FE, SE	Nests in caves on cliff faces in mountains up to 6,000 feet. Found in California's southern coastal ranges from Big Sur to Ventura County, east through the Transverse Range and southern Sierra Nevada.	Moderate. While nesting habitat is not present, foraging habitat is present within the San Luis Reservoir Region. Nearest CNDDB occurrence is 33 miles for this San Luis Reservoir Region.	N/A	Low. The Pacheco Reservoir is located outside the known range of this species.
California least tern	*Sterna antillarum browni*	FE	Breeds along seacoasts, beaches, bays, estuaries, lagoons, lakes, and rivers.	N/A	None. The SCVWD Service Area does not provide habitat for this species. No CNDDB occurrences in SCVWD Service Area.	Low. No suitable habitat for this species is present within the Pacheco Reservoir Region. No CNDDB occurrences of this species within the Pacheco Reservoir Region
Golden eagle	*Aquila chrysaetos*	BGEPA	Needs open terrain for hunting; grasslands, deserts, savannahs, and early successional stages of forest and shrub habitats.	High. Known to occur around San Luis Reservoir. Suitable nesting habitat present. CNDDB occurrence near the San Luis Reservoir.	Moderate. Known to occur within Alum Rock Park.	High. Suitable habitat present for this species within the Pacheco Reservoir Region.
Marbled murrelet	*Brachyramphus marmoratus*	FT, SE	Nests along coastlines with stands of mature redwood and Douglas-fir.	N/A	None. The SCVWD Service Area does not provide habitat for this species. No CNDDB occurrences near SCVWD Service Area.	None. No suitable habitat available for this species within the Pacheco Reservoir Region.

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Northern harrier	*Circus cyaneus*	CSC	Coastal salt and fresh-water marsh. Nest and forage in grasslands, from salt grass in desert sink to mountain cienagas. Nests on ground in shrubby vegetation, usually at marsh edge.	Present. This species was observed during the 2002 survey. CNDDB occurrences near San Luis Reservoir.	Present. Along shoreline.	Moderate. Suitable habitat is available within the Pacheco Reservoir Region.
Purple martin	*Progne subis*	CSC	Inhabits woodlands, low elevation coniferous forest of Douglas-fir, ponderosa pine, & Monterey pine.	N/A	Low. The SCVWD Service Area does not provide habitat for this species. Known from one CNDDB occurrence in Santa Cruz Mountains outside SCVWD Service Area.	Low. No suitable habitat within Pacheco Reservoir Region.
Swainson's hawk	*Buteo swainsoni*	ST	Breeds in grasslands with scattered trees, juniper-sage flats, riparian areas, savannahs, and agricultural or ranch lands. Alameda, Butte, Colusa, Contra Costa, Fresno, Glenn, Inyo, Kern, Kings, Lassen, Los Angeles, Madera, Merced, Modoc, Mono, Napa, Placer, Plumas, Sacramento, San Bernardino, San Joaquin, San Luis Obispo, Siskiyou, Solano, Stanislaus, Sutter, Tehama, Tulare, Yolo, and Yuba counties.	Present. Grasslands provides foraging habitat CNDDB occurrences near O'Neill Forebay. Observed during 2003 and 2016 field surveys; known to nest in the area.	Low. The SCVWD Service Area occurs outside of the geographic range for this species. Nearest CNDDB occurrence on Coyote Creek south of Bailey Ave Overpass.	Low. The Pacheco Reservoir Region is located outside the known geographic range of this species.

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Tricolored blackbird	*Agelaius tricolor*	ST, Fed under review	Highly colonial species, most numerous in Central Valley and vicinity. Requires open water, protected nesting substrate, and foraging area with insect prey within a few km of the colony.	High. The annual grassland provides foraging habitat and the riparian vegetation along south end of San Luis Reservoir near Sisk Dam provides nesting habitat.	High. The annual grassland provides foraging habitat and the freshwater marsh wetlands associated with the open water habitat may provide nesting habitat. Nearest CNDDB occurrence at Calero Reservoir.	Moderate. Suitable habitat is present in wetland habitat within the Pacheco Reservoir Region.
Western burrowing owl	*Athene cunicularia*	CSC	Open, dry annual or perennial grasslands, deserts, and scrublands characterized by low-growing vegetation.	Present. The annual grassland, scrub/chaparral, and ruderal provide habitat for this species. CNDDB occurrences east of the San Luis Reservoir. Observed east of reservoir in cattle pastures in 2016 (ESA 2016). Likely to occur in small numbers during winter and the nesting season.	High. The annual grassland and scrub/chaparral provide habitat for this species. Nearest CNDDB occurrences is just east of San Jose airport and near Kirby Canyon, west of Anderson Reservoir.	Moderate. Suitable habitat is present within grasslands. scrub/chaparral habitat within the Pacheco Reservoir Region.
Western snowy plover	*Charadrius alexandrinus nivosus*	FT, CSC	Occurs along the California coast and breeds on dune-backed beaches.	N/A	Moderate. The SCVWD Service Area provides habitat but nowhere near the Treatment Alternative Study Area. CNDDB occurrences near SCVWD Service Area but nowhere near the Treatment Alternative Study Area.	Low. No suitable habitat present. No CNDDB occurrences documented within the Pacheco Reservoir Region.

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White-tailed kite	*Elanus leucurus*	CFP	Coastal and valley lowlands; undisturbed, open grasslands, meadows, farmlands and emergent wetlands.	High. The trees surrounding the San Luis Reservoir Region provide nesting habitat. No CNDDB occurrences. Likely nester based on observances at San Luis Reservoir from 2000-2004.	High. The trees provide habitat for this species. Suitable nesting habitat within service area. CNDDB occurrence along Stevens Creek in Cupertino.	Moderate. Suitable nesting habitat is present throughout the Pacheco Reservoir Region.
Yellow-billed cuckoo	*Coccyzus americanus*	FT, SE	Frequents dense valley foothill riparian habitats within Butte, Colusa, Fresno, Glenn, Humboldt, Imperial, Inyo, Kern, Lake, Los Angeles, Madera, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Joaquin, San Luis Obispo, Siskiyou, Sonoma, Stanislaus, Sutter, Tehama, Ventura, Yolo, and Yuba counties in California.	N/A	None. The SCVWD Service Area occurs outside of the known extant geographic range for this species. Although one CNDDB occurrence is documented within the SCVWD Service Area, the record is from 1899, and is considered extirpated (Occurrence number 196).	None. The Pacheco Reservoir Region occurs outside the known extant geographic range for this species.
Mammals						
American badger	*Taxidea taxus*	CSC	Most abundant in drier open stages of most shrub, forest, and herbaceous habitats, with friable soils.	Present. Observed in 2018 near Basalt and Gonzaga Rds. The scrub/chaparral and grassland provide habitat for this species. CNDDB occurrences within the San Luis Reservoir Region.	High. The scrub/chaparral and grassland provide habitat for this species. Nearest CNDDB occurrence 2.4 miles northwest of Anderson Reservoir.	High. The chaparral and grassland habitat within the Pacheco Reservoir Region provide suitable habitat for this species.

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Fresno kangaroo rat	*Dipodomys nitratoides exilis*	FE	Found in grassland/ and chaparral. Known from Fresno, Kings, and Madera counties.	Low. The San Luis Reservoir Region occurs outside of the known extant geographic range for this species. No CNDDB occurrences in the San Luis Reservoir Region.	N/A	Low. The Pacheco Reservoir Region occurs outside the known geographic range of this species.
Giant kangaroo rat	*Dipodomys ingens*	FE	Found in grassland. Known from Fresno, Kern, San Benito, and San Luis Obispo counties and extirpated from Kings, Merced, and Santa Barbara counties.	Low. The San Luis Reservoir Region occurs outside of the known extant geographic range for this species. No CNDDB occurrences in the San Luis Reservoir Region.	N/A	Low. The Pacheco Reservoir Region occurs outside the known geographic range of this species.
Greater western mastiff bat	*Eumops perotis californicus*	CSC	Many open, semi-arid to arid habitats, including conifer and deciduous woodlands, coastal scrub, grasslands, chaparral, etc. Roosts in crevices in cliff faces, high buildings, trees, and tunnels.	Moderate. Grasslands, scrub/chaparral, and oak woodland provides foraging habitat for this species. No CNDDB occurrences near San Luis Reservoir.	Moderate. Grasslands, scrub/chaparral, and oak woodland provides foraging habitat for this species. No CNDDB occurrences near SCVWD Service Area.	Moderate. Potential habitat is present within grasslands and oak woodland present within the Pacheco Reservoir Region.
Pallid bat	*Antrozous pallidus*	CSC	Deserts, grasslands, shrublands, woodlands, and forests. Most common in open, dry habitats with rocky areas for roosting. Roosts must protect bats from high temperatures. Very sensitive to disturbance of roosting sites.	Moderate. Grasslands, scrub/chaparral, and oak woodland habitat provides foraging habitat for this species. No CNDDB occurrences near San Luis Reservoir.	Moderate. The trees within the SCVWD Service Area provide day roosts. A CNDDB occurrence is documented within SCVWD Service Area.	Moderate. Potential habitat is present within grasslands and oak woodland present within the Pacheco Reservoir Region.

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Ringtail	*Bassariscus astutus*	CFP	Mixed oak woodland and riparian habitats.	Moderate. The oak woodland, chaparral, and riparian provide habitat for this species. There are no nearby documented occurrences.	Moderate. The oak woodland and riparian provide habitat for this species. There are no nearby documented occurrence for this species.	Moderate. Oak woodland and riparian habitat provides suitable habitat for this species. There are no nearby documented occurrences.
San Joaquin kit fox	*Vulpes macrotis mutica*	FE, ST	Annual grassland or grassy open stages with scattered shrubby vegetation. Need loose-textured sandy soils for burrowing and suitable prey base.	High. The annual grassland provides habitat for this species. Many potential dens reported in 2009 survey. CNDDB occurrences near San Luis Reservoir. Few documented occurrences in recent years suggest an unstable and possibly declining population.	High. The annual grassland provides habitat for this species. Most recent CNDDB occurrence in general vicinity was in Morgan Hill in the early 1970s.	Moderate. The annual grassland provides habitat for this species. Most recent CNDDB occurrence was in 2002 about 1 mile west of Pacheco Reservoir.
Salt marsh harvest mouse	*Reithrodontomys raviventris*	FE	Requires dense cover including pickleweed (*Salicornia virginica*). Known only in the saline emergent wetlands of San Francisco Bay and its tributaries.	N/A	None. The SCVWD Service Area does not provide habitat. There are no CNDDB occurrences documented for this species.	None. No suitable habitat exists within the Pacheco Reservoir Region.
Townsend's big-eared bat	*Corynorhinus townsendii*	CSC	Throughout California in a wide variety of habitats. Most common in mesic sites.	Moderate. Grasslands, scrub/chaparral, and oak woodland provides foraging habitat for this species. No CNDDB occurrences near San Luis Reservoir.	Moderate. SCVWD Service Area provides foraging habitat.	Moderate. Suitable foraging habitat is present within the Pacheco Reservoir Region.

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Western red bat	*Lasiurus blossevillii*	CSC	Roosts primarily in trees, less often in shrubs. Roost sites often are in edge habitats adjacent to streams, fields, or urban areas.	Present. Identified during acoustic surveys near Basalt Quarry; may roost in tree groves within the project area. No CNDDB occurrences near San Luis Reservoir.	Moderate. SCVWD Service Area provides foraging habitat.	Moderate. Suitable habitat is present within the Pacheco Reservoir Region.
Tule elk	*Cervus elaphus nannodes*	Managed as Big Game Mammal	Grasslands, riparian areas and other habitats that provide brush, trees, shrubs, and herbaceous vegetation as cover.	Present. The riparian and grassland habitats support about 300 elk, which range around the reservoir. Population established on the San Luis National Wildlife Refuge in 1984.	N/A	N/A
Plants						
Alkali goldfields	*Lasthenia ferrisiae*					
Arburua Ranch jewelflower	*Streptanthus insignis* ssp. *lyonii*	CRPR 1B.2	Coastal scrub. Serpentine slopes. 230-850m. Blooms March through May.	No. The San Luis Reservoir Region does not provide habitat. Nearest known occurrence is on slopes along South Fork of Los Banos Creek.	N/A	Low. No suitable habitat for this species within the Pacheco Reservoir Region.
Arcuate bush-mallow	*Malacothamnus arcuatus*	CRPR 1B.2	Chaparral. Gravelly alluvium. 80-355m. Blooms April through September.	Moderate. The chaparral provides habitat. Known in area from single sighting from 1936.	Moderate. The chaparral provides habitat. Observations of this species in 2018 within the Pacheco Reservoir Region recorded in Calflora.Nearest CNDDB occurrences near Calero Reservoir and Alum Rock park.	Moderate.. Calflora observations in 2018 within the Pacheco Reservoir Region.

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Big-scale balsamroot	*Balsamorhiza macrolepis* var. *macrolepis*	CRPR 1B.2	Chaparral, cismontane woodland, grassland – sometimes on serpentinite and basalt rock outcrops. 90 – 1400m. Blooms March through June.	High. Grasslands and oak woodland provide habitat. Nearest known CNDDB occurrence in Pacheco State Park on slopes above San Luis Reservoir.	High. Grasslands and oak woodland provide habitat. Nearest CNDDB occurrence is east of Coyote Creek.	Moderate. Suitable habitat in grassland habitat on rock outcrops. No known occurrences of this species within the Pacheco Reservoir Region.
California alkali grass	*Puccinellia simplex*	CRPR 1B.2	Meadows and seeps, chenopod scrub, valley and foothill grasslands, vernal pools; 1-915m. Blooms March through May.	Moderate. The scrub/chaparral and grassland provide habitat. Known from one record from 1986 in Los Banos Valley.	N/A	Low. Limited suitable habitat and no known occurrences of this species within the Pacheco Reservoir Region.
California seablite	*Suaeda californica*	FE, CRPR 1B.1	Marshes and swamps, which are occasionally coastal salt. Known from San Luis Obispo County. Presumed extirpated from Alameda, Contra Costa, Santa Clara, and San Francisco counties. Blooms July through October.	N/A	None. The SCVWD Service Area occurs outside of the known extant geographic range. No CNDDB occurrences near SCVWD Service Area	None. The Pacheco Reservoir Region is located outside the known geographic range of this species
Chaparral harebell	*Campanula exigua*	CRPR 1B.2	Chaparral. Rocky sites, usually on serpentine in chaparral. 300-1250m. Blooms May through June.	Moderate. The scrub/chaparral provides habitat. Known in area from single sighting before 1950.	Moderate. The chaparral provides habitat. Nearest CNDDB occurrence is northeast of Alum Rock Park.	Moderate. The chaparral habitat within the Pacheco Reservoir Region provides habitat.

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Congdon's tarplant	*Centromadia parryi* ssp. *congdonii*	CRPR 1B.2	Grassland – alkaline; 1 – 230m. Blooms May through October.	Moderate. Grasslands would provide suitable habitat. Nearest known occurrence is in Pacheco State Park.	Moderate. Grasslands would provide suitable habitat. Nearest CNDDB occurrence is east San Jose.	Moderate. Grasslands would provide suitable habitat. No known occurrences of this species within the Pacheco Reservoir Region.
Contra Costa goldfields	*Lasthenia conjugens*	FE, CRPR 1B.1	Valley and foothill grassland, vernal pools, cismontane woodland. Extirpated from most of its range; extremely endangered. Blooms March through June.	N/A	Moderate. Grasslands and oak woodland provide habitat. Nearest CNDDB occurrence is east San Jose.	Moderate. Grasslands and oak woodland provide habitat. No known occurrences of this species within the Pacheco Reservoir Region.
Coyote ceanothus	*Ceanothus ferrisiae*	FE, CRPR 1B.1	Chaparral, valley and foothill grassland, coastal scrub, on serpentine sites in the Mt. Hamilton range. Blooms January through May.	N/A	Moderate. The chaparral, grassland, and oak woodland provide habitat. CNDDB occurrence along Coyote Creek near Anderson Reservoir.	Moderate. The chaparral, grassland, and oak woodland provide habitat. Calflora occurrences NW of Pacheco, near Anderson Lake..
Fragrant fritillary	*Fritillaria liliacea*	CRPR 1B.2	Coastal scrub, valley and foothill grassland, coastal prairie. Blooms February through April.	N/A	Moderate. The scrub, riparian, and grassland provide habitat Nearest CNDDB occurrences near Calero Reservoir.	Moderate. The scrub, riparian, and grassland provide habitat No known occurrences of this species within the Pacheco Reservoir Region.
Hairless popcorn-flower	*Plagiobothrys glaber*	CRPR 1A	Meadows and seeps, marshes and swamps. Blooms March through May.	N/A	Moderate. The freshwater marsh wetlands provide habitat.	Moderate. The chaparral habitat within the Pacheco Reservoir Region provides habitat.

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Hall's bush-mallow	*Malacothamnus hallii*	CRPR1B.2	Chaparral. Some populations on serpentine. 10-550m. Blooms May through September.	Moderate. The chaparral provides habitat. Nearest known occurrence is near Pacheco Pass, in San Luis Wildlife Area. Potential habitat in scrub and mesic grassland habitats along northwestern shore.	Moderate. The chaparral provides habitat. CNDDB occurrences near Anderson Reservoir and along Guadalupe Creek north of Highway 17.	Moderate. The chaparral habitat within the Pacheco Reservoir Region provides habitat.
Hispid bird's-beak	*Chloropyron mollis* ssp. *hispidum*	CRPR 1B.1	Meadows and seeps, playas, and valley and foothill grasslands with alkaline soil. Blooms June through September.	Moderate. Grasslands would provide suitable habitat. No CNDDB occurrences near San Luis Reservoir	N/A	Low. Suitable habitat is lacking in the Pacheco region. No known occurrences of this species within the Pacheco Reservoir Region.
Hospital Canyon larkspur	*Delphinium californicum* ssp. *interius*	CRPR 1B.2	Chaparral – openings, cismontane woodland, 230 – 1095m. Blooms March through June.	High. The chaparral and oak woodland provide habitat. Known occurrence approximately 4 miles north of San Luis Reservoir.	N/A	Moderate. The chaparral habitat within the Pacheco Reservoir Region provides habitat.
Lemmon's jewelflower	*Caulanthus lemmonii*	CRPR 1B.2	Pinyon-juniper woodland, valley and foothill grassland. Blooms February through May.	Moderate. Grasslands provide habitat. No CNDDB occurrences near San Luis Reservoir. No suitable habitat within study area.	N/A	Low. Suitable habitat is lacking in the Pacheco region. No known occurrences of this species within the Pacheco Reservoir Region.

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Lime Ridge navarretia	*Navarretia gowenii*	CRPR 1B.1	In rocky serpentine areas bordering chaparral. Blooms May through June.	Moderate. The chaparral provides habitat. Nearest occurrence is approximately 7 miles north of San Luis Reservoir.	N/A	Moderate; suitable chaparral habitat present within the Pacheco Reservoir Region.
Loma Prieta hoita	*Hoita strobilina*	CRPR 1B.1	Chaparral, cismontane woodland, riparian woodland. Blooms May through July.	N/A	Moderate. The chaparral, woodland, and riparian provide habitat. Nearest CNDDB occurrences near Lexington Reservoir and Santa Teresa County Park.	Low. Pacheco is outside the known range of this species. No known occurrences of this species within the Pacheco Reservoir Region.
Maple-leaved checkerbloom	*Sidalcea malachroides*	CRPR 4.2	Broad-leafed upland forest, coastal prairie, coastal scrub, north coast coniferous forest. Blooms April through August.	N/A	None. The SCVWD Service Area does not provide habitat. CNDDB occurrence is in Alum Rock.	Low. No suitable habitat present. No known occurrences of this species within the Pacheco Reservoir Region.
Metcalf Canyon jewelflower	*Streptanthus albidus* ssp. *albidus*	FE, CRPR 1B.1	Valley and foothill grassland, occasionally on serpentinite substrate. Blooms April through June.	N/A	Moderate. Grasslands provides habitat. CNDDB occurrences near Yerba Buena Road.	Moderate. No known occurrences of this species within the Pacheco Reservoir Region, however suitable habitat is present.
Most beautiful jewelflower	*Streptanthus albidus* ssp. *peramoenus*	CRPR 1B.2	Chaparral, valley and foothill grassland and cismontane woodland. Blooms April through September.	N/A	Moderate. The chaparral, woodland, and grassland provide habitat. Occurrences on ridge above Anderson Reservoir.	Moderate. The chaparral, woodland, and grassland provide habitat. Calflora occurrence outside Coe State Park. No known occurrences of this species within the Pacheco Reservoir Region.

Common Name	Scientific Name	Status	Habitat Requirements	Potential to Occur within the San Luis Reservoir Region[1]	Potential to Occur within the SCVWD Service Area[2]	Potential to Occur within the Pacheco Reservoir Region
Mt. Hamilton fountain thistle	*Cirsium fontinale* var. *campylon*	CRPR 1B.2	Cismontane woodland, chaparral, and valley and foothill grassland. Blooms April through October.	N/A	Moderate. The chaparral, oak woodland, and grassland provide habitat. CNDDB occurrences at Anderson Reservoir.	Moderate. The chaparral, oak woodland, and grassland provide habitat. No known occurrences of this species within the Pacheco Reservoir Region.
Mt. Hamilton jewelflower	*Streptanthus callistus*	CRPR 1B.3	Chaparral, cismontane woodland on open talus. Blooms April through May.	N/A	Moderate. The chaparral and oak woodland provide habitat. Nearest CNDDB occurrence in Henry Coe State Park	Moderate. The chaparral and oak woodland would provide habitat. No known occurrences of this species within the Pacheco Reservoir Region.
Pink creamsacs	*Castilleja rubicundula* ssp. *rubicundula*	CRPR 1B.2	Chaparral, meadows and seeps, valley and foothill grassland, on serpentine. Blooms April through June.	N/A	Moderate. The chaparral and grassland provide habitat. CNDDB occurrence on slopes above Anderson Reservoir.	Low. Moderate. The chaparral and grassland provide habitat. No known occurrences of this species within the Pacheco Reservoir Region.
Robust spineflower	*Chorizanthe robusta* var. *robusta*	FE, CRPR 1B.1	Cismontane woodland, coastal dunes, coastal scrub. Blooms April through September.	N/A	Moderate. The oak woodland provides habitat. CNDDB occurrences are documented for this species.	Low. Moderate. The oak woodland provides habitat. No known occurrences of this species within the Pacheco Reservoir Region.
Round-leaved filaree	*California macrophylla*	CRPR 1B.1	Cismontane woodland, grassland – clay soils; 15 – 1200m. Blooms March through May.	Moderate. Grasslands and oak woodland provide habitat. Nearest known occurrence is in Pacheco State Park.	N/A	Moderate. Grasslands and oak woodland provide habitat. No known occurrences of this species within the Pacheco Reservoir Region.
Saline clover	*Trifolium hydrophilum*	CRPR 1B.2	Marshes and swamps, valley and foothill grassland, vernal pools. Blooms April through June.	N/A	Moderate. The freshwater marsh wetlands associated with the open water and grassland provide habitat.	Moderate. Suitable grassland habitat is present within the Pacheco Reservoir Region.

Common Name	Scientific Name	Status	Habitat Requirements	Potential to Occur within the San Luis Reservoir Region[1]	Potential to Occur within the SCVWD Service Area[2]	Potential to Occur within the Pacheco Reservoir Region
San Francisco collinsia	*Collinsia multicolor*	CRPR 1B.2	Closed-cone coniferous forest, coastal scrub. Blooms March through May.	N/A	Moderate. The scrub provides habitat. CNDDB occurrence along Anderson Reservoir shoreline.	Low. Suitable habitat is not present. No known occurrences of this species within the Pacheco Reservoir Region.
Santa Clara Valley dudleya	*Dudleya abramsii* ssp. *setchellii*	FE, CRPR 1B.1	Valley and foothill grassland, cismontane woodland. Blooms April through October.	N/A	Moderate. Grasslands and oak woodland provide habitat. CNDDB occurrences near Anderson Reservoir.	Moderate. Suitable grassland and woodland habitat is present within the Pacheco Reservoir Region.
Santa Cruz Mountains beardtongue	*Penstemon rattanii* var. *kleei*	CRPR 1B.2	Chaparral, lower montane coniferous forest. Blooms May through June.	N/A	Moderate. The chaparral provides habitat. Nearest CNDDB occurrence is in Loma Prieta.	Low. Chaparral habitat is present, but site is outside the known range of this plant. No known occurrences of this species within the Pacheco Reservoir Region.
Santa Cruz Mountains pussypaws	*Calyptridium parryi* var. *hesseae*	CRPR 1B.1	Chaparral, cismontane woodland. Blooms May through August.	N/A	Moderate. The chaparral and oak woodland provide habitat. Nearest CNDDB occurrence is in Loma Prieta.	Moderate. The chaparral and oak woodland provide habitat. No known occurrences of this species within the Pacheco Reservoir Region.
Shining navarretia	*Navarretia nigelliformis* ssp. *radians*	CRPR 1B.2	Cismontane woodland, valley and foothill grassland, vernal pools. Apparently in grassland, and not necessarily in vernal pools. 200-1000m. Blooms April through July.	Moderate. The oak woodland and grassland provide habitat. Nearest known CNDDB occurrence is in Los Banos Valley in vicinity of Billy Wright Road.	N/A	Low. Not known to occur in the vicinity of the Pacheco Reservoir Region.

Common Name	Scientific Name	Status	Habitat Requirements	Potential to Occur within the San Luis Reservoir Region[1]	Potential to Occur within the SCVWD Service Area[2]	Potential to Occur within the Pacheco Reservoir Region
Smooth lessingia	*Lessingia micradenia* var. *glabrata*	CRPR 1B.2	Chaparral and cismontane woodland. Blooms July through November.	N/A	Moderate. The chaparral and oak woodland provide habitat for this species. CNDDB occurrence near Anderson Reservoir.	Moderate. Suitable woodland and chaparral habitat is present within the Pacheco Reservoir Region.
Spiny-sepaled button-celery	*Eryngium spinosepalum*	CRPR 1B.2	Vernal pools, valley and foothill grassland; 80-255 m. Blooms April through June.	High. Alkali pools southeast of the reservoir could support this species. RecentCalflora occurences on west side of San Luis Reservoir.	N/A	Low. Not known to occur in the vicinity of the Pacheco Reservoir Region.
Tiburon paintbrush	*Castilleja affinis* ssp. *neglecta*	FE, ST, CRPR 1B.2	Valley and foothill grassland on rocky and serpentine sites. Blooms April through June.	N/A	Moderate. Grasslands provides habitat. CNDDB occurrences on ridge above Anderson Reservoir.	Low. Project area has suitable grassland habitat but is at the edge of known range for this species.
Woodland woollythreads	*Monolopia gracilens*	CRPR 1B.2	Chaparral, valley and foothill grasslands (serpentine), cismontane woodland, broadleafed upland forests, north coast coniferous forest. Blooms March through July.	N/A	Moderate. The chaparral, grassland, and oak woodland provide habitat for this species. Nearest CNDDB occurrences may be near Anderson Reservoir.	Moderate. Suitable chaparral, grassland, and oak woodland habitat is present within the Pacheco Reservoir Region.

Source: CDFW 2018, Reclamation and CDPR 2013.

[1] Regionally occurring special-status species based on occurrences within the Howard Ranch, Crevison Peak, San Luis Dam, Pacheco Pass, Pacheco Peak, Three Sisters, Mariposa Peak, Los Banos Valley, and Mustang Peak 7.5-minute USGS quadrangles..

[2] Regionally occurring special-status species documented within the San Jose West, San Jose East, Calaveras Reservoir, Los Gatos, Santa Teresa Hills, Morgan Hill, Cupertino and Mt. Sizer 7.5-minute USGS quadrangles

Key:

Federal (U.S. Fish and Wildlife Service):

BGEPA = Bald and Golden Eagle Protection Act
FE = Listed as Endangered by the Federal Government
FT = Listed as Threatened by the Federal Government
FPE = Proposed for Listing as Endangered
FPT = Proposed for Listing as Threatened
FD = Federal Delisted Species
FC = Candidate for Federal listing

State (California Department of Fish and Wildlife):

SE = Listed as Endangered by the State of California
ST = Listed as Threatened by the State of California
SC = Candidate for State listing
SR = Listed as Rare by the State of California (plants only)
CSC = California species of special concern
CFP = California fully protected species

California Rare Plant Rank:

CRPR 1A – Species considered extinct in California
CRPR 1B – Rare and endangered in California and elsewhere
CRPR 2 – Species considered rare and endangered in California but more common elsewhere
0.1 – Seriously threatened
0.2 – Fairly threatened in California
0.3 – Not very threatened in California

M2.2.3 Special-Status Species Accounts

A brief description of those special-status plant and wildlife species that occur or have the potential to occur within the San Luis Reservoir Region or in the SCVWD Service Area based on local sightings and/or the potential presence of suitable habitat (but that may not necessarily be impacted by the project), is provided below.

M2.2.3.1 Invertebrates

Federal or State Threatened and Endangered Species

Valley Elderberry Longhorn Beetle The valley elderberry longhorn beetle was listed as federally threatened in 1980 (45 FR 52803). The valley elderberry longhorn beetle is dependent on its host plant, elderberry (*Sambucus* spp.), which is a common component of the remaining riparian forest of the Central Valley. The amount and distribution of suitable habitat for the valley elderberry longhorn beetle has been reduced by the extensive destruction of California's Central Valley riparian forest that has occurred during the last 150 years due to agricultural and urban development (USFWS 2009). Loss of non-riparian habitat where elderberry occurs (e.g., savanna and grassland adjacent to riparian habitat, oak woodland, mixed chaparral-woodland), and where the beetle has been recorded, suggests further reduction of the beetle's range and increased fragmentation of its upland habitat.

In 2018 surveys, a large elderberry stand was identified in the project area northwest of Basalt Quarry, numbering greater than 25 shrubs (Appendix I). No valley elderberry longhorn beetle activity was noted; however, due to the dense vegetation, not all shrubs were examined. In addition, four smaller stands were noted nearby, comprising a total of about 10 shrubs. A single elderberry shrub was found several feet outside the project area, at the sewage holding ponds located 0.5-mile northeast of the Basalt Campground. Other portions of the project area were not surveyed.

The CNDDB includes a valley elderberry longhorn beetle occurrence near the San Luis Reservoir Region, approximately one mile from Los Banos Creek Reservoir. In 1987, two valley elderberry longhorn beetles were collected along Los Banos Creek, approximately 6 miles southeast of San Luis Reservoir (CDFW 2016).

The elderberry shrubs within the San Luis Reservoir Region provide habitat for valley elderberry longhorn beetle. Valley elderberry longhorn beetle is not documented within the SCVWD Service Area. The species has not been documented within the Pacheco Reservoir Region, which is considered outside of the species' range.

Bay Checkerspot Bay checkerspot is federally listed as threatened in 1987 (52 FR 35366). It was federally listed as threatened in 1987. This species occurs

from sea level to treeline within coastal chaparral, meadows, fields, foothills, open woods, and alpine fellfields. Adult butterflies emerge in early spring. The adults emerge during a six-week period from late February to early May. The eggs are deposited at the base of the dwarf plantain plant or less frequently the owl's clover or paintbrush, host plants for larvae.

Bay checkerspot is not documented within the San Luis Reservoir Region.

The chaparral and oak woodland within the SCVWD Service Area provide habitat for this species.

This species has not been documented within the Pacheco Reservoir Region.

Vernal Pool Fairy Shrimp Vernal pool fairy shrimp was listed as federally threatened in 1994 (59 FR 48136). Vernal pool fairy shrimp are found in vernal pools, swales, and ephemeral freshwater habitats. This species is most commonly found in grass or mud bottomed pools or basalt flow depressional pools in unplowed grasslands. The pools vary in size from very small (200 square feet) to very large (25 acres).

Vernal pool fairy shrimp is not documented within the San Luis Reservoir Region. However, pools and seasonal wetlands provide suitable habitat for this species. Four pool areas were identified in 2018 surveys that may support vernal pool fairy shrimp. One alkali pool is located on grasslands near the dam face, and three occur in grasslands north of the California Department of Water Resources (DWR) administration buildings, between the dam and the forebay. One of these features was mapped as a seasonal wetland in the 2018 wetland delineation and the other three features are non-wetland areas (ESA 2018). Other portions of the project area were not surveyed.

Potentially occurring vernal pools and seasonal wetlands provide habitat for this species. Vernal pool fairy shrimp is not documented within the SCVWD Service Area. This species has not been documented within the Pacheco Reservoir Region.

Vernal Pool Tadpole Shrimp Vernal pool tadpole shrimp was listed as federally endangered in 1994 (59 FR 48136). Vernal pool tadpole shrimp are found in natural and artificial seasonally ponded habitats including vernal pools, swales, ephemeral drainages, stock ponds, reservoirs, ditches, backhoe pits, and ruts caused by vehicular activities. Wetlands range from very small (2 square meters) to very large (356,253 square meters).

Vernal pool tadpole shrimp is not documented within the San Luis Reservoir Region. However, they have potential to occur within suitable pools and seasonal wetlands in the area, which provide habitat for this species. Four pool areas were identified that may support vernal pool tadpole shrimp during 2018 surveys. One alkali pool is located on grasslands near the dam face, and three

in grasslands north of the DWR administration buildings (ESA 2018). Other portions of the project area were not surveyed.

Vernal pool tadpole shrimp is not documented within the SCVWD Service Area. Potentially occurring vernal pools and seasonal wetlands provide habitat for this species. Potentially occurring vernal pools and seasonal wetlands provide habitat for this species. This species has not been documented within the Pacheco Reservoir Region.

M2.2.3.2 Amphibians

Federal or State Threatened and Endangered Species

California Tiger Salamander California tiger salamander Central California Distinct Population Segment (DPS) is a Federal and State listed threatened species. California tiger salamander was federally listed as threatened in 2004 (69 FR 47212). California tiger salamander spend the majority of the year in underground burrows in grassland, savanna, or open woodland habitat. Between December and February, when seasonal ponds begin to fill, adult California tiger salamanders engage in mass migrations to aquatic sites during a few rainy nights and are explosive breeders (Barry and Shaffer 1994). Breeding ponds include shallow ephemeral or semi-permanent pools and ponds. Eggs are laid on submerged stems and leaves. Eggs take approximately two weeks to hatch. California tiger salamander larvae take approximately four months to metamorphose into adults. The breeding ponds need to hold water for a minimum of 4.5 months in order for California tiger salamander to complete its aquatic life cycle.

During drought years when ponds do not form, adults may spend the entire year in upland environments, while juveniles may spend 4 to 5 years in their upland burrows before reaching sexual maturity and breeding for the first time (Petranka 1998; Trenham et al. 2000). Adult tiger salamanders swiftly disperse after breeding and have been documented to migrate up to 129 meters (423 feet) the first night after leaving a breeding pond (Loredo et al. 1996). Adult California tiger salamanders readily aestivate[1] in grasslands near ponds and at great distances from breeding ponds. Adults are known to travel distances greater than 1 kilometer (0.62 mile) from breeding ponds and have been documented at distances of 2 kilometers (1.2 miles) or more (Orloff 2007). Typical aestivation sites include the burrows of California ground squirrels and valley pocket gophers (*Thomomys bottae*).

There are three CNDDB records over 2.5 and 4 miles from San Luis Reservoir. Critical habitat is designated for California tiger salamander approximately one mile southeast of San Luis Reservoir and approximately 2.5 miles from the construction gravel pit area (Figure M1-6) (USFWS 2016). San Luis Reservoir Region may provide suitable breeding habitat within the freshwater emergent

[1] Aestivation is a state of dormancy similar to hibernation that occurs during summer and fall.

and seasonal wetlands. Grassland provides upland habitat for California tiger salamander.

During 2018 surveys, one potential low-to-moderate quality California tiger salamander breeding pond was identified within the project area near the Basalt Quarry. Two additional potential breeding ponds were identified within 1 mile southeast of the quarry that could support breeding and serve as a source for species movement into the project area. Hence, California tiger salamander may be encountered in select areas south of the reservoir (ESA 2018). Aquatic habitat that may support breeding may occur in other portions of the project area.

Aquatic breeding habitat is present within the SCVWD Service Area. Grassland provides upland habitat for California tiger salamander. Suitable breeding and upland habitat for California tiger salamander is present in ponds and grassland within the Pacheco Reservoir Region.

California Red-Legged Frog California red-legged frog is a Federally-listed threatened species and California species of special concern. California red-legged frog was listed as federally threatened in 1996 (61 FR 25813). Critical habitat was designated in 2006 (71 FR 19244) and finalized in 2010 (75 FR 12816). They occur at ponds and slow-moving streams with permanent or semipermanent water. This species opportunistically migrates into upland habitats, up to 1.3 miles during normal dispersal behavior. The California red-legged frog may aestivate in upland environments when aquatic sites are unavailable or environmental conditions are inhospitable. If water is unavailable, they shelter from dehydration in a variety of refuges, including boulders, downed wood, moist leaf litter, and small mammal burrows. California red-legged frogs disperse up to one mile from their breeding habitat through upland habitat (USFWS 2002).

There are several CNDDB occurrences documented for California red-legged frogs within the western portion of the San Luis Reservoir Region. California red-legged frogs inhabit stock ponds within Pacheco State Park to the west of the reservoir and within the Upper Cottonwood Wildlife Area to the north of the reservoir.

Critical habitat is designated along the western boundary of the San Luis Reservoir. According to the primary constituent elements associated with the critical habitat designation, critical habitat for the California red-legged frog includes only aquatic and upland areas where suitable breeding and nonbreeding habitats are interspersed throughout the landscape and are interconnected by unfragmented dispersal habitat (50 CFR 17) (Figure M1-6).

During the 2018 surveys, a robust California red-legged frog breeding population was identified at a vegetated pond fed by Willow Spring, approximately 0.3-mile south of the reservoir, off the quarry access road. This

location is on the fringe of the designated borrow area. Habitat for this species was also identified outside of the project area in a spring-fed stock pond located approximately 0.6-mile northwest of the Basalt Hill summit. Adjacent uplands to 1.3 miles provide dispersal and aestivation habitat. Additional freshwater emergent and seasonal wetlands in the San Luis Reservoir Region may provide suitable breeding habitat and grasslands provide upland refugia and overland movement habitat for California red-legged frog. California red-legged frog are not expected to be encountered near Basalt Campground, below the dam, nor at the Medeiros Use Area (ESA 2018).

The reservoirs do not provide breeding habitat for California red-legged frogs due to fluctuations in water levels, lack of suitable egg-laying emergent vegetation, and abundant populations of nonnative fish that prey on this species. However, freshwater emergent and seasonal wetlands in the region may provide additional suitable breeding habitat and grasslands provide upland refugia and overland movement for California red-legged frog.

CNDDB occurrences are documented for California red-legged frog within the SCVWD Service Area. The ponds and permanent and intermittent drainages within the SCVWD Service Area provide aquatic habitat for California red-legged frog. The riparian forest in the vicinity of the drainages provides upland habitat for this species. The riverine pond and associated riparian habitat within the Pacheco Reservoir Region provide suitable habitat , and the Pacheco region is designated critical habitat for this species.

State Species of Special Concern

Foothill Yellow-Legged Frog Foothill yellow-legged frog is a California species of special concern and is a Candidate for listing under the federal Endangered Species Act. Foothill yellow-legged frog inhabit shallow, small to medium sized permanent streams with cobble substrates, beneath which they deposit their eggs, from sea level to 6,000 feet (Jennings and Hayes 1994).

Foothill yellow-legged frog has been recorded along the western end of Los Banos Creek over five miles southeast of San Luis Reservoir (CDFW 2016). Although CNDDB occurrences are documented in the vicinity, no permanent streams occur in the vicinity of the reservoirs.

A CNDDB record is documented for Foothill yellow-legged frog within the SCVWD Service Area. The permanent drainages provide habitat for this species.

Riverine habitat present in the Pacheco Reservoir Region may provide habitat for this species. There are multiple CNDDB documented occurrences of this species in streams within the Pacheco Reservoir Region.

M2.2.3.3 Reptiles

Federal or State Threatened and Endangered Species

Alameda Whipsnake Alameda whipsnake is a federally and state threatened. Alameda whipsnake was listed as federally threatened in 1997 (62 FR 64306). This species is found in chaparral, scrubland, open woodlands, rocky hillsides, foothills, and in higher-elevation mixed woodlands. This species lives underground or under cover when inactive. This species is mostly active from March through November. This species is known from Alameda, Contra Costa, San Joaquin, Santa Clara, and Stanislaus counties.

The San Luis Reservoir Region occurs outside of the known geographic range for this species.

Although not identified within the SCVWD Service Area, CNDDB occurrences are considered sensitive for this species. CNDDB occurrences are identified within the Eylar Mountain, Mount Day, and Calaveras Reservoir quadrangles, which are located within the northeastern boundary of the SCVWD Service Area. The chaparral, scrub, and oak woodland provide habitat for this species.

There are no documented occurrences of this species in the vicinity of the Pacheco Reservoir Region, which is considered to be beyond this species' range.

State Species of Special Concern

Western Pond Turtle Western pond turtle is a California species of special concern. They are commonly found in ponds, lakes, marshes, rivers, streams, and irrigation ditches with rocky or muddy substrates surrounded by aquatic vegetation. These watercourses usually are within woodlands, grasslands, and open forests, between sea level and 6,000 feet. Western pond turtles bask on logs or other objects when water temperatures are lower than air temperatures. Nests are located at upland sites ,up to 0.25-mile from an aquatic site (Jennings and Hayes 1994; Stebbins 2003; Zeiner et al. 1988–1990).

Western pond turtle has not been documented within San Luis or O'Neil Forebay reservoirs, but there are numerous occurrences from stock ponds and drainages within Pacheco State Park, San Luis Wildlife Area, and further to the west in the hills (CDFW 2016). The reservoirs and spring-fed ponds provide marginal aquatic habitat for this species. Grasslands in the vicinity of the reservoirs may provide upland basking and nesting habitat for this species.

CNDDB records are documented for this species within the SCVWD Service Area. The permanent and intermittent drainages and lakes, reservoirs, and groundwater recharge ponds associated with the wetlands and open water provide aquatic habitat for this species.

The Pacheco Reservoir Region provides suitable aquatic and upland habitat for this species.

San Joaquin Whipsnake San Joaquin whipsnake is a California species of special concern. They use open, dry areas with little or no tree cover. In the western San Joaquin Valley, they occur in valley grassland and saltbush scrub. They use small mammal burrows for refuge and egg-laying (Jennings and Hayes 1994). San Joaquin whipsnakes range from the eastern edge of the San Joaquin Valley from Colusa County southward to Kern County and into the inner South Coast Ranges, with an isolated population in the Sutter Buttes.

Occurrences of the San Joaquin whipsnake have been recorded from the mid to late 1980s around Los Banos Creek Reservoir over five miles to the southeast of San Luis Reservoir (CDFW 2016). The grassland and scrub provide habitat for this species within the San Luis Reservoir Region.

The SCVWD Service Area occurs outside of the known geographic range for this species.

The Pacheco Reservoir Region occurs outside the known geographic range for this species.

Coast Horned Lizard Coast horned lizard is a California species of special concern. This species occurs in several habitat types, ranging from areas with an exposed gravelly-sandy substrate containing scattered shrubs, clearings in riparian woodlands, chaparral, annual grassland with scattered perennial seepweed or saltbush, and sandy washes.

There are no CNDDB occurrences for Coast horned lizard within 10 miles of the San Luis Reservoir Region. The grassland and chaparral within the San Luis Reservoir Region provides habitat for this species.

CNDDB occurrences for Coast horned lizard occur within the SCVWD Service Area. The grassland within the SCVWD Service Area provides habitat for this species.

There are CNDDB documented occurrences of this species in the vicinity of the Pacheco Reservoir Region. The grassland provide habitat for this species.

M2.2.3.4 Birds

Federal or State Threatened and Endangered Species

Swainson's Hawk Swainson's hawks are a State-listed threatened species. They are large migratory hawks that nest in North America and winter in Central and South America. Swainson's hawks begin arriving in California in late February and depart for their wintering grounds in early September (Woodbridge 1998). Nests are typically constructed in sturdy trees within or

near agricultural lands, riparian corridors, and roadside trees. Nests are composed of a platform of sticks, bark, and fresh leaves. Swainson's hawks reside in the Central Valley from March through October, with eggs typically laid in April and early May (peaking in late April). This species is known from Alameda, Butte, Colusa, Contra Costa, Fresno, Glenn, Inyo, Kern, Kings, Lassen, Los Angeles, Madera, Merced, Modoc, Mono, Napa, Placer, Plumas, Sacramento, San Bernardino, San Joaquin, San Luis Obispo, Siskiyou, Solano, Stanislaus, Sutter, Tehama, Tulare, Yolo, and Yuba counties.

There are several CNDDB records documented for Swainson's hawk within the San Luis Reservoir Region. A Swainson's hawk was observed circling over the grasslands between San Luis Reservoir and O'Neil Forebay during a 2016 field survey (ESA 2016). Since 2011, several active nests has been documented at the CDFW O'Neill Forebay Wildlife Area, approximately 0.5 mile north of identified staging areas, with nesting also reported in 2006 at sites in the San Luis Reservoir Region near Sisk Dam. The grassland provides foraging habitat and the trees in the riparian and oak woodland provide suitable nesting habitat.

The SCVWD Service Area occurs outside of the geographic range for this species.

The Pacheco Reservoir Region is outside the known geographic range of this species.

California Condor – California condors are a state and federally listed species. California condor was federally listed as endangered in 1967 (32 FR 4001). They nest on the floors of cliff cavities or caves and in crevices among boulders on steep slopes at elevations from 1,968 to 3,281 feet. California condors forage within grasslands, oak savannas, mountain plateaus, ridges, and canyons, usually within 70 kilometers of the nest.

While no CNDDB records have been documented within the San Luis Reservoir Region, the annual grassland provides foraging habitat for California condors.

There are no CNDDB records for this species within the SCVWD Service Area.

There are no CNDDB records for this species in the Pacheco Reservoir Region.

Bald Eagle Bald eagles are State-listed as endangered and fully protected, and are protected by the Federal Bald and Golden Eagle Protection Act. They occupy a wide range of habitats, including woodlands, forests, grasslands, and wetlands. They winter throughout California near lakes, reservoirs, rivers, and some rangelands and coastal wetlands. Nesting is usually restricted to mountainous habitats near reservoirs, lakes, and rivers in northern California. Bald eagles usually nest in large coniferous trees within 1 mile of permanent water. They forage on large water bodies or rivers with easily approached snags and other perches (Zeiner et al. 1988–1990).

Bald eagles have not been documented to nest around San Luis Reservoir Region. One adult bald eagle was observed flying over B.F. Sisk Dam during 2018 field surveys, and one was observed along Pacheco Creek approximately five miles west of the reservoir during a summer 2016 field visit. The San Luis Reservoir Region provides wintering and potential nesting habitat for this species; however, nesting has not been recorded from the San Luis watershed (CDFW 2018).

There are no CNDDB records for this species within the SCVWD Service Area.

There is a single CNDDB record for this species within the Pacheco Reservoir Region.

Tricolored Blackbird Tricolored blackbird has no federal status and is listed as threatened under California Endangered Species Act (CESA). Tricolored blackbirds are a colonial species that nest in dense vegetation in and around freshwater wetlands. When nesting, tricolored blackbirds generally require freshwater wetland areas large enough to support colonies of 50 pairs or more. They prefer freshwater emergent wetlands with tall, dense cattails or tules for nesting, but will also breed in thickets of willow, blackberry, wild rose, or tall herbs. During the nonbreeding season, flocks are highly mobile and forage in grasslands, croplands, and wetlands (Zeiner et al. 1988–1990).

There are CNDDB records documented for tricolored blackbird within the San Luis Reservoir Region. The grassland provides foraging habitat and the cattail marsh riparian vegetation provides suitable nesting habitat.

There are CNDDB records documented for tricolored blackbird within the SCVWD Service Area. The grassland provides foraging habitat and the freshwater marsh wetlands associated with the open water habitat may provide nesting habitat.

There are CNDDB records documented for tricolored blackbird within the Pacheco Reservoir Region. The grassland provides foraging habitat and freshwater marsh wetlands associated with open water may provide nesting habitat.

State Fully Protected

Golden Eagle Golden eagles are fully protected in California and protected by the Federal Bald and Golden Eagle Protection Act. Golden eagle foraging habitat consists of relatively open habitat types such as; open-country grassland, prairie, savanna, shrub-steppe, desert, and tundra. This species is known to occur where there are dense populations of ground squirrels and black-tailed jackrabbits. Nesting habitat for this species includes cliffs, other elevated rocky substrates, and large and mature oak trees or eucalyptus. Within their nesting territory golden eagles may have up to twelve alternate nest structures that are maintained every year even though they may favor one nest several years in a

row. The population of golden eagles in California are mostly sedentary and do not migrate in the winter (USFWS 2013).

CNDDB occurrences of nesting golden eagles are documented within five miles of the northern portion of San Luis Reservoir. The trees within the oak woodland along the steep slopes provide nesting habitat and grasslands provide foraging habitat within the San Luis Reservoir Region.

There are no CNDDB records for this species within the SCVWD Service Area, however, this species is known to nest in Alum Rock Park within the eastern portion of the SCVWD. This species has the potential to nest within the SCVWD.

There are no CNDDB records for this species within the Pacheco Reservoir Region; however, suitable nesting and foraging habitat are present within the area.

American Peregrine Falcon American peregrine falcon are fully protected in California. They nest on ledges or holes on the faces of rocky cliffs or crags located near wetlands, lakes, rivers, or other waters. They also nest in man-made sites including tall buildings, bridges, rock quarries, and raised platforms.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

A CNDDB record documents this species nesting on the San Jose City Hall building. The wetlands and open water habitat and structure associated with developed areas provide nesting habitat within the SCVWD Service Area.

There are no CNDDB records of this species within the Pacheco Reservoir Region, but the species is likely to occur in suitable habitat.

White-Tailed Kite White-tailed kites are fully protected in California. They forage in open grasslands, meadows, farmlands, and emergent wetlands. They typically nest in oak woodlands or trees, especially along marsh or river margins, although they will use any suitable tree or shrub that is of moderate height. They are rarely found far from agricultural areas (Zeiner et al. 1988–1990).

There are no CNDDB records documented for white-tailed kites within 10 miles of the San Luis Reservoir Region. The trees surrounding the San Luis Reservoir Region provide nesting habitat.

Several CNDDB records are documented for white-tailed kite within the SCVWD Service Area. Numerous trees in the area provide potential nesting habitat for this species.

There are no CNDDB records for this species in the Pacheco Reservoir Region, but suitable nesting habitat is present.

State Species of Special Concern

Western Burrowing Owl Western burrowing owls are a California species of special concern. They are residents of open dry grassland and desert. They occupy burrows for both breeding and roosting. They use burrows excavated by ground squirrels and other small mammals and will use human-made burrows and cavities. Where the number and availability of natural burrows is limited, owls may occupy human-made burrows such as drainage culverts, cavities under piles of rubble, discarded pipe, and other tunnel-like structures (Zeiner et al. 1988–1990).

There are CNDDB records documented for western burrowing owl within the San Luis Reservoir Region. Several burrowing owls were observed just east of San Luis Recreation Area during the 2016 surveys. The burrows within grasslands and ruderal habitat provide nesting and roosting habitat for this species.

There are CNDDB records documented for western burrowing owl within the SCVWD Service Area. The burrows within grassland areas provide nesting and roosting habitat for this species.

There are CNDDB records for western burrowing owl within the Pacheco Reservoir Region. The burrows within grasslands may provide nesting and roosting habitat for this species.

Northern Harrier Northern harriers are a California species of special concern. They are found in a wide variety of habitats from annual grasslands up to lodgepole pines and alpine meadow habitats. They are known to frequent meadows, grasslands, open rangelands, desert sinks, and freshwater and saltwater emergent wetlands. Harriers are seldom found in wooded areas. Nests are constructed amid shrubby vegetation usually in emergent wetlands or near a river or lake. They may also nest in grasslands, grain fields, or sagebrush flats several miles from water (Zeiner et al. 1988–1990). Northern harriers are commonly observed foraging over croplands, marshlands, or grasslands within the project region.

There are CNDDB records documented for northern harrier within the northern portion of the San Luis Reservoir Region. The freshwater emergent marsh and grassland provide nesting habitat for this species. There are no CNDDB records for this species within the SCVWD Service Area. There is a CNDDB record for this species within the Pacheco Reservoir Region.

Migratory Bird Treaty Act (MBTA) and §3503.5 Fish and Game Code
Nests of migratory birds and other birds of prey are protected under 50 CFR 10 of the MBTA and/or Section 3503 of the California Fish and Game Code. The generally accepted nesting season is from February 1 to August 31.

The San Luis Reservoir Region provides habitat for nesting birds in all habitat types.

The SCVWD Service Area provides habitat for nesting birds in all habitat types.

The Pacheco Reservoir Region provides habitat for nesting migratory birds in all habitat types.

M2.2.3.5 Mammals

Federal or State Threatened and Endangered Species

San Joaquin Kit Fox San Joaquin kit fox are Federally-listed as endangered and State-listed as threatened. San Joaquin kit fox was federally listed as endangered in 1967 (32 FR 4001). They are a permanent resident of arid grasslands and open scrubland, where friable soils are present. Dens are required year-round for reproduction, shelter, temperature regulation, and protection from predators (USFWS 1998). Historically their habitat included native alkali marsh and saltbush scrub of the valley floor, but the availability of such habitats has diminished markedly due to agricultural conversion. Grasslands with friable soils are considered the principal habitat for denning, foraging, and dispersal, while open oak woodlands provide lower quality foraging and dispersal habitat. Prior to 1930, San Joaquin kit foxes inhabited most of the San Joaquin Valley from southern Kern County to northern San Joaquin County. The current range is thought to cover less than half of the original area, with the largest portion of the range remaining in the southern and western parts of the San Joaquin Valley (USFWS 1998).

North of Kern County, San Joaquin kit foxes primarily occur in a narrow north-south band bordered by I-5 and the Coast Range. A low-density kit fox population is found on lands just south of Santa Nella, which may be augmented from dispersers from the Panoche Valley kit fox population to the south. San Joaquin kit foxes were documented in the vicinity on numerous occasions during the 1970s through the 1990s (CDFW 2016). Three observations of kit foxes were made in 2005 on Billy Wright Road, which is between San Luis Reservoir and Los Banos Creek Reservoir. No observations in the vicinity have been recorded in the CNDDB since December 2005. However, a habitat evaluation for kit fox in 2010 found one known den (with kit fox tracks) and 194 potential kit fox dens within the B.F. Sisk project boundary, similar to the current area of analysis (Reclamation 2010). The species was not observed during 2018 field surveys. The project area grassland provides suitable denning, dispersal, and foraging habitat within the San Luis Reservoir Region.

A CNDDB record of San Joaquin kit fox is located within the vicinity of Anderson Lake, within the SCVWD Service Area. Grasslands provides habitat for this species.

There are CNDDB documented occurrences for San Joaquin kit fox within the Pacheco Reservoir Region and neighboring watersheds, and suitable habitat is potentially present in grasslands within the inundation footprint.

State Fully Protected

Ringtail The ringtail is a fully protected species. This species is found from northern Oregon down through California except the agricultural portion of the Central Valley. They are found in dense riparian growth, montane evergreen forests, oak woodlands, pinyon juniper, chaparral, and deserts. Their territory is usually no farther than ½ mile away from a permanent water source and they find reproductive and resting cover in hollow trees, logs, snags, rocks, and abandoned burrows (CDFW 1995).

There are no CNDDB occurrences for this species within the San Luis Reservoir Region, SCVWD Service Area, or Pacheco Reservoir Region. The oak woodland, chaparral, and riparian provide habitat in these areas provide habitat for this species.

State Species of Special Concern

Bats including Pallid Bat, Townsend's Big-Eared Bat, Western Red Bat, and Greater Western Mastiff Bat Several bats are California species of special concern. Day roosts occur in rock crevices, unoccupied buildings, hollows in large trees, and under bridges.

Pallid bats are a California species of special concern. They inhabit low elevation (< 6,000 feet) rocky arid desert lands and canyonlands, shrub-steppe grasslands, and higher elevation coniferous forests (> 7,000 feet). Pallid bats roost in rock crevices, unoccupied buildings, hollows in large trees, and under bridges. They are most abundant in xeric (dry) ecosystems, including the Great Basin, Mojave, and Sonoran Deserts (Western Bat Working Group 2016).

Western red bat is a California species of special concern. This species is associated strongly with riparian areas, particularly mature stands of cottonwood and sycamore, and may also be found in orchards. Western red bats range through the Central Valley, southern Coast Range, Salinas Valley and San Francisco Bay area (Pierson *et al.*, 2006).

There are no CNDDB occurrences for any rare bats within 10 miles of the San Luis Reservoir Region. However, trees within several habitat types provide roosting habitat for this species within the San Luis Reservoir Region. Three species of bat [Yuma myotis (*Myotis yumanensis*), Mexican free-tailed bat (*Tadarida brasiliensis*), and the western red bat], were recorded in the project

area during 2018 field surveys, and roosting habitat was present in a concrete structure for Yuma myotis and Mexican free-tailed bat (ESA 2018).

A CNDDB record is documented for Pallid bat within the SCVWD Service Area. The trees within the several habitat types in the SCVWD Service Area provide roosting habitat for this species, as well as other species of bats.

There is a CNDDB record for Pallid bat within the Pacheco Reservoir Region. Other bat species are also likely to occur and to roost within trees and structures in this region.

American Badger American badger is a California species of special concern. In California, American badgers occupy a diversity of habitats. Grasslands, savannas, and mountain meadows near the timberline are preferred, though they can be found in deserts as well. The principal requirements seem to be sufficient food, friable soils, and relatively open, uncultivated ground.

CNDDB occurrences are documented for American badger within the San Luis Reservoir Region. This species was observed during 2018 field surveys near the junction of Basalt Road and Gonzaga Road and a badger skull was found in the cattail marsh below the dam (ESA 2018). American badgers are documented within the SCVWD Service Area and Pacheco Reservoir Region. Grasslands in these areas provide habitat for this species.

Managed as Big Game Mammals

Tule Elk Though not a Federal or State special-status species, tule elk are a notable wildlife feature within the San Luis Reservoir Region. This species inhabits native grass, and forb, and perennial bunch grass areas in valley floor and surrounding foothills and oak woodland.

Approximately half a million tule elk were distributed throughout the Sacramento and San Joaquin valleys and the oak-woodlands and oak-grasslands of the Coast Range at the time the early European explorers arrived. By the 1860s, the population was nearly extirpated due to market hunting, competition from introduced livestock, conversion of perennial grasslands to annual grasslands, and the change of large amounts of their habitat to agricultural land use (Reclamation and CDPR 2013).

In the early 1990s, as part of a continuing effort to expand the tule elk population throughout its historic range, CDFW reintroduced tule elk to a private ranch (Wild Rose Ranch) on the southwest side of San Luis Reservoir. The population has slowly increased to the upper 200s, with over half of the elk spending most of their time in Pacheco State Park. This group generally stays west of a line between Dinosaur Point to south of Portuguese Cove. When the water level in San Luis Reservoir is low and there is green vegetation along the shoreline, these individuals will move down to the reservoir from Pacheco State Park (Reclamation and CDPR 2013).

Tule Elk do not occur within the SCVWD Service Area or Pacheco Reservoir Region.

M2.2.3.6 Plants

Federal or State Threatened and Endangered Species

Tiburon Paintbrush Tiburon paintbrush is listed as Federally-listed endangered, State-listed threatened, and has a California Rare Plant Rank of 1B. Tiburon paintbrush was federally listed as endangered in 1995 (60 FR 6671). Tiburon paintbrush is a hemiparasitic perennial herb found in valley and foothill serpentine grassland. This species blooms from April through June.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the Anderson Reservoir within the SCVWD Service Area. Grasslands provides habitat for this species.

There are no CNDDB records for this species in the Pacheco Reservoir Region.

Contra Costa Goldfields Contra Costa goldfields is listed as Federally-listed endangered and has a California Rare Plant Rank of 1B. Contra Costa goldfields was federally listed as endangered in 1997 (62 FR 33029). This species is an annual found in vernal pools, cismontane woodland, valley and foothill grassland, and alkaline playa habitats. The blooming period for this species is from March to June.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. The grassland and oak woodland provide habitat for this species.

There are no CNDDB records for this species in the Pacheco Reservoir Region.

Coyote Ceanothus Coyote ceanothus is Federally-listed endangered and has a California Rare Plant Rank of 1B. Coyote ceanothus was federally listed as endangered in 1995 (60 FR 6671). This species is found in chaparral, coastal scrub, and valley and foothill grassland, and has an affinity for serpentine soils (California Native Plant Society [CNPS] 2018).

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. The grassland, chaparral and oak woodland provide habitat for this species.

There are no CNDDB records for this species around the Pacheco Reservoir Region.

Robust Spineflower Robust spineflower is Federally-listed endangered and has a California Rare Plant Rank of 1B. Robust spineflower was federally listed as endangered in 1994 (59 FR 5499). This species is an annual herb usually found on sandy or gravelly substrate in chaparral, cismontane woodland, coastal dunes, and coastal scrub. The blooming period for this species is from April through September.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. The oak woodlands provide habitat for this species.

There are CNDDB records for this species within the Pacheco Reservoir Region.

Metcalf Canyon Jewelflower Metcalf Canyon jewelflower is federally endangered and has a California Rare Plant Rank of 1B. Metcalf Canyon jewelflower was federally listed as endangered in 1995 (60 FR 6671). Metcalf Canyon jewelflower is an annual herb found in valley and foothill grassland, occasionally on serpentinite substrate. This species blooms from April through July.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. Grasslands provides habitat for this species.

There are no CNDDB records for this species within the Pacheco Reservoir Region.

Santa Clara Valley Dudleya Santa Clara Valley dudleya is Federally-listed endangered and has a California Rare Plant Rank of 1B. Santa Clara Valley dudleya was federally listed as endangered in 1995 (60 FR 6671). This species is found on rocky, serpentinite substrate within cismontane woodland and valley and foothill grassland. The distribution of this species is generally limited to southern Santa Clara County.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. The grassland and oak woodland provide habitat for this species.

There are CNDDB records for this species within the Pacheco Reservoir Region.

California Rare Plant Rank Species

Arcuate Bush-Mallow Arcuate bush-mallow has a California Rare Plant Rank of 1B. This species is found in chaparral and cismontane woodland. The blooming period for this species is from April through September.

There is one CNDDB record for this species within 10 miles of the San Luis Reservoir Region. Chaparral areas provide potential habitat for this species.

There are CNDDB occurrences for this species within the SCVWD Service Area. Chaparral areas provide potential habitat for this species.

There are no CNDDB records for this species within the Pacheco Reservoir Region.

Big-Scale Balsamroot Big-scale balsamroot has a California Rare Plant Rank of 1B. This species is a perennial herb sometimes found on serpentinite soils in chaparral, cismontane woodland, and valley and foothill grassland. The blooming period for this species is from March through June.

There are CNDDB records for this species within 10 miles of the San Luis Reservoir Region. The grassland and oak woodland provide habitat.

There are CNDDB occurrences for this species within the SCVWD Service Area. The grassland and oak woodland provide habitat.

There are no CNDDB records for this species within the Pacheco Reservoir Region.

California Alkali Grass California alkali grass has a California Rare Plant Rank of 1B. This species is found on alkaline, vernally mesic, sinks, flats, and lake margins within chenopod scrub, meadows and seeps, valley and foothill grassland, and vernal pools. The blooming period for this species is from March through May.

There are CNDDB records for this species within 10 miles of the San Luis Reservoir Region. The grassland and scrub/chaparral provide habitat.

There no CNDDB occurrences for this species within the SCVWD Service Area.

There are no CNDDB records for this species within the Pacheco Reservoir Region.

Chaparral Harebell Chaparral harebell has a California Rare Plant Rank of 1B. This species is found in chaparral, which is occasionally rocky, and usually serpentinite. The blooming period for this species is from May through June.

There are CNDDB records for this species within 10 miles of the San Luis Reservoir Region. Chaparral areas provide potential habitat for this species.

There are CNDDB occurrences for this species within the SCVWD Service Area. Chaparral areas provide potential habitat for this species.

There are CNDDB records for this species within the Pacheco Reservoir Region.

Congdon's Tarplant Congdon's tarplant has a California Rare Plant Rank of 1B. It is found in valley and foothill grassland, which is occasionally alkaline. The blooming period for this species is from May through June.

There are CNDDB records for this species within 10 miles of the San Luis Reservoir Region. Grasslands provides habitat.

There are CNDDB occurrences for this species within the SCVWD Service Area. Grasslands provides habitat.

There are no CNDDB records for this species within the Pacheco Reservoir Region.

Fragrant Fritillary Fragrant fritillary has a California Rare Plant Rank of 1B. It is a perennial herb found in broadleaved upland forest, chaparral, cismontane woodland, coastal scrub, riparian woodland, and valley and foothill grassland at elevations from 60 to 1,300 meters. The blooming period for this species is from February through April.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. The scrub, riparian, and grassland provides habitat.

There are no CNDDB occurrences for this species within the Pacheco Reservoir Region.

Hairless Popcornflower Hairless popcornflower has a California Rare Plant Rank of 1A. It is found in meadows and seeps, which are occasionally alkaline, and marshes and swamps, which are occasionally coastal salt. The blooming period for this species is from March through May.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. The marshes and swamps provide habitat.

There are CNDDB occurrences for this species around the Pacheco Reservoir Region.

Hall's Bush-Mallow Hall's bush-mallow has a California Rare Plant Rank of 1B. This species is found in chaparral and coastal scrub. The blooming period for this species is from May through September and occasionally into October.

There are CNDDB records for this species within 10 miles of the San Luis Reservoir Region. Chaparral areas provide potential habitat for this species.

There are CNDDB occurrences for this species within the SCVWD Service Area. The scrub, riparian, and grassland provides habitat. Chaparral areas provide potential habitat for this species.

There are CNDDB occurrences for this species within the Pacheco Reservoir Region.

Hispid Bird's Beak Hispid bird's beak has a California Rare Plant Rank of 1B. This species is usually found in alkaline substrate in meadows and seeps, playas, and valley and foothill grassland. The blooming period for this species is from June through September and occasionally into October.

There are CNDDB records for this species within 10 miles of the San Luis Reservoir Region. Grasslands provides habitat.

There are no CNDDB occurrences for this species within the SCVWD Service Area.

There are no CNDDB records for this species within the Pacheco Reservoir Region.

Hospital Canyon Larkspur Hospital canyon larkspur has a California Rare Plant Rank of 1B. This species is found occasionally in openings of chaparral, in mesic areas of cismontane woodland, and in coastal scrub. The blooming period for this species is from April through June.

There are CNDDB records for this species within 10 miles of the San Luis Reservoir Region. The chaparral and oak woodland provide habitat.

There are no CNDDB occurrences for this species within the SCVWD Service Area.

There are CNDDB records for this species within the Pacheco Reservoir Region.

Lemmon's Jewel-Flower Lemmon's jewel-flower has a California Rare Plant Rank of 1B. This species is found in pinyon-juniper woodland and valley and foothill grassland. The blooming period for this species is from February through May.

There are CNDDB records for this species within 10 miles of the San Luis Reservoir Region. Grasslands provide habitat.

There are no CNDDB occurrences for this species within the SCVWD Service Area.

There are no CNDDB records for this species within the Pacheco Reservoir Region.

Lime Ridge Navarretia Lime Ridge Navarretia has a California Rare Plant Rank of 1B. This species is found in chaparral. The blooming period for this species is from May through June.

There are CNDDB records for this species within 10 miles of the San Luis Reservoir Region. Chaparral areas provide potential habitat for this species.

There are no CNDDB occurrences for this species within the SCVWD Service Area.

There are CNDDB records for this species within the Pacheco Reservoir Region.

Loma Prieta Hoita Loma Prieta hoita has a California Rare Plant Rank of 1B. This species is usually found on serpentinite mesic substrate in chaparral, cismontane woodland, and riparian woodland. The blooming period for this species is from May through October.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. The chaparral, woodland, and riparian provide habitat.

There are no CNDDB records for this species within the Pacheco Reservoir Region.

Maple-Leaved Checkerbloom Maple-Leaved Checkerbloom has a California Rare Plant Rank of 1B. This species is usually found in broad-leafed upland forest, coastal prairie, coastal scrub, north coast coniferous forest. The blooming period for this species is from May through October.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. The chaparral, woodland, and riparian provide habitat.

There are no CNDDB records for this species within the Pacheco Reservoir Region.

Most Beautiful Jewel-Flower Most beautiful jewel-flower has a California Rare Plant Rank of 1B. This species is found in chaparral, cismontane woodland, and valley and foothill grassland, and has an affinity for serpentine soils. The blooming period for this species is from March through October.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. The chaparral, woodland, and grassland provide habitat.

There are no CNDDB occurrences for this species within the Pacheco Reservoir Region.

Mt. Hamilton Fountain Thistle Mt. Hamilton fountain thistle has a California Rare Plant Rank of 1B. It is found in chaparral, cismontane woodland and valley and foothill grassland, and has an affinity for serpentine soils. The blooming period for this species is from February through October.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. The chaparral, woodland, and grassland provide habitat.

There are no CNDDB records for this species within the Pacheco Reservoir Region.

Pink Creamsacs Pink creamsacs has a California Rare Plant Rank of 1B. It is a hemiparasitic annual herb found in open chaparral, cismontane woodland, meadows and seeps, and valley and foothill grassland, and has an affinity for serpentine soils.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. The chaparral and grassland provide habitat.

There are no CNDDB occurrences for this species within the Pacheco Reservoir Region.

Round-Leaved Filaree Round-leaved filaree has a California Rare Plant Rank of 1B. It is a found in valley and foothill grassland and cismontane woodland, on clay soils. The blooming period for this species is from March through May.

There are CNDDB records for this species within 10 miles of the San Luis Reservoir Region. The grassland and woodland provide habitat for this species.

There are no CNDDB occurrences documented for this species within the SCVWD Service Area.

There are no CNDDB records for this species within the Pacheco Reservoir Region.

Saline Clover Saline clover has a California Rare Plant Rank of 1B. It is a found in valley and foothill grassland, marshes and swamps, and vernal pools. The blooming period for this species is from April through June.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. The grassland and freshwater marsh provide habitat for this species.

There are CNDDB occurrences for this species within the Pacheco Reservoir Region.

San Francisco Collinsia San Francisco collinsia has a California Rare Plant Rank of 1B. This species is found in closed-cone coniferous forest, coastal scrub, and can sometimes be found in areas with serpentine soil. The blooming period for this species is from February through May.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. The scrub provides habitat for this species.

There are no CNDDB records for this species within the Pacheco Reservoir Region.

Santa Cruz Mountains Beardtongue Santa Cruz Mountains beardtongue has a California Rare Plant Rank of 1B. This species is found in chaparral and lower montane coniferous forest. The blooming period for this species is from May through June.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. Chaparral areas provide potential habitat for this species.

There are no CNDDB records for this species within the Pacheco Reservoir Region.

Santa Cruz Mountains Pussypaws Santa Cruz Mountains pussypaws has a California Rare Plant Rank of 1B. This species is found in chaparral and cismontane woodland. The blooming period for this species is from May through August.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. The chaparral and woodland provide habitat for this species.

There are no CNDDB records for this species within the Pacheco Reservoir Region.

Shining Navarretia Shining navarretia has a California Rare Plant Rank of 1B. This species is found in cismontane woodland, valley and foothill grassland, and vernal pools. The blooming period for this species is from March through June.

There are CNDDB records for this species within 10 miles of the San Luis Reservoir Region. The oak woodland and grassland provide habitat.

There are no CNDDB occurrences for this species within the SCVWD Service Area.

There are CNDDB records for this species within the Pacheco Reservoir Region.

Smooth Lessingia Smooth lessingia has a California Rare Plant Rank of 1B. It is an annual herb found in chaparral and cismontane woodland, which are often along roadsides, and has an affinity for serpentine soil (CNPS 2018).

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. Chaparral areas provide potential habitat for this species.

There are CNDDB records for this species within the Pacheco Reservoir Region.

Spiny Sepaled Button-Celery Spiny-sepaled button-celery has a California Rare Plant Rank of 1B. This species is found in vernal pools and valley and foothill grassland. The blooming period is from April through May.

There are CNDDB records for this species within 10 miles of the San Luis Reservoir Region. Grassland areas provide potential habitat for this species.

There no CNDDB occurrences for this species within the SCVWD Service Area.

There are CNDDB occurrences for this species around the Pacheco Reservoir Region.

Woodland Woollythreads Woodland woollythreads has a California Rare Plant Rank of 1B. It is found in chaparral, valley and foothill grassland, which is occasionally on serpentinite, cismontane woodland, broadleafed upland, and north coast coniferous forest. The blooming period for this species is from February through July.

There are no CNDDB records for this species within 10 miles of the San Luis Reservoir Region.

There are CNDDB occurrences for this species within the SCVWD Service Area. The chaparral, grassland, and oak woodland provide habitat.

There are CNDDB occurrences for this species within the Pacheco Reservoir Region.

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San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix N: Surface Water Supply Technical Report

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Appendix N
Surface Water Supply Technical Report

The Surface Water Supply Technical Appendix supplements Section 4.2, Surface Water Supply, in the San Luis Low Point Improvement Project (SLLPIP) Environmental Impact Statement/Environmental Impact Report (EIS/EIR). This technical report describes the changes to water supply associated with each action alternative. The changes are estimated using the CalSim II model.

N.1 Background

The Federal and State governments constructed the Central Valley Project (CVP) and State Water Project (SWP) in pursuit of the State Water Plan to maximize use of the state's water supplies and provide flood control. The Federal CVP currently has 253 water service contracts (including Sacramento River Settlement Contracts) (United States Fish and Wildlife Service [USFWS] 2008). The SWP currently has contracts to deliver supplies to 29 water suppliers across the state. These water contracts are subject to reductions, depending on the amount of water available each year. Water forecasting starts in the fall of the previous year when storage and hydrologic conditions are assessed. Annual water allocation for both the CVP and SWP are generally announced early in the calendar year for the following growing season and updated monthly.

This water supply technical report includes San Luis Reservoir, CVP facilities including the Delta-Mendota Canal and the San Felipe Division, SWP facilities including the California Aqueduct and the South Bay Aqueduct (SBA), and Santa Clara Valley Water District (SCVWD) infrastructure that conveys water to end users in Santa Clara County. Figure N-1 shows the study area.

N.1.1 San Luis Reservoir

San Luis Reservoir is an off-stream storage reservoir in Merced County. Department of Interior, Bureau of Reclamation (Reclamation) owns and jointly operates San Luis Reservoir with the California Department of Water Resources (DWR) to provide seasonal storage for the CVP and the SWP. San Luis Reservoir is capable of receiving water from both the Delta-Mendota Canal and the California Aqueduct, which enables the CVP and SWP to pump water into the reservoir during the wet season (October through March) and release water into the conveyance facilities during the dry season (April through September) when demands are higher. Deliveries from San Luis Reservoir also flow west through Pacheco Pumping Plant and Conduit to the San Felipe Division of the

CVP. The CVP contractors that receive water from San Luis Reservoir include the San Felipe Division and the Central Valley Region CVP Contractors. This section describes the annual reservoir operations, water storage and releases, and water supply facilities associated with San Luis Reservoir.

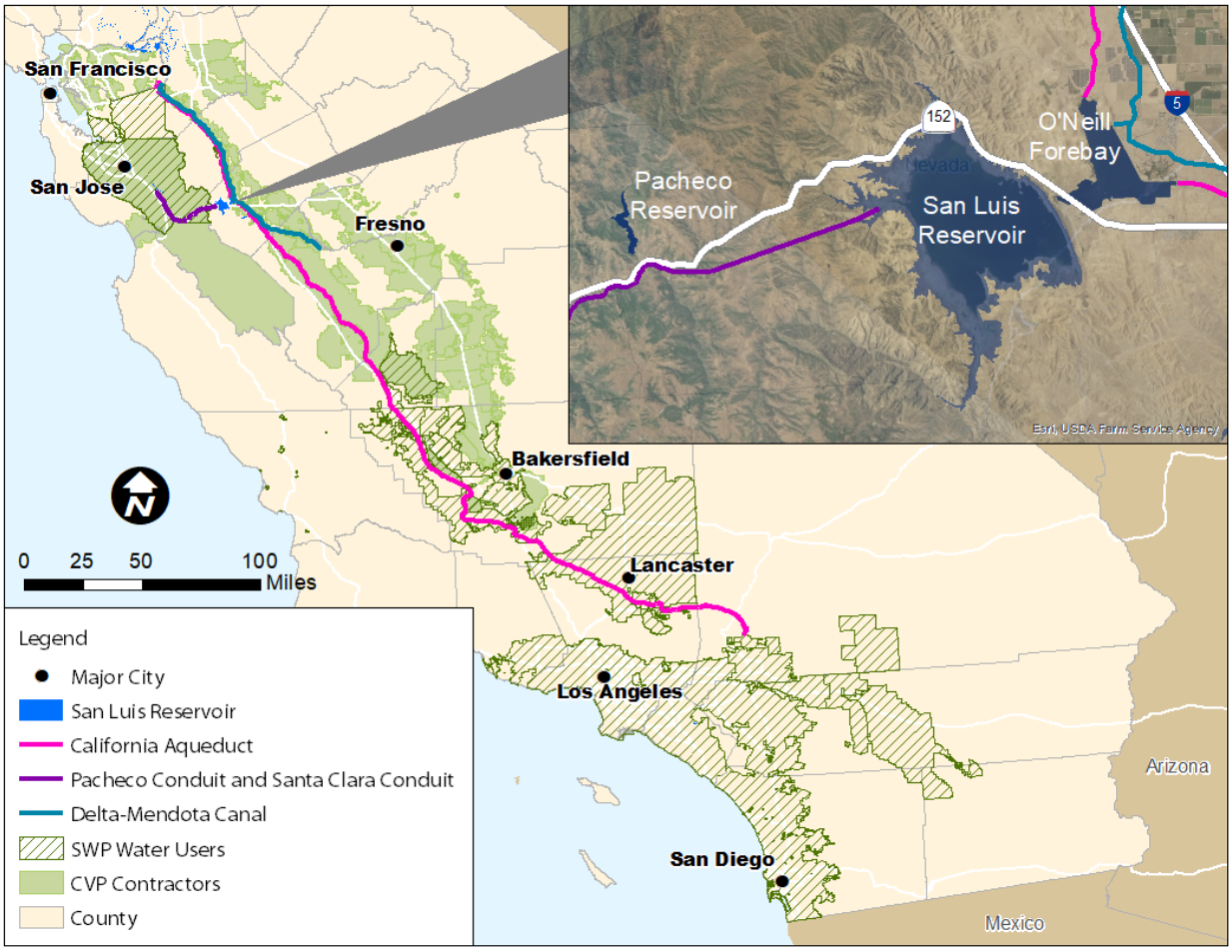
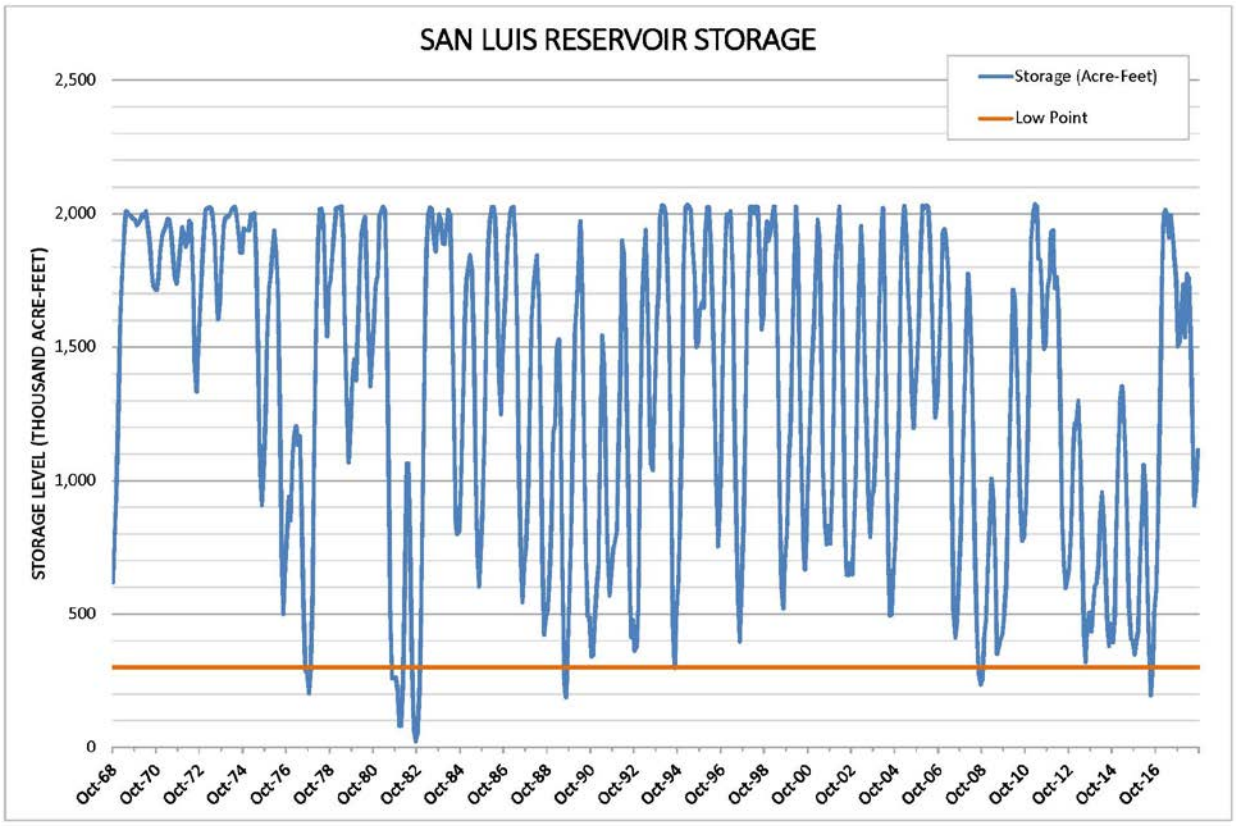


Figure N-1. Surface Water Supply Study Area

Figure N-2 shows monthly storage in San Luis Reservoir from 1968 through early 2018. Storage is highly variable throughout the year as the reservoir refills in the fall and winter months and releases water in spring and summer to meet CVP and SWP demands. In most years, the storage level in San Luis Reservoir has remained above 300 thousand acre-feet (TAF). As Figure N-2 shows, San Luis Reservoir was drawn down in 1981 and 1982 to a storage level of 79 TAF to facilitate repairs. During the drought periods of 1976–1977, 1988–1992 and 2007-2008, the reservoir was drawn down to below 300 TAF. San Luis Reservoir also fell below 300 TAF in the summer of 2016 (Reclamation 2016a).



Source: DWR California Data Exchange Center (CDEC) 2018

Figure N-2. Monthly Storage in San Luis Reservoir from 1921 to 2018

Table N-1 presents average monthly storage in San Luis Reservoir from 1970 through 2018. February, March, and April typically have the highest average storage as this is just after spring snowmelt from Northern California has been pumped through the Delta into the California Aqueduct and Delta-Mendota Canal and on to San Luis Reservoir. On average, storage in the reservoir is generally lowest in July, August, and September as water is being released to meet demands.

Table N-1. Average Monthly Storage in San Luis Reservoir (1921 through 2018)

Month	Storage (acre-feet)
January	1,475,953
February	1,628,474
March	1,762,224
April	1,693,288
May	1,451,058
June	1,137,430
July	894,445

Month	Storage (acre-feet)
August	775,277
September	846,592
October	909,379
November	1,048,939
December	1,248,938

Source: DWR CDEC 2018

During summer months, releases from San Luis Reservoir into O'Neill Forebay are made via the Gianelli Intake[1] and the Gianelli Pumping-Generating Plant turbines, which generate electricity. The water flows east into the San Luis Canal, and occasionally, water is also released from O'Neill Forebay back into the Delta-Mendota Canal, where electricity is also generated.

N.1.2 South-of-Delta CVP Facilities and Contractors

Reclamation operates the CVP, which diverts water from the Delta using the C.W. "Bill" Jones Pumping Plant (Jones Pumping Plant) into the Delta-Mendota Canal. The Delta-Mendota Canal is a 117-mile long canal that delivers water to users in the Central Valley and to and from San Luis Reservoir for storage. Water conveyed through the Delta-Mendota Canal to San Luis Reservoir is pumped from the canal to the O'Neill Forebay where it connects with the California Aqueduct and the San Luis Canal. The Delta-Mendota Canal continues east from the O'Neill Forebay to the Mendota Pool (Reclamation 2011a).

N.1.2.1 South-of-Delta CVP Contractors

The San Luis & Delta-Mendota Water Authority (SLDMWA) was formed in 1992 and covers approximately 3,300 square miles on the west side of the San Joaquin Valley and the Central Coast. It extends from the City of Tracy in San Joaquin County in the north to Kettleman City in Kings County in the south and contains 32 public agencies in the Central Valley Region that contract with Reclamation for CVP water (see Table N-2 below).

[1] The top of the Gianelli Intake is at an elevation of 296 feet and the bottom is at an elevation of 273 feet.

Table N-2. SLDMWA Agencies

Upper Delta-Mendota Canal	San Luis Canal	Exchange Contractors and Refuges	San Felipe Division	Lower Delta-Mendota Canal and Mendota Pool
Banta-Carbona Irrigation District	Panoche Water District	Central California Irrigation District	Pajaro Valley Water Management Agency	Broadview Water District
Byron-Bethany Irrigation District	Pleasant Valley Water District	Columbia Canal Company	San Benito County Water District	Eagle Field Water District
Centinella Water District	San Luis Water District	Firebaugh Canal Water District	Santa Clara Valley Water District	Fresno Slough Water District
City of Tracy	Westlands Water District	Grassland Water District		James Irrigation District
Del Puerto Water District		San Luis Canal Company		Laguna Water District
Patterson Water District				Mercy Springs Water District
Westside Irrigation District				Oro Loma Water District
West Stanislaus Irrigation District				Pacheco Water District
				Reclamation District 1606
				Tranquillity Irrigation District
				Turner Island Water District
				Widren Water District

Water supplies for the SLDMWA member agencies include CVP water, groundwater, and local surface water. The SLDMWA agencies hold contracts for approximately 3.0 million acre-feet (MAF) of CVP water annually. Approximately 2.5 MAF of the water is used to irrigate 1.2 million acres of agricultural lands in the Central Valley and Santa Clara and San Benito Counties, while 150,000 to 250,000 acre-feet (AF) is used for municipal and industrial (M&I) purposes, and 250,000 to 300,000 AF is used for environmental purposes including wildlife habitat management in the San Joaquin Valley (SLDMWA 2016).

The CVP has only delivered 100 percent of the contracted water to agricultural and M&I contractors in the SLDMWA service area three times since 1990 and SWP has only delivered 100 percent of the contracted amount twice since 1990. Because of groundwater overdraft conditions throughout the SLDMWA region, groundwater supplies are declining. This has further reduced water supplies for the SLDMWA agencies. In 2014 only 45 percent of the maximum contract volume were delivered to south-of-Delta CVP contractors (Reclamation 2015) and in 2015 south-of-Delta CVP M&I allocations were 25% of the contract total (Reclamation 2016b). In 2016, south-of-Delta CVP M&I allocations increased to 55% of the contract total (Reclamation 2016b). The San Felipe Division of the CVP and SCVWD are discussed below in more detail.

In recent years, Reclamation has made significant cutbacks to water deliveries for many CVP contractors due to the drought, among other factors, as shown in Table N-3. In 2015, south-of-Delta CVP M&I allocations were 25% of the contract total, which increased to 55% of the contract total in 2016 (Reclamation 2017b). Most CVP South-of-Delta agricultural water service contractors received an initial allocation of 65% of contracted supplies, and South-of Delta M&I contractors initially received a 90% allocation for 2017. However, these allocations were later revised to 100% in April 2017 (Reclamation 2017b). The San Felipe Division of the CVP and SCVWD are discussed below in more detail.

Table N-3. Water Allocations for South-of-Delta CVP Contractors, 2012-2017 (Percent of Maximum Contract Allocation)

	2012	2013	2014	2015	2016	2017
Agricultural	40%	20%	0%	0%	5%	100%
M&I	75%	70%	50%	25%	55%	100%
Exchange Contractors	100%	100%	65%	75%	100%	100%
Refuges	100%	100%	65%	75%	100%	100%
Eastside Division	100%	100%	55%	0%	0%	100%
Friant Class I	50%	62%	0%	0%	65%	100%
Friant Class II	0%	0%	0%	0%	0%	100%

Source: Reclamation 2017b

N.1.3 South-of-Delta SWP Facilities and Contractors

N.1.3.1 South-of-Delta SWP Facilities

DWR operates the SWP, which diverts water from the Delta through the Harvey O. Banks Pumping Plant (Banks Pumping Plant) into Bethany Reservoir. The California Aqueduct is 444 miles long and delivers water from Bethany Reservoir south to the Central Valley and Southern California. The California Aqueduct flows south 60 miles to O'Neill Forebay at San Luis Reservoir (DWR 2015). At O'Neill Forebay, the California Aqueduct becomes the San Luis Canal, which is managed jointly by Reclamation and DWR and serves both the CVP and SWP. The San Luis Canal is Federally-built and extends 103 miles from O'Neil Forebay southeast to just past Kettleman City (Reclamation 2011a). At this point it becomes the California Aqueduct again, an SWP facility that delivers water over the Tehachapi Mountains to southern California.

The SBA was constructed by the SWP in the 1960's to provide water to the south San Francisco Bay area in Alameda and Santa Clara Counties. The South Bay Pumping Plant lifts water from Bethany Reservoir into the SBA. Water then flows to a junction and a portion is pumped into Lake Del Valle. Water from the SBA can be stored in Lake Del Valle and released back into the SBA. After the Del Valle junction, water flows through pipelines to La Costa Tunnel, southwest past Sunol, through the Mission Tunnel, and south through the hills overlooking San Francisco Bay. The SBA ends in a 160-foot diameter Santa

Clara Terminal Tank in San Jose at the Penitencia water treatment plant (WTP) (DWR 2001).

The SBA conveys an annual maximum of 46,000 AF to the Alameda County Flood Control and Water Conservation District (Zone 7), 42,000 AF to Alameda County Water District, and 100,000 AF to SCVWD (DWR 2001). The SCVWD turnout on the SBA has a maximum capacity of 182 cubic feet per second (cfs).

N.1.3.2 South-of-Delta SWP Contractors

The SWP delivers water to 29 public water agencies in Northern, Central and Southern California that hold long-term contracts for surface water deliveries (see Table N-4 below for a list of south-of-Delta agencies with SWP contracts). The agencies deliver water for both urban and agricultural use, representing over 25 million municipal water users and 750,000 acres of irrigated farmland. Five of the agencies use the SWP water primarily for agricultural uses and the remaining 24 use the SWP water primarily for municipal use. As noted above, the Alameda County Flood Control and Water Conservation District (Zone 7), Alameda County Water District and SCVWD all receive their SWP supplies through the SBA.

Water supplies for the agencies include imported SWP water, groundwater, local surface water, and for some agencies other imported supplies. The agencies collectively have received deliveries ranging from approximately 1.4 MAF in dry water years to approximately 4.0 MAF in wet years.

Similar to CVP south-of-Delta deliveries, SWP exports from the Delta and the corresponding south-of-Delta deliveries have decreased over time. Implementation of the 2008 and 2009 United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) Biological Opinions for the Long-Term Operations of the SWP and CVP resulted in substantial changes in south-of-Delta SWP deliveries. In the period between 2005 and 2013, average annual SWP exports have fallen by 12 percent (DWR 2015).

Table N-4. South-of-Delta SWP Contractors

Alameda County Flood Control & Water Conservation District - Zone 7	Metropolitan Water District of Southern California
Alameda County Water District	Mojave Water Agency
Antelope Valley-East Kern Water Agency	Oak Flat Water District
Castaic Lake Water Agency	Palmdale Water District
Coachella Valley Water District	San Bernardino Valley Municipal Water District
County of Kings	San Gabriel Valley Municipal Water District
Crestline-Lake Arrowhead Water Agency	San Gorgonio Pass Water Agency
Desert Water Agency	San Luis Obispo County Flood Control and Water Conservation District

Dudley Ridge Water District	Santa Barbara County Flood Control and Water Conservation District
Empire-West Side Irrigation District	Santa Clara Valley Water District
Kern County Water Agency	Tulare Lake Basin Water Storage District
Littlerock Creek Irrigation District	Ventura County Watershed Protection District

N.1.4 San Felipe Division and Santa Clara Valley Water District

N.1.4.1 San Felipe Division

The San Felipe Division of the CVP was authorized in 1960 and currently delivers water to agriculture and M&I users in Santa Clara County, the northern portion of San Benito County, the southern portion of Santa Cruz County, and the northern edge of Monterey County (Reclamation 2011a). The three agencies that make up the San Felipe Division are SCVWD, San Benito County Water District (SBCWD), and Pajaro Valley Water Management Agency (PVWMA). Table N-5 shows the CVP contract allocations for each of the San Felipe Division agencies. The PVWMA currently does not have a connection to the CVP system or San Luis Reservoir and is therefore not discussed further in this water supply section.

Table N-5. Contract Allocations for the San Felipe Division

San Felipe Division Members	Contract Type		Source of CVP Water
	Agriculture (AF)	M&I (AF)	
SCVWD[1]	33,100	119,400	San Luis Reservoir
SBCWD	38,244	5,556	San Luis Reservoir
PVWMA[2]	6,260	0	None (See Note 2)

Source: Reclamation 2016c

AF = Acre-Feet

[1] The SCVWD CVP water is used throughout Santa Clara County.

[2] Currently, the PVWMA does not have a connection to the CVP system. However, the PVWMA plans to construct a connection in the future. PVWMA has a contract reservation for an additional 19,900 AF per year which is not under contract until provisions of the CVPIA are fulfilled

SCVWD and SBCWD receive water directly from San Luis Reservoir through the San Felipe Division facilities (see Table N-6 and Figure N-1). Water for the San Felipe Division is withdrawn from San Luis Reservoir via two intakes on the west side of the reservoir. From the intakes, water flows west through the Pacheco Tunnel Reach 1 to the Pacheco Pumping Plant. At the plant, water is lifted to Reach 2 of the Pacheco Tunnel and conveyed through the Pacheco Conduit to the bifurcation of the Santa Clara and Hollister Conduits.

Water for SCVWD is delivered to the Coyote Pumping Plant via the Santa Clara Conduit, a tunnel that runs through the Diablo Mountains. From Coyote Pumping Plant, the water can either be delivered to Anderson Reservoir, Calero

Reservoir, groundwater recharge facilities, or the Rinconada and/or Santa Teresa WTPs.

Water from the Hollister Conduit serves San Benito County and extends from Pacheco Conduit to San Justo Reservoir. Located three miles southwest of the City of Hollister, San Justo Reservoir has a total storage capacity of 9,785 AF (Reclamation 2011b). The reservoir regulates San Benito County's imported water supplies, provides for pressure deliveries to some agricultural lands in the service area, and provides storage for peaking of agricultural water (USFWS 2008). SCVWD operates all San Felipe Division facilities with the exception of the Hollister Conduit and San Justo Reservoir, which are operated by SBCWD.

Table N-6. San Felipe Division Facilities

San Felipe Division Facility	Location and Description
Pacheco Tunnel	Reaches 1 and 2, along with the Pacheco Pumping Plant, bring water from San Luis Reservoir through the Diablo Mountain Range.
Pacheco Pumping Plant	At the end of Pacheco Tunnel Reach 1.
Pacheco Conduit	Extends from the Pacheco Tunnel Reach 2 outlet to the bifurcation of the Santa Clara and Hollister Conduits.
Santa Clara Tunnel and Conduit	Conveys water from the Pacheco Conduit to the Coyote Pumping Plant.
Hollister Conduit	Extends from Pacheco Conduit to San Justo Reservoir.
Coyote Pumping Plant	End of Santa Clara Conduit near Anderson Dam. Can pump CVP water to Anderson Dam or direct it to SCVWD raw water pipelines that serve the water treatment plants.
San Justo Dam and Reservoir	Stores CVP water from Hollister Conduit.

Source: Reclamation 2011a.

N.1.4.2 Low Point Issue

As described in Chapter 1, conditions at San Luis Reservoir can promote the growth of reservoir-wide algae during the summer months, when the reservoir reaches the lower water surface elevations. The thickness of the algal blooms vary, but algal cells are typically observed in the water delivered through the Lower San Felipe Intake when the reservoir surface is drawn within 35 feet of the intake. The algal blooms are very difficult to treat at SCVWD's two WTPs that receive San Luis Reservoir water and can cause taste and odor issues for M&I water users in Santa Clara County.

San Luis Reservoir is currently the only point of delivery for the San Felipe Division's CVP supplies authorized under their current CVP Water Service Contracts (SCVWD contract No. 7-07-20-W0023 dated June 7, 1977 amended March 28, 2007; SBCWD contract No. 8-07-20-W0130 dated April 15, 1978 amended March 28, 2007).

The water elevation in San Luis Reservoir during the late summer and early fall periods varies from year to year, depending on various conditions. These conditions include the amount of stored water carried over from the previous year (carryover water), the volume of water that can be delivered from the Delta (usually depending on hydrologic conditions and regulatory restrictions on Delta exports), demands of Federal and State contractors, and operational decisions made by Reclamation and DWR.

In most years, the storage level in San Luis Reservoir has remained above 300 TAF (which corresponds to the water surface elevation at which the low point issue is likely to arise). The reservoir has not been drawn down to its minimum operating pool of 79 TAF since before the San Felipe Division began deliveries in 1987, when drawdown events occurred in response to droughts and to allow maintenance. During the drought periods of 1976–1977, 1988–1992, and 2008, the reservoir was drawn down to below 300 TAF (Figure N-2). San Luis Reservoir also fell below 300 TAF in summer 2016 (Reclamation 2016a). San Luis Reservoir was drawn down to a storage level of 79 TAF to facilitate repairs in 1981 and 1982. In the past, Reclamation has projected that San Luis Reservoir storage levels would drop below 300 TAF, which could affect water deliveries to the San Felipe Division. The low point issues did not materialize in most of these years because SWP contractors left some water in storage as carryover for future years. However, changing water supply conditions and increasing demands make continued long-term storage above 300 TAF unlikely.

The uncertainty associated with San Luis Reservoir water supply deliveries in turn affects SCVWD's water delivery operations. The duration of low point occurrences is projected to increase in the future and the SCVWD's ability to adjust operations to fully mitigate impacts associated with the low point issue will diminish over time as local supplies, currently reserved for use during drought events, are relied on to replace interrupted imported supplies.

N.1.4.3 Santa Clara Valley Water District

The SCVWD service area has several water supply sources, including imported water (CVP and SWP), water from the San Francisco Public Utilities Commission, natural groundwater, local surface water, recycled water, and surface water rights held by San Jose Water Company and Stanford University (SCVWD 2015). Table N-7 shows a breakdown of the SCVWD water supply sources for 2015.

Table N-7. SCVWD 2015 Water Supply

Source	Percent
Natural Groundwater Recharge	15%
Local Surface Water	17%
Recycled Water	8%

Source	Percent
San Francisco Public Utilities Commission	16%
CVP and SWP Allocations	23%
Carryover, Transfer, and Semitropic Takes	21%

Source: SCVWD 2015

SCVWD receives imported water from the CVP through San Luis Reservoir and the Pacheco Conduit, and from the SWP through the SBA. SCVWD has a maximum contract for 100 TAF per year of water from the SWP, although deliveries vary depending on hydrological conditions. Almost all of this supply is used to meet M&I needs (SCVWD 2010). SCVWD's maximum CVP contract is for 152.5 TAF per year, with 119.4 TAF for M&I and 33.1 TAF for agricultural irrigation. The actual amount SCVWD receives from the CVP is generally less than the contractual amount because of climate conditions, environmental regulations, and conveyance limitations. As Table N-7 shows, in 2015, the largest component of SCVWD's overall water supply (23 percent) was imported via the CVP and SWP and was used to replenish groundwater or was treated for drinking water use.

Groundwater is an important water supply source for Santa Clara County and its preservation was the goal that spurred the formation of the SCVWD. In a normal year, 40 to 50 percent of all water used in SCVWD is groundwater (SCVWD 2010). SCVWD manages two groundwater subbasins: the Santa Clara Valley Subbasin (subdivided into Santa Clara Plain and Coyote Valley in the 2012 Groundwater Management Plan) and the Llagas Subbasin. Natural recharge of the subbasins is insufficient to off-set groundwater pumping; therefore, SCVWD implements managed recharge using local and imported surface water. Recharge facilities managed by SCVWD include over 320 acres of off-stream ponds and over 30 local creeks (SCVWD 2010). In an average year, natural recharge accounts for approximately 60 TAF, while managed recharge accounts for 116 TAF (SCVWD 2005b; SCVWD 2010). Managed recharge also helps to prevent overdraft and land subsidence and allows for carryover of surplus water from wet years to dry years (SCVWD 2005a).

SCVWD has a long-term agreement with Semitropic Water Storage District to bank or store SWP water for future use. The agreement does not provide additional water supply for SCVWD, but it does allow excess water to be stored in wet years for later use during dry years or other periods of shortage. SCVWD currently has 350 TAF of storage capacity at the Semitropic Groundwater Storage Bank. SCVWD uses storage in the Semitropic Groundwater Storage Bank as an in-lieu supply; SCVWD does not withdraw water from Semitropic's groundwater basin, but instead takes a portion of Semitropic's SWP water allocation from the Delta through the SBA. However, Semitropic Water Storage District's allocation, like that of other south-of-Delta contractors, is proportional to SWP percentage allocation for the year and can therefore limit the amount of water SCVWD can withdraw.

SCVWD also participates in transfers and exchanges. SCVWD has exchanged portions of its CVP allocations with SBCWD and partners in the San Joaquin Valley who are CVP contractors. A total of 7 TAF was exchanged in 2004 (SCVWD 2005b). In 1998, SCVWD and two other agencies (PVWMA and Westlands Water District) entered in to an agreement for the permanent assignment of 6.26 TAF per year from Mercy Springs Water District, an agricultural CVP contractor. The agreement provides SCVWD an option for dry-year supplies up to 20 TAF over 20 years (SCVWD 2005b).

SCVWD has an effective water conservation program and has saved approximately 64,000 AF in 2015. SCVWD aims to meet a conservation target of approximately 98,800 AF by 2030 (SCVWD 2015).

In Santa Clara County, additional water sources that are not under the jurisdiction of SCVWD are available, and their use helps to reduce reliance on SCVWD supplies. Several municipalities in Santa Clara County have agreements with the City and County of San Francisco for water from the Hetch-Hetchy system. The San Jose Water Company and Stanford University have surface water rights of approximately 11,000 AF per year that they exercise to meet their demands (SCVWD 2015). Approximately 20 TAF of recycled water is currently used from four publicly-owned wastewater treatment plants in Santa Clara County (SCVWD 2015).

SCVWD manages water resources and sells treated water wholesale to retailers in Santa Clara County. Water infrastructure operated by SCVWD includes raw water conveyance, storage, water treatment, and treated water distribution. Raw water is treated at three SCVWD WTPs (Santa Teresa, Penitencia, and Rinconada) and then distributed, or used for groundwater recharge. Ten reservoirs managed by SCVWD capture local runoff and store it for groundwater recharge, irrigation, or drinking water treatment (SCVWD 2015). The total storage capacity of all ten reservoirs is approximately 170 TAF; however, this capacity has been restricted to approximately 113 TAF due to Safety of Dams interim operating restrictions (SCVWD 2010). With the exception of Anderson Reservoir, the local reservoirs were constructed for annual operations, storing water in the winter and releasing that water in the summer and fall for groundwater recharge.

N.1.4.4 Anderson Reservoir

Built in the 1950's, Anderson Reservoir has maximum capacity of 90,373 AF and is the largest of SCVWD's ten reservoirs (SCVWD 2010). Water from Anderson Reservoir is released into Coyote Creek for groundwater recharge and aquatic habitat. Anderson Reservoir is one of only two reservoirs connected to SCVWD's water distribution system and treatment plants. Water from San Luis Reservoir can be conveyed through the San Felipe Division facilities and stored in Anderson Reservoir for later use (SCVWD 2010). Anderson Reservoir is an important component of SCVWD's water supply system because it has the ability to provide carryover storage from year to year (SCVWD 2010). This

allows the reservoir to serve as a backup supply source for SCVWD's WTPs when imported water deliveries are curtailed (SCVWD 2010).

In 2011, the SCVWD completed a seismic study for Anderson Reservoir. Based on the results of the study, operating restrictions have been approved for Anderson Reservoir until a series of seismic upgrades are complete. The operating restrictions reduce Anderson Reservoir's maximum capacity from 90,373 AF to 61,810 AF, or 68 percent of its maximum capacity. Seismic upgrades are anticipated to be completed by 2024 (SCVWD 2016).

N.1.4.5 Pacheco Reservoir

Pacheco Reservoir is located on North Fork Pacheco Creek, and it was established in 1939 through construction of the North Fork Dam. This existing earthen dam is owned and operated by PPWD, and operated for groundwater recharge via releases to Pacheco Creek in spring and early summer. The design capacity of Pacheco Reservoir is 6,000 AF, with an operational capacity of 5,500 AF. The earthen dam is 100-feet tall and collects rainfall from a 75-square-mile watershed. Since the 1940s, the facility has undergone multiple repairs to its spillway.

North Fork Dam is currently under restricted-operation criteria through an April 5, 2017, order of the California Department of Water Resources' Division of Safety of Dams (DSOD), due to existing spillway deficiencies. PPWD is coordinating with the Federal Emergency Management Agency and DSOD on short-term and long-term repairs. The DSOD has stated that if satisfactory progress is not made to address spillway deficiencies, additional remedies would be invoked, inclusive of revocation of the PPWD's Certificate of Approval to store water.

N.1.4.6 Water Treatment

SCVWD operates three WTPs that treat water for M&I use. The Rinconada WTP treats and delivers up to 80 million gallons of water each day. This water is sent to retailers who then supply residential and commercial users in Santa Clara, Campbell, Sunnyvale, Cupertino, Mountain View and Los Altos and the towns of Los Gatos and Los Altos Hills. Water for the Rinconada WTP comes from the SBA and San Luis Reservoir. SCVWD's Anderson and Calero Reservoirs can also supply water to the WTP (SCVWD 2012a).

The Santa Teresa WTP is the largest WTP operated by SCVWD. It treats and delivers up to 100 million gallons of water per day for most of South San Jose (Almaden Valley, Blossom Valley, Santa Teresa), which includes both residential and commercial users. This WTP can also serve most of Penitencia WTP's service area if needed. Almost all the water for this WTP is imported from San Luis Reservoir. Anderson and Calero Reservoirs can also supply water to this WTP (SCVWD 2012b).

The Penitencia WTP is the smallest of the three WTPs and obtains most of its water from the SBA. It treats and delivers up to 40 million gallons of water per day to about 270,000 residential and commercial users in the east side of Santa Clara Valley from Milpitas in the north to Aborn Road in the south (SCVWD 2012c).

N.1.4.7 Current Water Supply Issues - 2008 Low Point Event

In 2008, SCVWD implemented several actions in response to low San Luis Reservoir levels and algal blooms. Storage in San Luis Reservoir dropped to as low as 220,000 AF – well below the Upper San Felipe Intake. At this level, water in San Luis Reservoir was only 22 feet above the Lower San Felipe Intake. SCVWD had to implement measures to continue meeting the water demands within its service area. The following is a brief description of the measures implemented by SCVWD in 2008 to address the low point event and maintain adequate water supplies summarized from a SCVWD technical memorandum on District operations in 2008 (SCVWD 2009).

1. SCVWD blended Anderson Reservoir water with CVP water from San Luis Reservoir for the Santa Teresa and Rinconada WTPs. Blending the algae-laden water with better quality water improved SCVWD's ability to treat the water to the appropriate water quality standards. This was possible because Anderson Reservoir had supply available; however, this might not always be possible during drought conditions. Additionally, current Division of Safety of Dams requirements reduce the ability to utilize storage high in Anderson Reservoir as a blending supply until seismic upgrades are complete (currently scheduled for 2024).

2. SCVWD increased its use of SWP water from the SBA to blend with its CVP water from San Luis Reservoir. SWP allocations were high enough to allow the changed operations. This option would be less useful with lower allocations or increased Delta pumping constraints.

3. SCVWD decreased the amount of surface water directed to groundwater recharge by reducing releases from Anderson Reservoir. This action was implemented to increase availability of surface water supply in Anderson Reservoir during the low point event. Limiting groundwater recharge to protect for low storage in San Luis Reservoir reduces overall groundwater storage and protection against drought and other outages.

4. SCVWD had to increase chemical applications at Santa Teresa and Rinconada WTPs to treat higher algae and turbidity conditions. Chemical costs increased, and filters required more frequent cleaning operations, increasing energy use, and the potential for an overall decrease in plant capacity.

5. SCVWD suspended availability of lower-cost non-contract water to retailers, during the spring. This resulted in several retailers switching to

groundwater during the spring, reserving surface water supplies (especially those in Anderson Reservoir) for the late summer/fall. As a result, the end-of-season groundwater level in 2008 was at the lowest levels in over a decade. The low groundwater levels may have increased pumping costs.

Although these actions allowed SCVWD to continue to deliver a portion of its CVP contract supplies during the months when San Luis Reservoir storage was low, the measures to accommodate the decreased CVP supplies resulted in adverse water supply and economic impacts to SCVWD. These actions depleted water resources that would otherwise be available to manage for drought conditions and other emergency system outages during 2008, and affected the availability of SCVWD to manage future water shortage events.

In 2016, algae growth and water levels below 300 TAF in San Luis Reservoir generated taste and odor issues in SCVWD's treated water supply generating customer complaints which caused the district to suspend deliveries from the reservoir and shift to local supplies stored in Anderson and Coyote reservoirs (Mercury News 2016). This shift to local supplies reduced storage levels in the two local reservoirs that are normally reserved through the summer as emergency supply and drawn down later in the fall to make room for winter inflow (Mercury News 2016).

N.2 Alternative 1 - No Action/No Project Alternative

Under the No Action/No Project Alternative, the CVP and SWP would continue to operate and provide water supply, as under existing conditions. Future changes in hydrology, land use, and regulations could affect water deliveries; however, the types of changes that could occur are unclear and incorporating these changes into the No Action/No Project Alternative would be speculative.

Under the No Action/No Project Alternative, SCVWD operations would remain the same as existing conditions. Under this alternative, modeling results have predicted that there would be 17 years (out of the 82 calendar years analyzed) where the San Luis Reservoir would be drawn below a 300 TAF level, i.e. low point years, for at least one month.

N.3 Alternative 2 - Lower San Felipe Intake Alternative

The Lower San Felipe Intake Alternative would involve construction of a new, lower San Felipe Intake to allow reservoir drawdown to its minimum operating level without algae reaching the San Felipe Intake.

N.3.1 Deliveries to South-of-Delta CVP Contractors

Under the No Action/No Project Alternative, deliveries from San Luis Reservoir to SCVWD are interrupted during low point events. These supplies

remain in San Luis Reservoir and increase the amount of reservoir carryover storage. In the year following a low point event, the amount of water in San Luis would be greater than in years without prior low point events because of the undelivered SCVWD water. Under the Lower San Felipe Intake Alternative, average reservoir levels in San Luis Reservoir would be less than the No Action/No Project Alternative because SCVWD would be able to withdraw their full CVP water allocation each year from San Luis Reservoir, even during low point months. This would result in less carryover water stored in San Luis Reservoir and a lower minimum storage level on average.

Decreased carryover storage by SCVWD as a result of low point events could decrease deliveries to CVP south-of-Delta agricultural contractors in subsequent years when SCVWD was not able to access that carried over supply. As shown in Tables N-8 and N-9, the change in delivery of water to CVP south-of-Delta agricultural contractors under this alternative is minimal, resulting in a less than one percent change in all water years. Figures N-3 and N-4 show the modeled impacts of the Lower San Felipe Intake Alternative on CVP south-of-Delta agricultural deliveries.

Table N-8. Averaged Modeled Difference in Total CVP South-of-Delta Agricultural Deliveries between the No Action/No Project Conditions and Lower San Felipe Intake Alternative by Water Year Type (1,000 acre-feet)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.3
AN	0.0	0.0	0.0	0.0	0.0	-0.2	-0.4	-0.6	-1.0	-1.2	-1.6	-0.3	-5.3
BN	-0.1	-0.1	-0.1	-0.2	-0.2	-0.1	-0.2	-0.2	-0.4	-0.5	-0.3	-0.1	-2.5
D	-0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.3	-0.4	-0.3	-0.1	-1.7
C	-0.1	-0.1	-0.1	-0.2	-0.2	0.0	0.1	0.1	0.1	0.2	0.1	0.0	0.0
All	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.2	-0.3	-0.3	-0.3	-0.1	-1.6

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table N-9. Averaged Modeled Difference in Total CVP South-of-Delta Agricultural Deliveries between the No Action/No Project Conditions and Lower San Felipe Intake Alternative by Water Year Type (% change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	0.1%	0.1%	0.1%	0.1%	0.1%	-0.5%	-0.6%	-0.5%	-0.5%	-0.5%	-1.0%	-0.5%	-0.5%
BN	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%
D	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.3%	-0.2%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%
C	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.3%	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	0.0%
All	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.3%	-0.2%	-0.2%

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

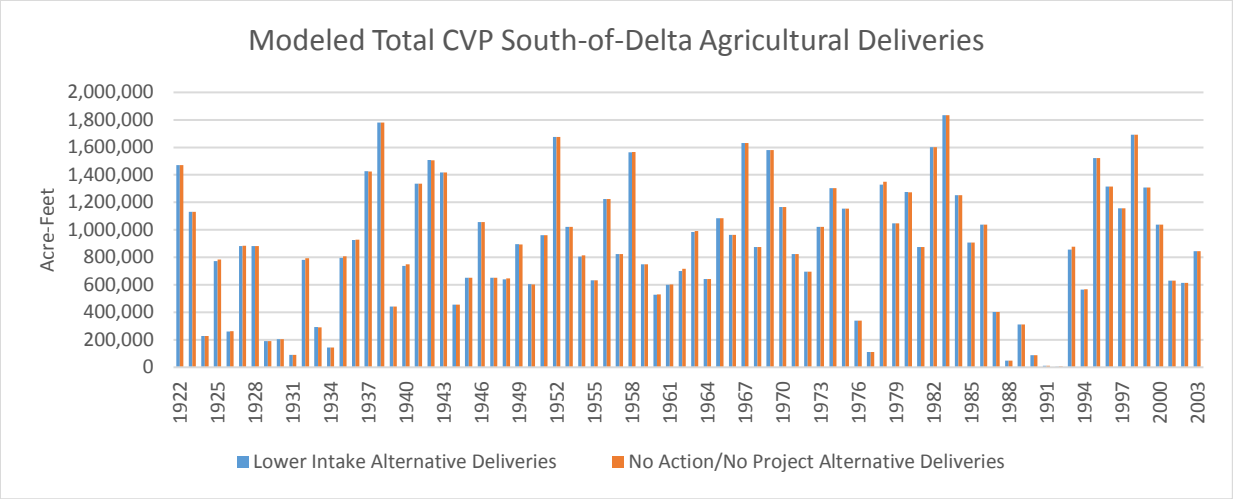


Figure N-3. Modeled Total CVP South-of-Delta Agricultural Deliveries under the No Action/No Project Conditions and Lower San Felipe Intake Alternative

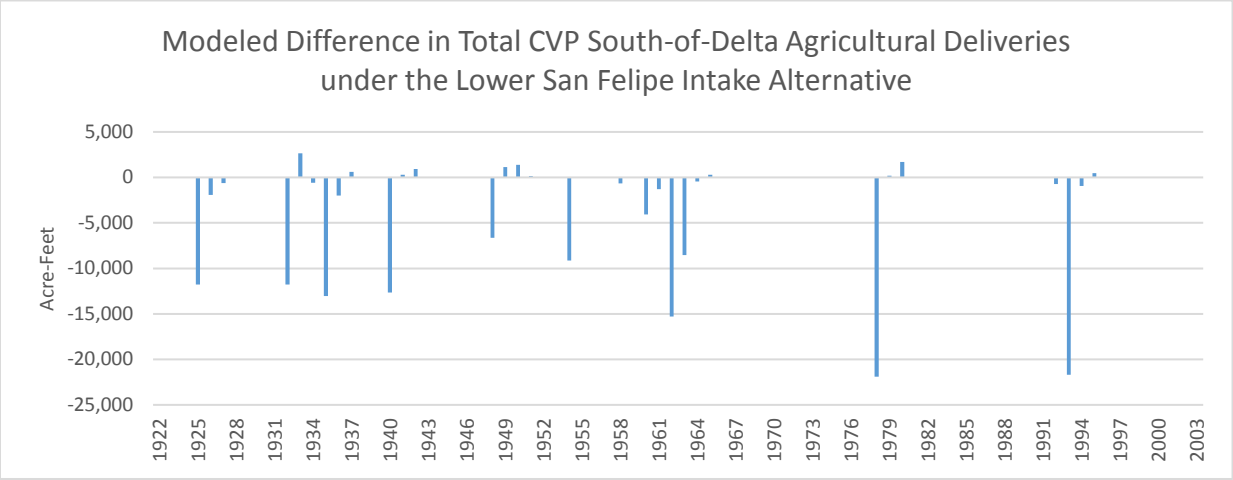


Figure N-4. Modeled Difference in Total CVP South-of-Delta Agricultural Deliveries between the No Action/No Project Conditions and Lower San Felipe Intake Alternative

N.3.2 Deliveries to South-of-Delta SWP Contractors

The Lower San Felipe Intake Alternative would affect the operations of CVP supplies, but SWP supplies would remain unchanged. As shown in Tables N-10 and N-11, there is functionally no difference in the SWP deliveries (Table A deliveries) and surplus water supply (Article 21[2] deliveries). Figures N-5 through N-8 show the modeled impacts of the Lower San Felipe Intake Alternative on SWP deliveries and surplus water supply.

[2] Article 21 water is the water available to SWP contractors after fulfillment of SWP contractors Table A deliveries (DWR 2012)

Table N-10. Averaged Modeled Difference in State Water Project Deliveries (Table A and Article 21 deliveries) between the No Action/No Project Conditions and Lower San Felipe Intake Alternative by Water Year Type (1,000 acre-feet)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
SWP Table A Deliveries													
W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
BN	0.0	-0.3	0.3	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.3
D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
All	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
SWP Article 21 Deliveries													
W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AN	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
BN	0.0	0.0	-0.1	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2
D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table N-11. Averaged Modeled Difference in State Water Project Deliveries (Table A and Article 21 deliveries) between the No Action/No Project Conditions and Lower San Felipe Intake Alternative by Water Year Type (% change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
SWP Table A Deliveries													
W	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BN	0.0%	-0.1%	0.1%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
D	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SWP Article 21 Deliveries													
W	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	0.0%	0.0%	0.0%	-0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
BN	0.0%	0.0%	-6.8%	0.0%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
D	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All	0.0%	0.0%	-0.5%	-0.2%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

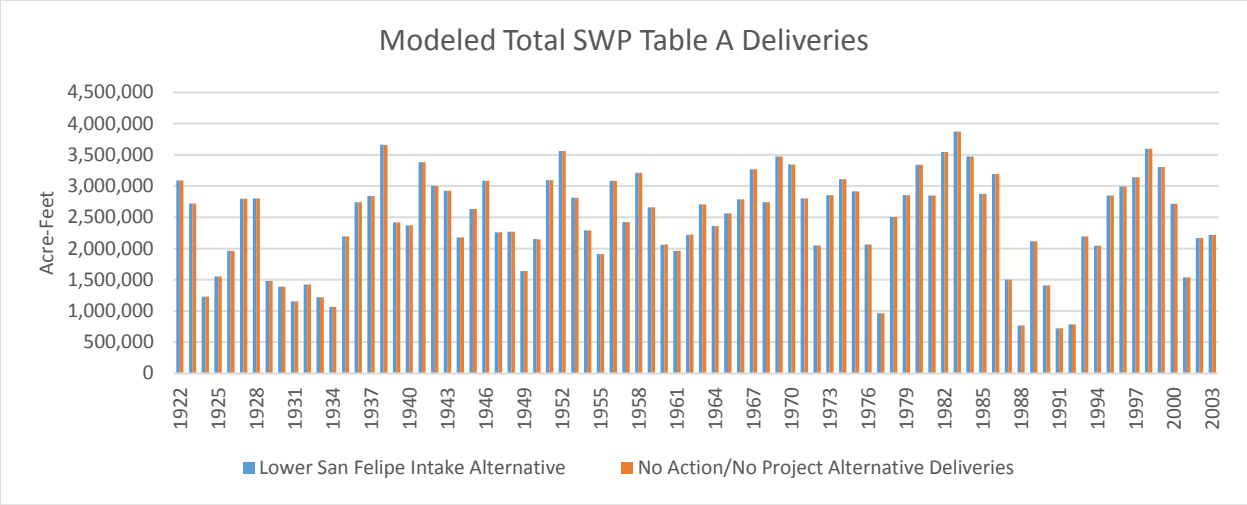


Figure N-5. Modeled Total SWP Table A Deliveries under the No Action/No Project Conditions and Lower San Felipe Intake Alternative

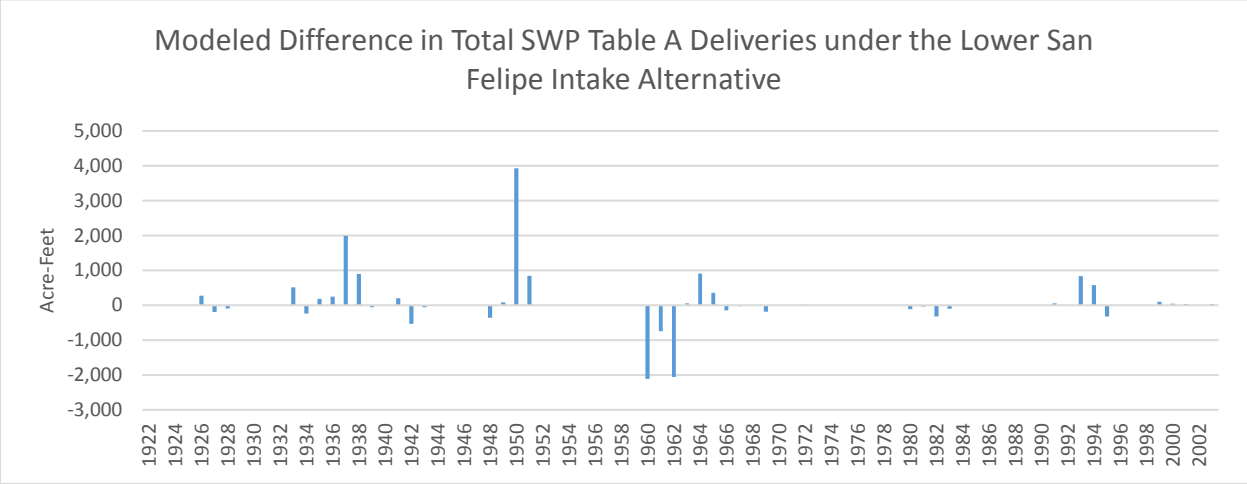


Figure N-6. Modeled Difference in Total SWP Table A Deliveries between the No Action/No Project Conditions and Lower San Felipe Intake Alternative

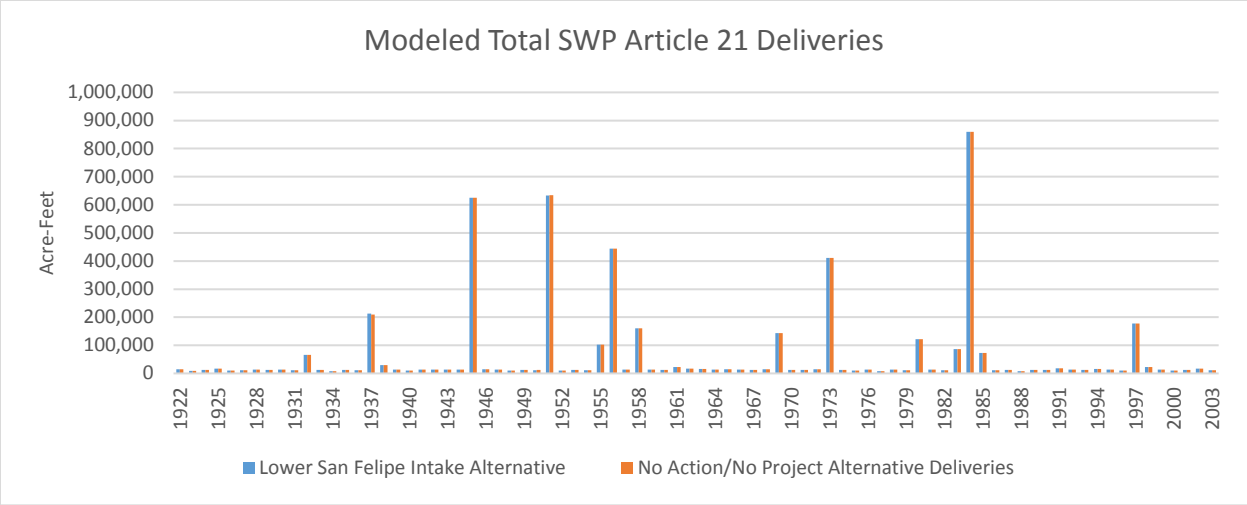


Figure N-7. Modeled Total SWP Article 21 Deliveries under the No Action/No Project Conditions and Lower San Felipe Intake Alternative

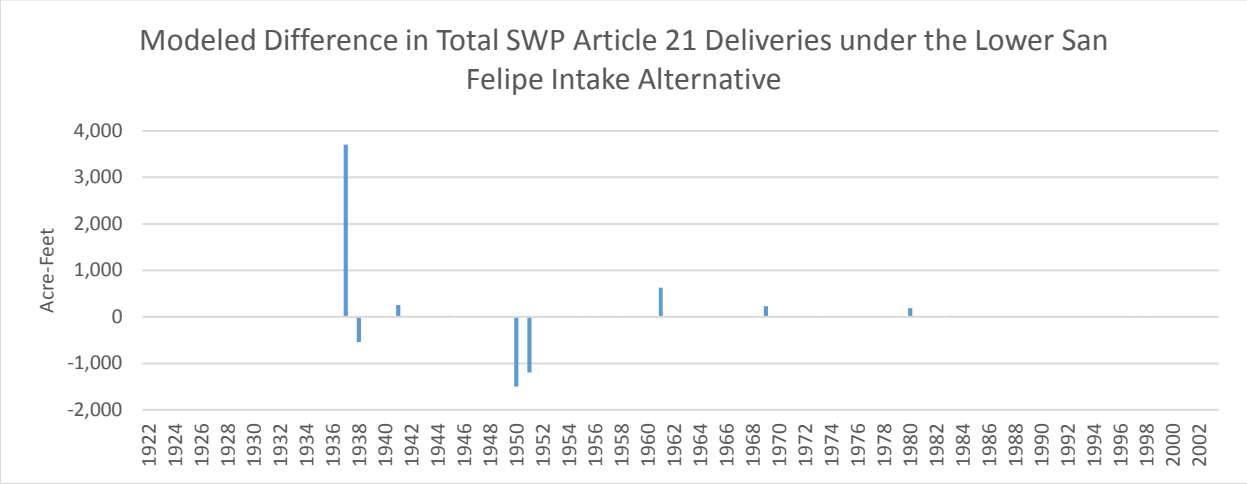


Figure N-8. Modeled Difference in Total SWP Article 21 Deliveries between the No Action/No Project Conditions and Lower San Felipe Intake Alternative

N.3.3 Deliveries to Santa Clara Valley Water District

The Lower San Felipe Intake Alternative would result in the construction of a new lower intake for the San Felipe Division that would prevent algae-laden water from entering the intake. This alternative would reduce or avoid the need to blend San Luis Reservoir water with other higher quality water supplies or switch to alternate water supply sources such as groundwater when surface water supplies were reduced. Under this alternative, modeling results have predicted that there would be 17 years (out of the 82 calendar years analyzed) where San Luis Reservoir would be drawn below 300 TAF of storage i.e. low point years. As shown in Tables N-12 and N-13, San Felipe Division CVP M&I deliveries would increase on average by 3 TAF and there would be no difference in agricultural deliveries. Figure N-9 shows how the Lower San Felipe Intake Alternative addresses SCVWD low point water supply interruptions along with treated water demand shortages in the No Action Alternative. Results show that the Lower San Felipe Intake Alternative would allow uninterrupted delivery of SCVWD CVP M&I deliveries in all low point years and would be able to fully replace SCVWD's unmet treated water demand in 10 of the 17 low point years (on a calendar year basis).

Table N-12. Averaged Modeled Difference in San Felipe Division CVP Agricultural and CVP M&I Deliveries between the No Action/No Project Conditions and Lower San Felipe Intake Alternative by Water Year Type (1,000 acre-feet)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
San Felipe Division Agricultural Deliveries													
W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
BN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
San Felipe Division CVP M&I Deliveries													
W	0.0	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
AN	1.2	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	5.1
BN	1.3	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	1.4	6.6
D	0.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	2.5
C	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	3.5
All	0.6	0.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.1	3.2

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table N-13. Averaged Modeled Difference in San Felipe Division CVP Agricultural and CVP M&I Deliveries between the No Action/No Project Conditions and Lower San Felipe Intake Alternative by Water Year Type (% change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
San Felipe Division Agricultural Deliveries													
W	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	0.1%	0.1%	0.1%	0.1%	0.1%	-0.5%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.4%
BN	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%
D	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.3%	-0.2%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%
C	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.3%	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	-0.2%
All	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
San Felipe Division CVP M&I Deliveries													
W	0.0%	3.4%	3.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%
AN	21.3%	21.3%	0.0%	0.0%	0.0%	-0.2%	-0.1%	-0.2%	-0.2%	-0.2%	28.3%	-0.2%	5.2%
BN	22.1%	22.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	25.7%	15.7%	7.0%
D	7.9%	3.8%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	21.1%	2.8%
C	6.4%	-0.2%	-0.2%	-0.2%	-0.2%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	74.8%	4.8%
All	8.7%	8.2%	1.1%	-0.1%	-0.1%	-0.1%	0.0%	-0.1%	-0.1%	-0.1%	7.4%	11.2%	3.2%

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

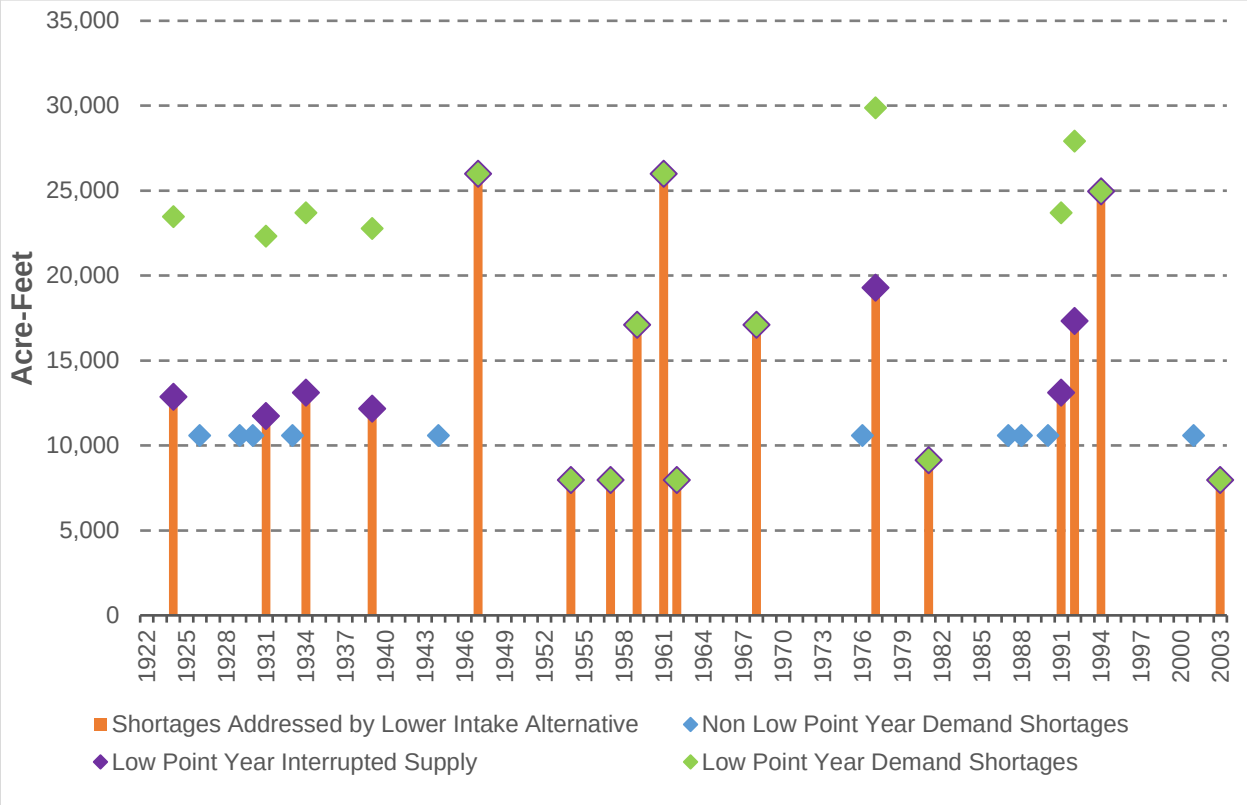


Figure N-9. Annual Shortages Addressed by the Lower San Felipe Intake Alternative

N.3.4 Changes to South-of-Delta Exports

Operation of the Lower San Felipe Intake Alternative would increase total south-of-Delta exports in some years when compared to the No Action/No Project Alternative. Simulated Delta exports would increase or decrease by less than 1 percent in all months of all water-year types (Tables N-14 and N-15). In August, October, and November, there would be a less than 1 percent decrease in Delta exports. During most years Delta exports, would be unchanged.

Table N-14. Averaged Modeled Difference in Delta Exports between the No Action/No Project Conditions and Lower San Felipe Intake Alternative by Water Year Type (1,000 acre-feet)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.9	0.5	0.0	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0
AN	-0.7	0.0	0.1	0.6	0.4	0.0	0.0	0.0	0.0	-0.1	-0.3	0.7
BN	0.2	-0.6	0.4	0.0	0.7	0.0	0.0	0.0	0.0	-0.2	0.7	0.4
D	-0.2	-0.1	0.5	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	-0.5	1.5
C	0.2	-0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	-1.0	1.5
All	0.2	0.0	0.2	0.1	0.3	0.1	0.0	0.0	0.0	0.0	-0.2	0.7

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

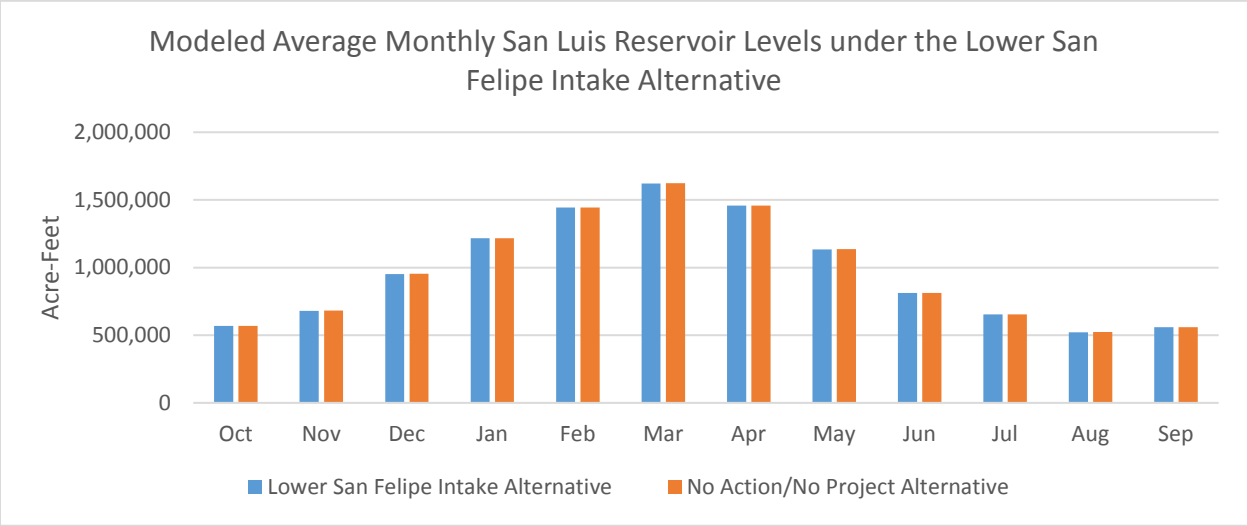
Table N-15 Averaged Modeled Difference in Delta Exports between the No Action/No Project Conditions and Lower San Felipe Intake Alternative by Water Year Type (% change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.2%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	-0.2%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
BN	0.0%	-0.2%	0.1%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
D	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.4%
C	0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.1%	-0.7%	0.6%
All	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

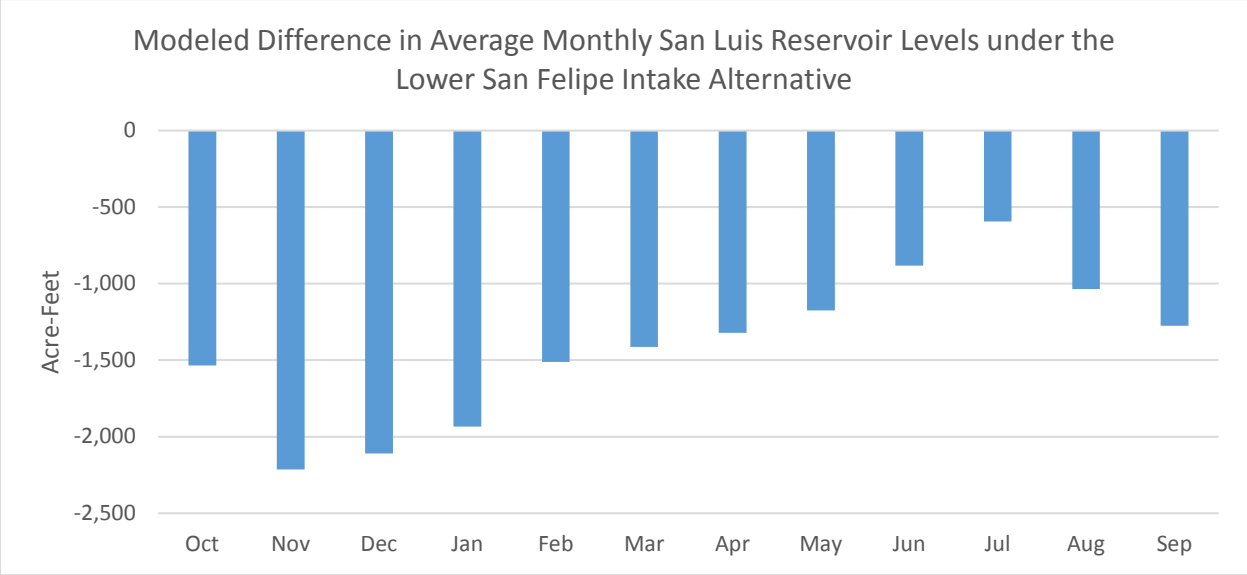
N.3.5 Changes in San Luis Reservoir Storage Levels

Under the Lower San Felipe Intake Alternative, SCVWD would be able to fully divert its CVP allocation and would not have to leave water in San Luis storage as it does in the No Action/No Project Alternative; therefore, reservoir levels would be lower. San Luis Reservoir would experience an average 2 TAF decrease in total annual storage across all years and less than a 1 foot decrease in reservoir elevation. Figure N-10 displays the average monthly San Luis Reservoir storage levels under the Lower San Felipe Intake Alternative. Figure N-11 displays the difference in average monthly San Luis Reservoir storage levels compared to the No Action/No Project Alternative.



Note: Data results from CalSim modeling presented in Appendix B.

Figure N-10. Modeled Average Monthly San Luis Reservoir Levels under the No Action/No Project Conditions and the Lower San Felipe Intake Alternative



Note: Data results from CalSim modeling presented in Appendix B.

Figure N-11. Modeled Difference in Average Monthly San Luis Reservoir Levels between the No Action/No Project Conditions and Lower San Felipe Intake Alternative

N.4 Alternative 3 - Treatment Alternative

The Treatment Alternative would develop new treatment technology retrofits at the SCVWD's Santa Teresa WTP to improve the WTP's ability to treat water from San Luis Reservoir during low point conditions.

N.4.1 Deliveries to South-of-Delta CVP Facilities and Contractors

Under the Treatment Alternative, average reservoir levels in San Luis Reservoir would likely be lower than existing conditions and the No Action/No Project Alternative because SCVWD would be able to withdraw their full contract amount of CVP water each year from San Luis Reservoir, even during low point years. This would result in less carryover water stored in the reservoir and lower overall levels during some years. Decreased carryover storage by SCVWD as a result of low point events could decrease deliveries to CVP south-of-Delta agricultural contractors in subsequent years when SCVWD was not able to access that carried over supply. The change in delivery of water to CVP south-of-Delta agricultural contractors would be the same as described for the Lower San Felipe Intake Alternative in Tables N-8 and N-9 and Figures N-3 and N-4; the change in water supply delivery would be minor.

N.4.2 Deliveries to South-of-Delta SWP Contractors

There would be no change in the SWP and CVP deliveries using the SBA and California Aqueduct, but the potential changes in surplus water would also apply to SWP contractors, as the San Luis Reservoir is a shared facility, holding both SWP and CVP water. Similar to the CVP under existing conditions, the availability of surplus water is infrequent, and contractors do not base long term water supply decisions based on the availability, or lack thereof, of this water.

N.4.3 Deliveries to Santa Clara Valley Water District

The Treatment Alternative would result in modifications to the existing Santa Teresa WTP to allow it to more effectively treat the algae-laden water from San Luis Reservoir. This alternative would avoid supply curtailments during low point events because it would allow water to be withdrawn from San Luis Reservoir using the existing San Felipe Intake that would have otherwise remained in San Luis Reservoir. Algae-laden water would be treated at the WTP and then conveyed to users.

Compared to the No Action/No Project Alternative, the Treatment Alternative would decrease the number of low point years that WTP production would not meet demands. This improvement would be similar to the improvements presented above for the Lower San Felipe Intake Alternative in Tables N-12 and N-13, by supporting SCVWD deliveries from San Luis Reservoir when levels fall below 300 TAF. The alternative would deliver additional M&I supply in all low point years when compared to the No Action/No Project Alternative, reducing SCVWD unmet demand during low point events. This alternative would increase the ability of San Felipe Division infrastructure to supply CVP water to SCVWD and would increase water reliability for the SCVWD in the long-term.

N.4.4 Changes in San Luis Reservoir Storage Levels

Under the Treatment Alternative, average reservoir levels in San Luis Reservoir would likely be lower than existing conditions and the No Action/No Project Alternative because SCVWD would be able to withdraw their full contract

amount of CVP water each year from San Luis Reservoir, even during low point years. This would result in less carryover water stored in the reservoir and lower overall levels during some years. The frequency and duration of this impact would be the same as described for the Lower San Felipe Intake Alternative in Figures N-10 and N-11; the changes in water supply would be minor. When compared to the No Action/No Project Alternative, the reduction in San Luis Reservoir storage would average a 2 TAF decrease and less than a 1 foot decrease in reservoir elevation.

N.5 Alternative 4 - San Luis Reservoir Expansion Alternative

The San Luis Reservoir Expansion Alternative would raise Sisk Dam by approximately ten feet and increase storage capacity at San Luis Reservoir by approximately 120,000 AF. The San Luis Reservoir Expansion Alternative would allocate the increased capacity to the CVP only.

N.5.1 Deliveries to South-of-Delta CVP Contractors

South-of-Delta CVP agricultural deliveries are expected to increase up to 25,000 AF under certain water year types. Tables N-16 and N-17 summarizes the change in delivery of CVP water under this option. Figures N-11 and N-12 show the modeled impacts of the San Luis Reservoir Expansion Alternative on CVP South-of-Delta agricultural deliveries.

Table N-16. Averaged Modeled Difference in Total CVP Agricultural Deliveries between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative by Water Year Type (1,000 acre-feet)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.6	0.4	0.6	1.1	1.2	0.5	2.0	2.9	4.6	5.7	4.1	1.3	25.1
AN	0.7	0.5	0.8	1.4	1.6	0.8	1.1	1.7	2.7	3.4	2.4	0.8	17.8
BN	0.1	0.1	0.1	0.1	0.1	0.4	1.9	2.7	4.4	5.4	3.9	1.2	20.4
D	0.7	0.5	0.7	1.3	1.5	-0.1	-0.3	-0.4	-0.6	-0.8	-0.6	-0.2	1.8
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All	0.5	0.3	0.5	0.8	1.0	0.3	1.1	1.5	2.5	3.1	2.2	0.7	14.4

Notes: Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table N-17. Averaged Modeled Difference in Total CVP Agricultural Deliveries between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative by Water Year Type (% change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	1.7%	1.7%	1.7%	1.7%	1.7%	0.8%	2.1%	2.0%	2.0%	2.0%	2.0%	2.0%	1.9%
AN	3.1%	3.1%	3.1%	3.1%	3.1%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.8%
BN	0.2%	0.2%	0.2%	0.2%	0.2%	1.0%	3.2%	3.1%	3.1%	3.1%	3.1%	3.1%	2.3%
D	2.9%	2.9%	2.9%	2.9%	2.9%	-0.3%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%	0.3%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%
All	1.7%	1.7%	1.7%	1.7%	1.7%	0.8%	1.8%	1.7%	1.7%	1.7%	1.7%	1.7%	1.6%

Notes: Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

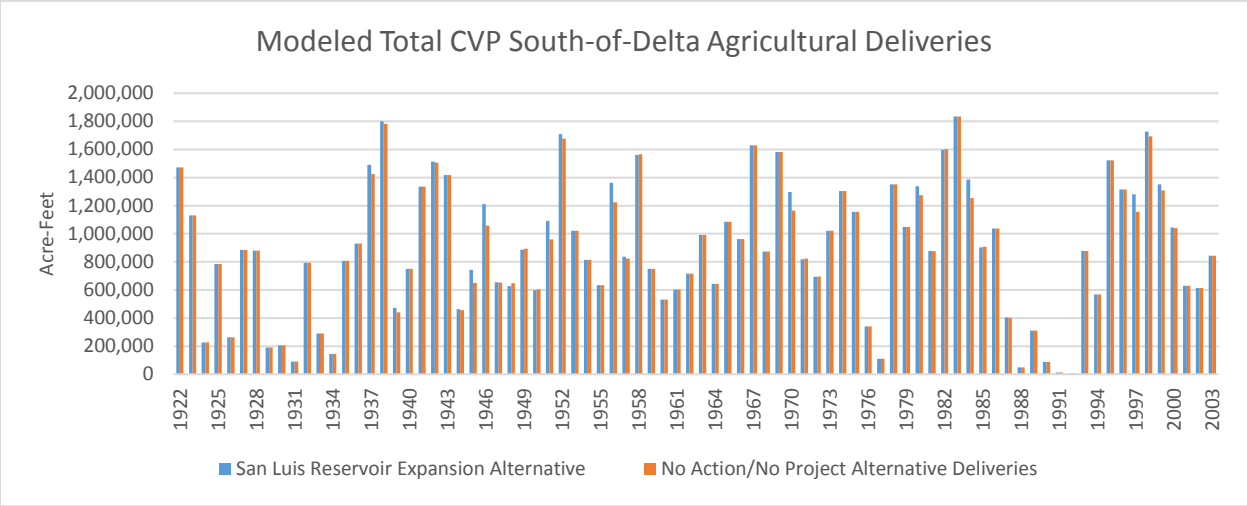


Figure N-12. Modeled Total CVP South-of-Delta Agricultural Deliveries under the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative

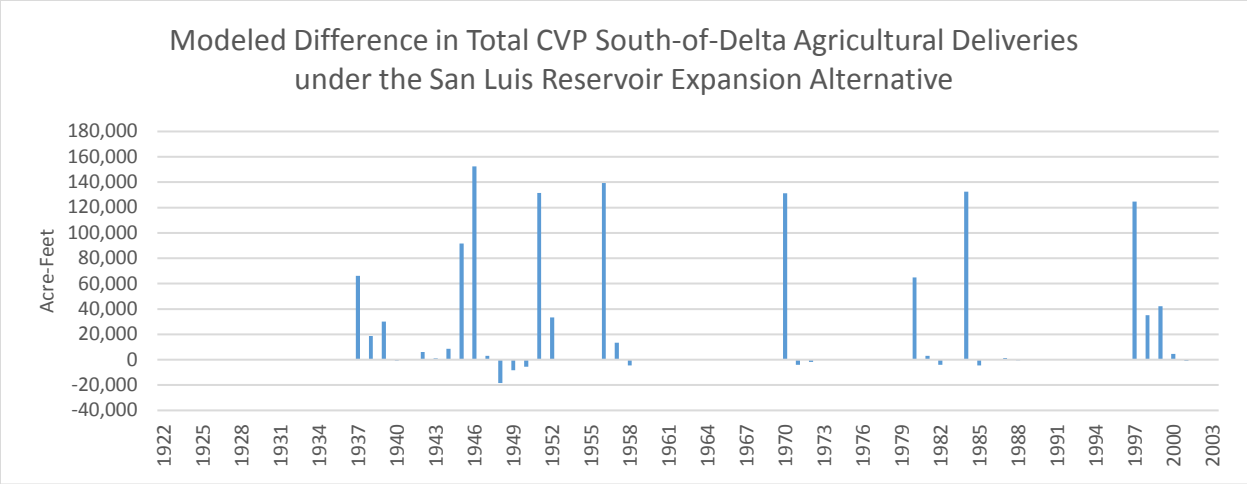


Figure N-13. Modeled Difference in Total CVP South-of-Delta Agricultural Deliveries between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative

N.5.2 Deliveries to South-of-Delta SWP Contractors

South-of-Delta SWP deliveries are expected to decrease an average of 3,000 AF under the San Luis Reservoir Expansion Alternative. Tables N-18 and N-19 summarizes the change in delivery of SWP water under this alternative. Figures N-13 through N-16 show the modeled impacts of the San Luis Reservoir Expansion Alternative on SWP deliveries and surplus water supply. Table A SWP deliveries would decrease slightly in all year types except critical and dry water years where they would increase by less than 1%. In addition, this alternative would reduce potential surplus water supply (Article 21) deliveries to SWP contractors as CVP deliveries increase. The availability of this surplus water in any particular year is uncertain, and contractors do not base long term water supply decisions based on the availability, or lack thereof, of this water.

Table N-18. Averaged Modeled Difference in Table A SWP Deliveries (Table A and Article 21) between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative by Water Year Type (1,000 acre-feet)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
SWP Table A Deliveries													
W	-0.3	-0.3	-0.3	-0.1	-0.1	-0.1	-0.5	-0.7	-0.8	-0.8	-0.8	-0.7	-5.6
AN	-1.0	-0.9	-0.9	0.0	-0.5	0.0	0.0	0.0	0.0	0.1	0.0	0.0	-3.0
BN	0.8	0.5	0.6	0.1	-1.8	-0.3	-0.5	-1.8	-1.4	-1.1	-1.0	-1.0	-7.0
D	-0.8	-0.9	-0.8	0.0	0.0	0.0	0.1	0.5	0.8	1.1	1.0	0.8	1.8
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
All	-0.3	-0.3	-0.3	0.0	-0.4	-0.1	-0.2	-0.4	-0.3	-0.2	-0.2	-0.2	-3.0

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
SWP Article 21 Deliveries													
W	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.2
AN	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
BN	0.0	0.0	-0.1	0.0	-9.2	-4.2	0.0	0.0	0.0	0.0	0.0	0.0	-13.6
D	0.0	0.1	-0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.1
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All	0.0	0.0	0.0	0.0	-1.5	-0.7	0.0	0.0	0.0	0.0	0.0	0.0	-2.3

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table N-19. Averaged Modeled Difference in Table A SWP Deliveries (Table A and Article 21) between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative by Water Year Type (% change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
SWP Table A Deliveries													
W	-0.1%	-0.1%	-0.1%	-0.2%	-0.1%	-0.1%	-0.3%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
AN	-0.4%	-0.5%	-0.4%	0.2%	-1.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
BN	0.3%	0.2%	0.3%	0.7%	-8.5%	-0.7%	-0.3%	-0.8%	-0.4%	-0.3%	-0.3%	-0.3%	-0.3%
D	-0.3%	-0.5%	-0.4%	0.0%	0.1%	-0.1%	0.1%	0.3%	0.3%	0.3%	0.3%	0.3%	0.1%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All	-0.1%	-0.1%	-0.1%	0.0%	-1.0%	-0.1%	-0.2%	-0.2%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
SWP Article 21 Deliveries													
W	0.0%	0.0%	0.0%	0.0%	0.0%	-0.4%	-3.7%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%
AN	0.0%	0.0%	0.0%	1.0%	1.2%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%
BN	0.0%	0.0%	-9.1%	0.0%	-43.6%	-10.4%	0.0%	0.0%	0.0%	0.0%	1.3%	0.0%	-19.2%
D	0.0%	9.4%	-7.1%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	6.3%	0.0%	0.5%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All	0.0%	0.7%	-1.4%	0.5%	-9.2%	-2.8%	-1.2%	0.0%	0.0%	0.0%	2.5%	0.0%	-3.7%

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

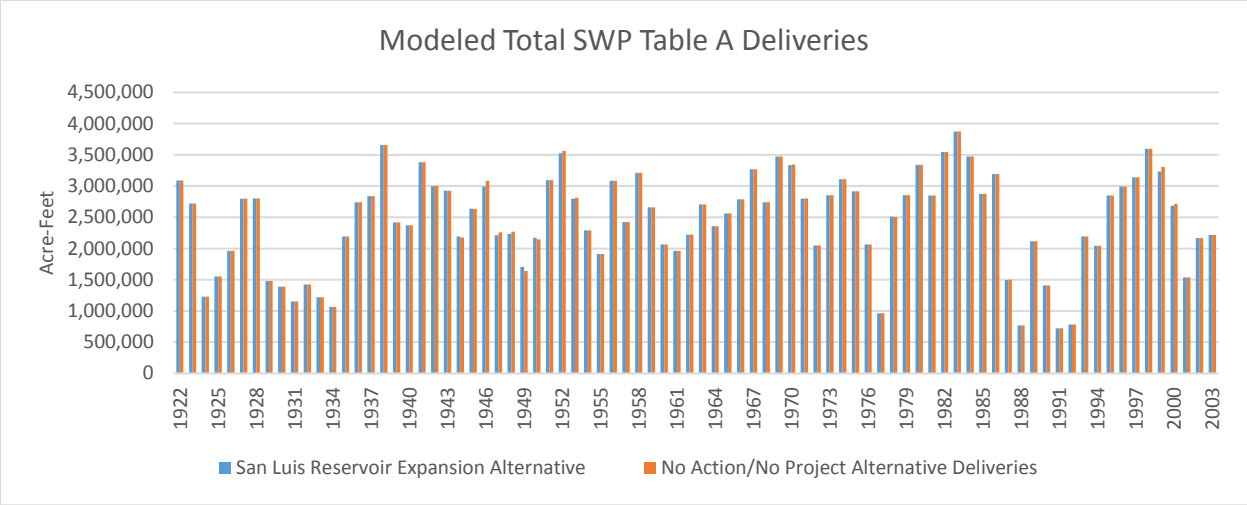


Figure N-14. Modeled Total SWP Table A Deliveries under the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative

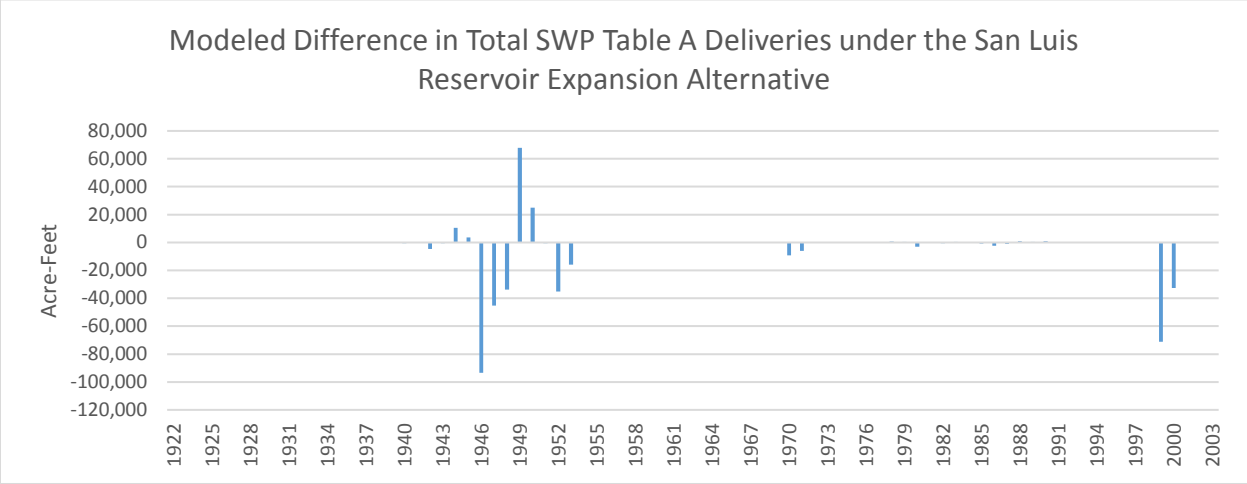


Figure N-15. Modeled Difference in Total SWP Table A Deliveries between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative

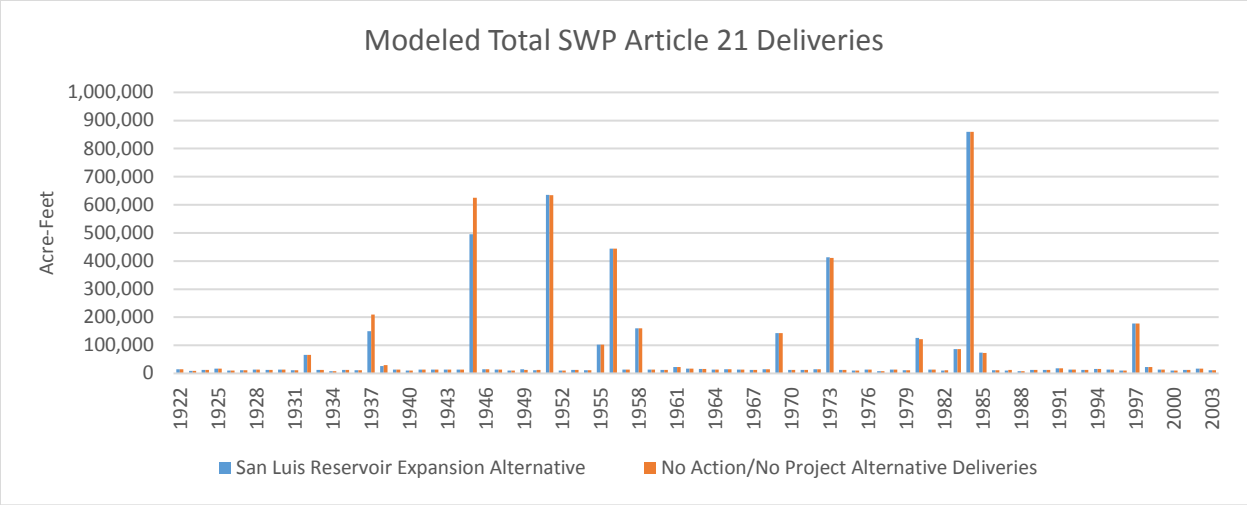


Figure N-16. Modeled Total SWP Article 21 Deliveries under the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative

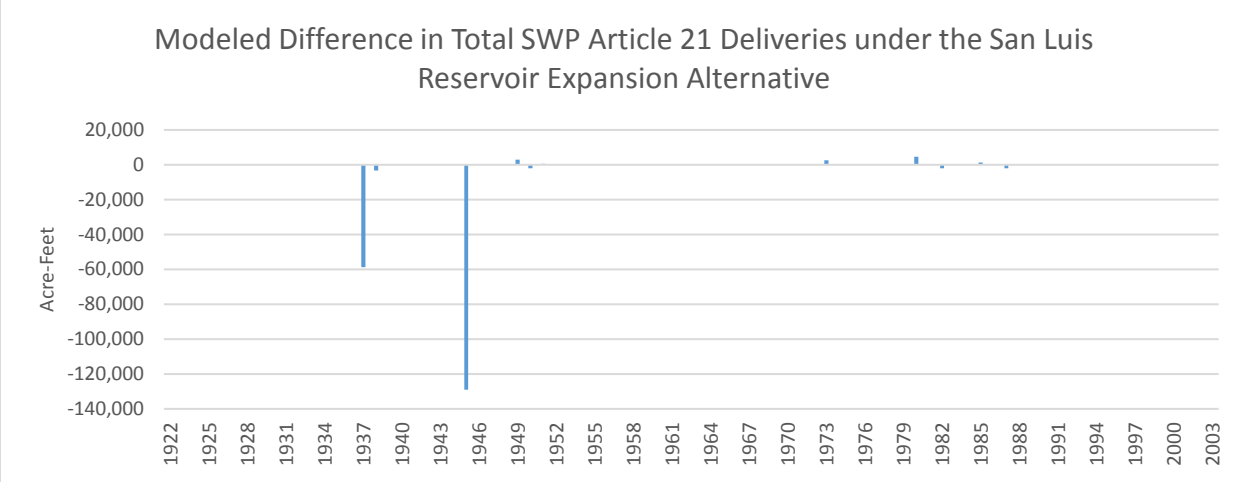


Figure N-17. Modeled Difference in Total SWP Article 21 Deliveries between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative

N.5.3 Deliveries to Santa Clara Valley Water District

Under this alternative, modeling results have predicted that there would be 17 years (out of the 82 calendar years analyzed) where San Luis Reservoir would be drawn below 300 TAF of storage i.e. low point years. Under the San Luis Reservoir Expansion Alternative, San Felipe Division CVP M&I and agricultural deliveries would increase on average by 600 AF, as shown in Tables N-20 and N-21. Figure N-17 shows how the San Luis Reservoir Expansion Alternative addresses SCVWD low point water supply interruptions along with treated water demand shortages in the No Action Alternative. The alternative would deliver additional water supplies in 8 of the 17 low point

years, but would not in any year fully address the low point generated water supply shortages.

Table N-20. Averaged Modeled Difference in San Felipe Division CVP Agricultural and CVP M&I Deliveries between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative by Water Year Type (1,000 acre-feet)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
San Felipe Division CVP Agricultural Deliveries													
W	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.2	0.1	1.0
AN	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.8
BN	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.7
D	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.6
San Felipe Division CVP M&I Deliveries													
W	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	1.4
AN	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7
BN	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	-0.6	-0.3
D	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.6

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table N-21. Averaged Modeled Difference in San Felipe Division CVP Agricultural and CVP M&I Deliveries between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative by Water Year Type (% change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
San Felipe Division CVP Agricultural Deliveries													
W	1.7%	1.7%	1.7%	1.7%	1.7%	0.8%	2.1%	2.0%	2.0%	2.0%	2.0%	2.0%	1.9%
AN	3.1%	3.1%	3.1%	3.1%	3.1%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	2.0%
BN	0.2%	0.2%	0.2%	0.2%	0.2%	1.0%	3.2%	3.1%	3.1%	3.1%	3.1%	3.1%	1.9%
D	2.9%	2.9%	2.9%	2.9%	2.9%	-0.3%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%	0.9%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%
All	1.7%	1.7%	1.7%	1.7%	1.7%	0.8%	1.8%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%
San Felipe Division CVP M&I Deliveries													
W	1.2%	1.2%	1.2%	1.2%	1.2%	0.6%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.2%
AN	0.4%	0.4%	0.6%	0.6%	0.6%	0.8%	0.8%	0.8%	0.8%	0.8%	1.0%	0.8%	0.7%
BN	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.8%	0.8%	0.8%	0.8%	1.1%	-6.9%	-0.3%
D	1.5%	1.4%	1.4%	1.4%	1.4%	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.6%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All	0.8%	0.8%	0.8%	0.8%	0.8%	0.4%	0.8%	0.8%	0.8%	0.8%	0.8%	-0.4%	0.6%

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

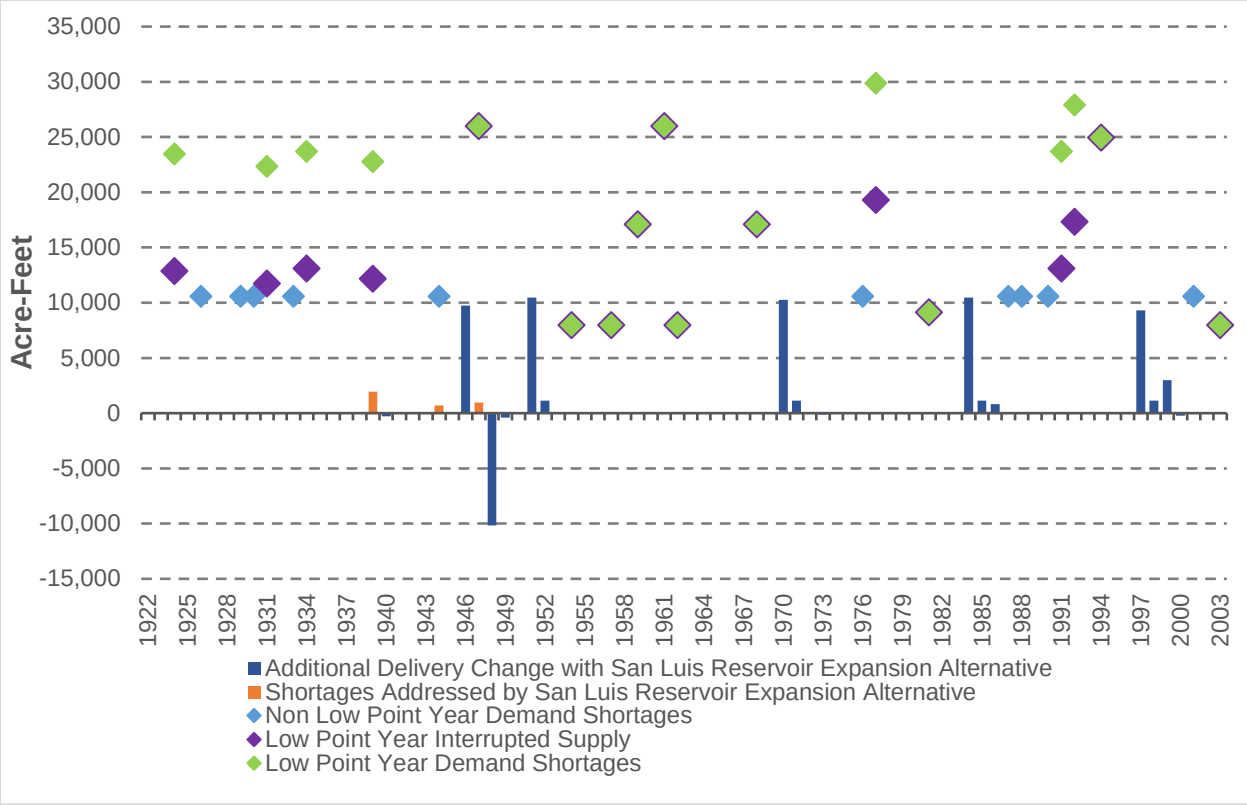


Figure N-18. Annual Shortages Addressed by the San Luis Reservoir Expansion Alternative

N.5.4 Changes in South-of-Delta Exports

Increasing storage capacity in San Luis Reservoir under the San Luis Reservoir Expansion Alternative would increase total south-of-Delta exports in some years when compared to the No Action/No Project Alternative. Except for one model period, simulated Delta exports would increase by less than two percent in all months of all water-year types (Tables N-22 and N-23). In February of Above Normal water years, there would be a 2.5 percent increase in Delta exports. During most years Delta exports, would be unchanged.

Table N-22. Averaged Modeled Difference in Delta Exports between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative by Water Year Type (1,000 acre-feet)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	1.4	-1.0	0.0	1.8	5.8	14.6	1.5	0.0	0.0	1.2	0.7	0.4
AN	6.8	0.2	-2.7	6.5	9.9	1.1	0.0	0.0	0.0	-0.4	0.1	-0.8
BN	0.9	-4.0	1.3	0.0	-4.2	0.2	0.0	0.0	0.0	0.2	0.0	1.9
D	3.6	-4.5	-0.1	0.0	0.0	0.0	0.0	0.0	0.1	1.8	-1.5	-0.9
C	0.1	0.0	-0.3	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.1

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table N-23. Averaged Modeled Difference in Delta Exports between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative (% change)

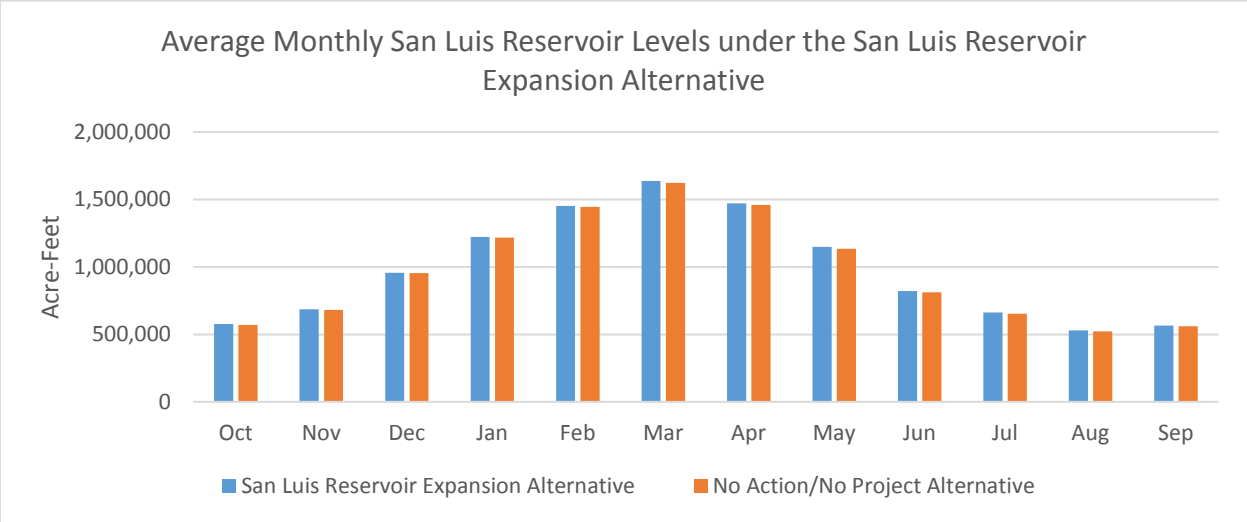
Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.3%	-0.2%	0.0%	0.4%	1.1%	2.4%	0.8%	0.0%	0.0%	0.2%	0.1%	0.1%
AN	1.7%	0.1%	-0.5%	1.6%	2.5%	0.2%	0.0%	0.0%	0.0%	-0.1%	0.0%	-0.1%
BN	0.2%	-0.9%	0.2%	0.0%	-1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%
D	0.9%	-1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	-0.4%	-0.2%
C	0.0%	0.0%	-0.1%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

These increased exports are comprised of water that would have otherwise been surplus Delta outflow in the No Action/No Project Alternative. The water rights for the CVP include provisions for the re-diversion of upstream storage withdrawals and diversion of surplus flows to San Luis Reservoir. The CVP would operate an expanded San Luis Reservoir within these existing water rights.

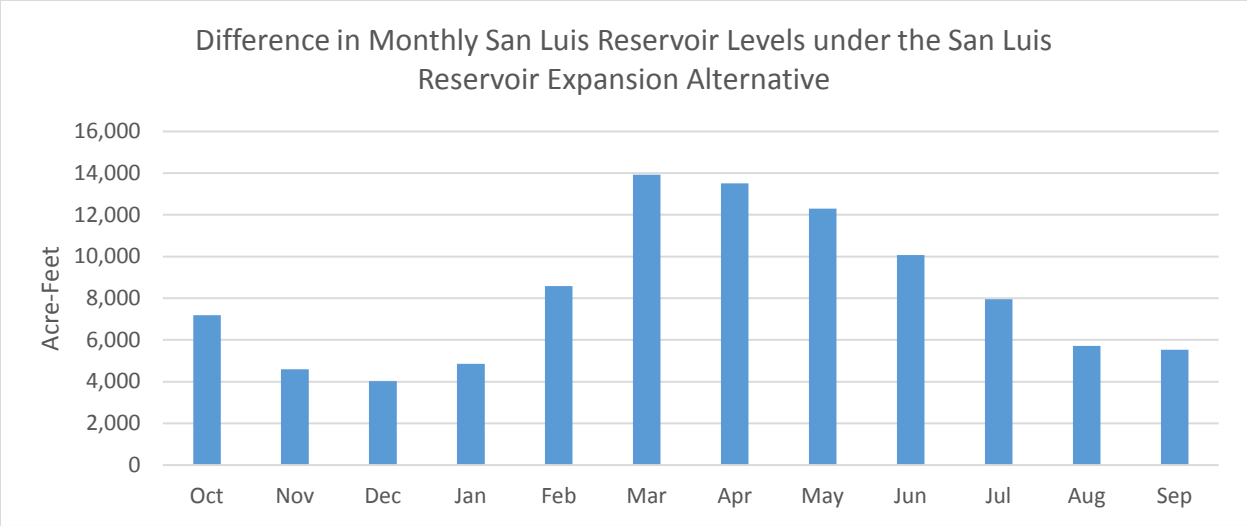
N.5.5 Changes in San Luis Reservoir Storage Levels

The San Luis Reservoir Expansion Alternative would generate slightly increased storage levels in San Luis Reservoir when compared to the No Action/No Project Alternative (see Appendix B for detailed modeling results). San Luis Reservoir would experience an average increase of 8 TAF in total storage and slightly greater than a 1 foot increase in reservoir elevation under this alternative. Figure N-19 displays the average monthly San Luis Reservoir storage levels under the San Luis Reservoir Expansion Alternative. Figure N-20 displays the difference in average monthly San Luis Reservoir storage levels compared to the No Action/No Project Alternative.



Note: Data results from CalSim modeling presented in Appendix B.

Figure N-19. Modeled Average Monthly San Luis Reservoir Levels under the No Action/No Project Conditions and the San Luis Reservoir Expansion Alternative



Note: Data results from CalSim modeling presented in Appendix B.

Figure N-20. Modeled Difference in Average Monthly San Luis Reservoir Levels between the No Action/No Project Conditions and San Luis Reservoir Expansion Alternative

N.6 Alternative 5 - Pacheco Reservoir Expansion Alternative

The Pacheco Reservoir Expansion Alternative would construct and operate a new dam and reservoir with an active storage capacity of approximately 140,800 AF. The new dam and reservoir would be constructed on Pacheco Creek 0.5 mile upstream from the existing North Fork Dam and would inundate most of the existing Pacheco Reservoir. Pacheco Reservoir would be filled using a combination of natural hydrology within the North Fork Pacheco Creek basin, including the East Fork, and by SCVWD-owned water from San Luis Reservoir under a CVP contract.

N.6.1 Deliveries to South-of-Delta CVP Contractors

Under the Pacheco Reservoir Expansion Alternative, average reservoir levels in San Luis Reservoir would likely be lower than existing conditions and the No Action/No Project Alternative because SCVWD would be able to withdraw their full contract amount of CVP water each year from San Luis Reservoir, even during low point years. This would result in less carryover water stored in the reservoir and lower overall levels during some years. Decreased carryover storage by SCVWD as a result of low point events could decrease deliveries to CVP south-of-Delta agricultural contractors in subsequent years when SCVWD was not able to access that carried over supply. The change in delivery of water to CVP south-of-Delta agricultural contractors would be the same as described for the Lower San Felipe Intake Alternative in Tables N-8 and N-9 and Figures N-3 and N-4; the change in water supply delivery would be minor.

N.6.2 Deliveries to South-of-Delta SWP Contractors

The Pacheco Reservoir Expansion Alternative would affect the operations of CVP supplies, but SWP supplies would remain unchanged. The frequency and duration of this impact would be the same as described for the Lower San Felipe Intake Alternative, as shown in Tables N-10 and N-11; there would be no difference in the SWP deliveries.

N.6.3 Deliveries to Santa Clara Valley Water District

Under this alternative, modeling results have predicted that there would be 17 years (out of the 82 calendar years analyzed) where San Luis Reservoir would be drawn below 300 TAF of storage (i.e. low point years) in at least one month. Under the Pacheco Reservoir Expansion Alternative, San Felipe Division CVP M&I deliveries would increase on average by 2,800 AF, as shown in Tables N-24 and N-25. Figure N-19 shows how the Pacheco Reservoir Expansion Alternative addresses SCVWD low point water supply interruptions along with treated water demand shortages in the No Action Alternative. Results show that the Pacheco Reservoir Expansion Alternative would allow uninterrupted delivery of SCVWD CVP M&I deliveries 14 out of the 17 low point years (on a calendar year basis) when compared to the No Action/No Project Alternative, partially reducing SCVWD unmet demand during low point events.

Table N-24. Averaged Modeled Difference in San Felipe Division Agricultural and M&I Deliveries between the No Action/No Project Conditions and Pacheco Reservoir Expansion Alternative by Water Year Type (1,000 acre-feet)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
San Felipe Division Agricultural Deliveries													
W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
BN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
San Felipe Division M&I Deliveries													
W	0.0	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
AN	1.2	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	5.1
BN	1.3	1.9	0.0	0.0	0.0	-2.0	0.0	0.0	0.0	0.0	2.0	1.4	4.6
D	0.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	2.5
C	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	3.5
All	0.6	0.8	0.1	0.0	0.0	-0.4	0.0	0.0	0.0	0.0	0.7	1.1	2.8

Notes: Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table N-25. Averaged Modeled Difference in San Felipe Division Agricultural and M&I Deliveries between the No Action/No Project Conditions and Pacheco Reservoir Expansion Alternative by Water Year Type (% change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
San Felipe Division Agricultural Deliveries													
W	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	0.1%	0.1%	0.1%	0.1%	0.1%	-0.5%	-0.6%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.4%
BN	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%
D	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.3%	-0.2%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%
C	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.3%	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	-0.2%
All	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
San Felipe Division M&I Deliveries													
W	0.0%	3.4%	3.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%
AN	21.3%	21.3%	0.0%	0.0%	0.0%	-0.2%	-0.1%	-0.2%	-0.2%	-0.2%	28.3%	-0.2%	5.2%
BN	22.1%	22.1%	-0.1%	-0.1%	-0.1%	-18.5%	-0.1%	-0.1%	-0.1%	-0.1%	25.7%	15.7%	4.9%
D	7.9%	3.8%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	21.1%	2.8%
C	6.4%	-0.2%	-0.2%	-0.2%	-0.2%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	74.8%	4.8%
All	8.7%	8.2%	1.1%	-0.1%	-0.1%	-3.2%	0.0%	-0.1%	-0.1%	-0.1%	7.4%	11.2%	2.9%

Notes: Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

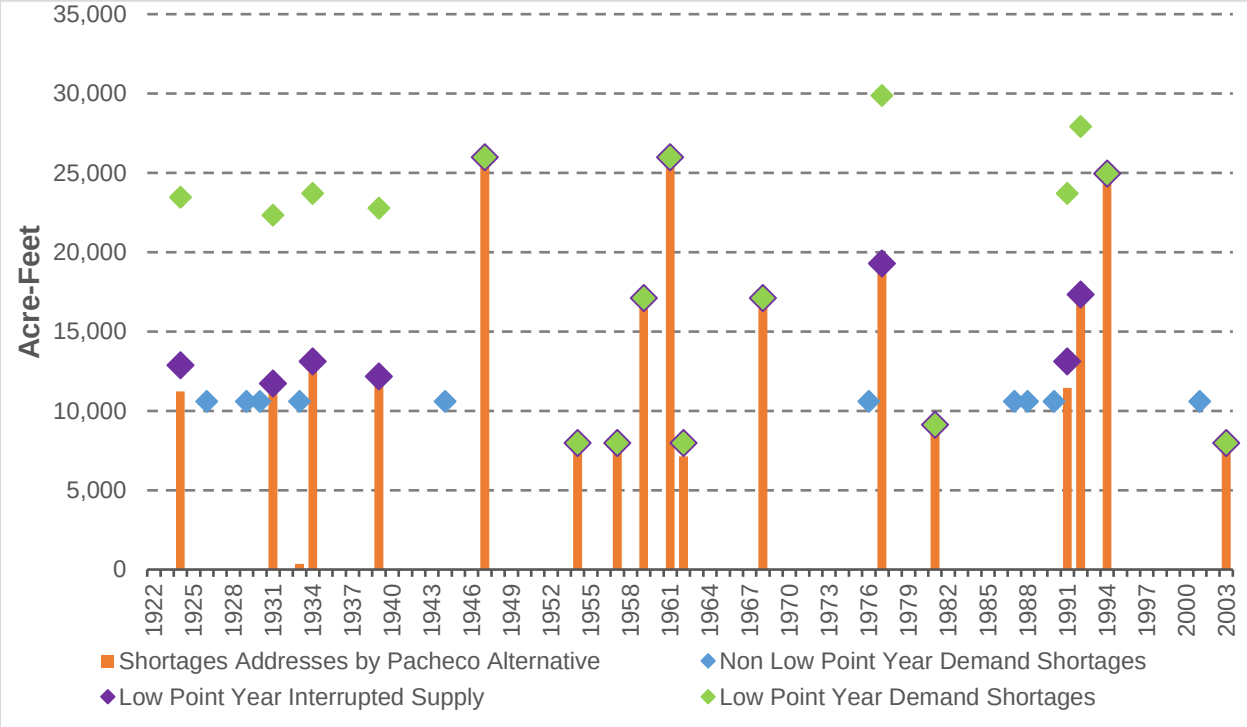


Figure N-21. Annual Shortages Addressed by the Pacheco Reservoir Expansion Alternative

The Pacheco Reservoir Expansion Alternative would require a new water right to store more flow from the North Fork Pacheco Creek and modify the use of this water to include fish preservation and enhancement. This water right would capture unused flow and would not affect downstream water supplies.

N.6.4 Changes in South-of-Delta Exports

Operation of the Pacheco Reservoir Expansion Alternative would increase total south-of-Delta exports in some years when compared to the No Action/No Project Alternative. Simulated Delta exports would increase by less than 1 percent in all months of all water-year types (Tables N-26 and N-27). In August, October, and November, there would be a less than 1 percent decrease in Delta exports. During most years Delta exports, would be unchanged.

Table N-26. Averaged Modeled Difference in Delta Exports between the No Action/No Project Conditions and Pacheco Reservoir Expansion Alternative by Water Year Type (1,000 acre-feet)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.9	0.5	0.0	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0
AN	-0.7	0.0	0.1	0.6	0.4	0.0	0.0	0.0	0.0	-0.1	-0.3	0.7
BN	0.2	-0.8	0.4	0.0	0.7	0.0	0.0	0.0	0.0	-0.2	0.7	0.3
D	0.0	-0.1	0.4	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	-0.5	1.5
C	0.2	-0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	-1.0	1.6
All	0.3	-0.1	0.2	0.1	0.3	0.1	0.0	0.0	0.0	0.0	-0.2	0.7

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

Table N-27. Averaged Modeled Difference in Delta Exports between the No Action/No Project Conditions and Pacheco Reservoir Expansion Alternative by Water Year Type (% change)

Sac Yr Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.2%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	-0.2%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
BN	0.0%	-0.2%	0.1%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
D	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.4%
C	0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.1%	-0.7%	0.6%
All	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%

Notes: Modeling Period 1922-2003, Data results from CalSim modeling presented in Appendix B.
AN – Above Normal; BN – Below Normal; C – Critical; D – Dry; Sac Yr Type – Sacramento River Water Year Type; W – Wet

These increased exports would divert what in the No Action/No Project Alternative what would have otherwise been surplus flow. The water rights for the CVP and SWP both include provisions for the re-diversion of upstream storage withdrawals and diversion of surplus flows to storage in San Luis Reservoir. Storage of water in Pacheco Reservoir previously diverted from the

Delta and stored in San Luis Reservoir under the existing CVP water right would require the addition of a point of re-diversion to that permit.

N.6.5 Changes in San Luis Reservoir Storage Levels

Under the Pacheco Reservoir Expansion Alternative, average reservoir levels in San Luis Reservoir would likely be lower than existing conditions and the No Action/No Project Alternative because SCVWD would be able to withdraw their full CVP water allocation each year from San Luis Reservoir, even during low point years. This would result in less carryover water stored in the reservoir and lower overall levels during some years. The frequency and duration of this impact would be the same as described for the Lower San Felipe Intake Alternative in Figures N-10 and N-11; the changes in water supply would be minor. When compared to the No Action/No Project Alternative, the reduction in San Luis Reservoir storage would average a 2 TAF decrease and less than a 1 foot decrease in reservoir elevation.

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San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix O: Detailed Air Quality Emission Calculations

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Appendix O
Detailed Air Quality Emission Calculations

O.1 Assessment Methods

The following sections provide additional discussion of emission estimation methodologies used for each source group. Attachment 1 summarizes the emission factors and detailed calculations for each emissions source.

For the unpaved haul roads and other sources of fugitive dust (e.g., grading), it was assumed that they would be watered regularly to reduce emissions. Fugitive dust emissions would be reduced by 61 percent with watering (Countess Environmental 2006). For the paved haul roads, it was assumed that a pipe-grid trackout-control device would be installed to minimize trackout from unpaved roads and other dirt construction areas. Paved road dust emissions would be reduced by 80 percent with the installation of the control device (Countess Environmental 2006).

In cases where emission factors are only available for inhalable particulate matter (PM_{10}), emissions of fine particulate matter (PM2.5) are estimated using speciation profiles published by California Air Resources Board (CARB) (2016).

O.1.1 On-Site Construction Equipment Engine Emissions

Emission factors were developed using several of CARB's emission factor models. For off-road construction equipment, the OFFROAD2017 Web Database (CARB 2017) was primarily used to estimate emissions. Emission factors were developed by Merced and Santa Clara Counties for calendar years 2020 to 2022.

The average power rating (horsepower [hp]) for the equipment was weighted from the equipment population and hp bins contained in the models. The emission factors that were developed for each piece of equipment are multiplied by the number of pieces of each equipment type that would be used during each phase of construction for each alternative. Peak daily and annual emissions were calculated based on the emission factors and data provided by the design engineers. Table O-1 summarizes the maximum daily equipment counts for each alternative. Although the equipment counts represent the maximum daily values, it is not assumed that every piece of equipment would operate simultaneously.

Table O-1. Off-Road Engine Equipment Counts

Equipment Type	Lower San Felipe Intake Alternative – Tunneling Option	Lower San Felipe Intake Alternative – Pipeline Option	Treatment Alternative	San Luis Reservoir Enlargement and Treatment Alternative[1]	Pacheco Reservoir Expansion Alternative
Aerial Lifts	0	0	0	0	2
Air Compressors	0	0	0	0	4
Boomtrucks	0	0	0	0	3
Bulldozer	2	2	1	4	6
Cement and Mortar Mixers	0	0	0	0	1
Chipper	0	0	0	0	0
Concrete Pumpers	2	1	2	2	0
Concrete Saw Cutters	0	0	2	2	0
Cranes	4	3	2	2	7
Drill Rig	1	0	0	0	0
Dump Truck	0	0	0	13	10
Excavator	1	1	1	3	1
Flatbed Trucks (on site)	3	3	4	4	3
Grader	2	2	0	1	2
Loaders	2	2	1	1	12
Maintenance Trucks	0	0	0	0	23
Portable Diesel Generators	7	4	0	0	4
Pressure Washers	0	0	0	0	2
Pumps	0	0	0	0	5
Roller	0	0	0	0	7
Scraper	1	1	0	0	1
Signal Boards	0	0	0	0	12
Skidders	0	0	0	0	3
Truck Mounted Drill Rig (Wells)	0	0	0	0	4
Vibrating Plate	0	0	0	0	0
Water Truck	2	2	2	5	6
Welders	0	0	0	0	4
Wheel Trencher	0	0	2	2	0
Total	**27**	**21**	**17**	**39**	**122**

Notes:

[1] Equipment inventory represents equipment that would operate during a peak day of construction. It was assumed that all equipment would operate simultaneously throughout construction.

The construction schedule is based on a 10-hour work day (one shift) for all alternatives except the San Luis Reservoir Enlargement Alternative and the Pacheco Reservoir Expansion Alternative, which are based on two shifts (20 hours per day). For the Lower San Felipe Intake Alternative, it was assumed that tunnel boring operations would continue 24 hours per day; therefore, 12 employees would work in the tunnel each day (assumes four workers per 8-hour shift).

O.1.2 Off-Site Haul/Delivery Truck and Construction Worker Engine Emissions and Road Dust

Engine exhaust emissions would occur from several on-road vehicles including dump trucks, concrete trucks, delivery trucks, gravel/paving trucks, and soil hauling trucks. Water trucks and flatbed trucks could also operate onsite during construction activities. Furthermore, emissions would also occur from construction workers commuting to the various construction sites. Off-site vehicle trip assumptions are consistent with those used in Chapter 15, Traffic and Transportation.

Haul and delivery truck emission factors were estimated using EMFAC2014 (CARB 2014) for heavy-duty diesel engines while the water and flatbed trucks were assumed to be medium-duty vehicles. Construction worker commuting emissions were estimated from the specific county's fleet mix for passenger automobiles and light-duty trucks. Both gasoline and diesel engines were assumed to be used by the construction workers.

For the haul/delivery trucks and construction workers, emission factors were estimated from the combined speeds in the various counties (i.e., a "burden" model run), rather than a specific speed. The onsite trucks were assumed to operate at 40 miles per hour (mph). In addition to engine exhaust emissions, emission factors for tire wear, brake wear, and re-entrained paved road dust were also estimated. The EMFAC2014 model estimates tire wear and brake wear, but paved road dust emissions were estimated using the USEPA's *Compilation of Air Pollutant Emission Factors* (AP-42, USEPA 2011).

O.1.3 Unpaved Road Dust

Fugitive dust emissions would occur from unpaved access roads within the project site. The methodology documented in Section 13.2.2 (USEPA 2006a) of AP-42 was used to estimate fugitive dust emissions from the haul trucks operating on these roads.

AP-42 requires an emission factor to be calculated using variables like the surface material silt content and mean vehicle weight on the roads. Two different equations are provided in AP-42 depending on whether the road is located at an industrial site or a publicly accessible road. The latter equation for publicly accessible roads assumes that the road will be dominated by light-duty vehicles; since haul trucks would be the primary equipment on the various haul roads, the equation for industrial sites (shown below) was used to estimate emissions.

$$E_{ext} = k(s/12)^{a}(W/3)^{b}[(365 - P)/365]$$

Where:

E_{ext} = annual size-specific emission factor extrapolated for natural mitigation (pounds per vehicle mile traveled [lbs/VMT])

k, a, and b empirical constants (Table O-2)

s = surface material silt content (percent)

W = mean vehicle weight (tons)

P = number of days in a year with at least 0.254 millimeters (mm) (0.01 inches [in]) of precipitation, 49 days

Table O-2 summarizes the empirical constants used in the preceding equation and the calculated emission factors for the articulated trucks. A silt content of 8.5 percent was used for all unpaved haul roads, which was estimated as the mean silt content for construction sites by USEPA (2006a). The vehicular weight was estimated as 88 tons, which is the average of the loaded and unloaded Caterpillar 773G weights, which is assumed to be used at the site. The number of days of precipitation was estimated at approximately 49 days for Merced County (CAPCOA 2017).

Table O-2. Unpaved Road Dust Emission Factors

Constant	PM_{10}	$PM_{2.5}$
k (lbs/VMT)	1.5	0.15
a	0.9	0.9
b	0.45	0.45
E_{ext} (lbs/VMT)	4.4	0.4

Source: USEPA 2006a

Key:
lbs/VMT = pounds per vehicle miles traveled; PM10 = inhalable particulate matter; PM2.5 = fine particulate matter

Based on information provided by the project applicant, it was assumed the 13 articulate trucks would move 11,200 cubic yards of soil per day along the haul route.

O.1.4 Material Handling

Fugitive dust emissions would also occur from material handling activities, from truck loading/unloading, and other "drops." The methodology documented in Section 13.2.4 (USEPA 2006b) of AP-42 was used to estimate fugitive dust emissions from these activities. Dust emissions were estimated using the following equation:

$$E = (0.0032)\frac{(U/5)^{1.3}}{(M/2)^{1.4}}$$

Where:

E = emission factor (pounds per ton [lbs/ton])

k = particle size multiplier (0.35 for PM_{10}, 0.053 for $PM_{2.5}$)

U = wind speed (9.64 mph)[1]

M = material moisture content (7.9 percent)

Emissions were calculated assuming there would be a production rate of 22,400 cubic yards per day (two shifts per day); assuming a construction schedule of 7 days per week (365 days per year), this would result in an annual excavated quantity of 114,464,000 cubic yards. Emission factors were calculated as 0.00038 pounds PM_{10} per ton of soil and 0.000058 pounds $PM_{2.5}$ per ton of soil.

O.1.5 Grading

Fugitive dust emissions would also occur during grading for haul road maintenance. Fugitive dust emissions from this activity were estimated in accordance with Section 11.9 of AP-42 with the following equations (USEPA 1998):

$$E_{TSP} = 0.040(S)^{2.5} \text{ and } E_{PM15} = 0.051(S)^{2.0}$$

Where:

E_{TSP} = emission factor for total suspended particles up to 30 microns (lbs/VMT)

E_{PM15} = emission factor for particles up to 15 microns (lbs/VMT)

S = mean vehicle speed (mph)

To estimate PM_{10} emissions, the equation for total suspended particulate matter (TSP) was multiplied by a scaling factor of 0.60, while the PM_{15} equation was multiplied by 0.031 to estimate $PM_{2.5}$ emissions. The average grader speed was assumed to be 7.1 mph, which is the default value in AP-42. Using these assumptions, the emission factors were calculated as 1.54 pounds PM_{10} per vehicle miles traveled (VMT) and 0.17 pounds $PM_{2.5}$ per VMT.

Grading activities were assumed to occur 30 days per month for 20 hours per day. Using the number of graders provided by the project applicant and assuming construction would occur over a year, the total VMT was estimated for each alternative. The annual VMT was then multiplied by the emission factor to calculate emissions.

O.1.6 Bulldozing

Fugitive dust emissions would also occur during bulldozing. Fugitive dust emissions from this activity were estimated in accordance with Section 11.9 of AP-42 (USEPA 1998) with the following equations:

$$E_{TSP} = \frac{5.7(s)^{1.2}}{(M)^{1.3}} \text{ and } E_{PM15} = \frac{1.0(s)^{1.5}}{(M)^{1.4}}$$

[1] Wind speed estimated for 2015 calendar year data from the Route 152 San Luis meteorological station (CF031) (MesoWest 2016).

Where:

E_{TSP} = emission factor for total suspended particles up to 30 microns (lbs/VMT)

E_{PM15} = emission factor particles up to 30 microns (lbs/VMT)

s = material silt content (6.9 percent)

M = material moisture content (7.9 percent)

To estimate PM_{10} emissions, the equation for TSP was multiplied by the scaling factor of 0.75, while the PM_{15} equation was multiplied by 0.105 to estimate $PM_{2.5}$ emissions (USEPA 1998). The material silt and moisture contents were assumed to be 6.9 and 7.9 percent, respectively, which are the default values in AP-42. Using these assumptions, the emission factors were calculated as 0.75 pounds PM_{10} per hour and 0.41 pounds $PM_{2.5}$ per hour.

As with grading, bulldozing activities were assumed to occur 30 days per month for 20 hours per day. Using the expected duration of construction for the schedule provided by the project applicant and the quantity of dozers, the number of bulldozing hours per dozer was estimated. The project hours were then multiplied by the emission factor to estimate project emissions.

O.1.7 Marine Emissions (Tugboats, Barges, and Dredges)

Marine emissions would occur from vessels used during construction of either a tunnel or pipeline in the Lower San Felipe Intake Alternative. The tugboats used to move the barges and dredges within the San Luis Reservoir and the crew and supply boats would use both propulsion and auxiliary engines. Emission factors were developed following equations contained in CARB's *Initial Statement of Reasons for the Proposed Rulemaking: Amendments to the Regulations to Reduce Emissions from Diesel Engines on Commercial Harbor Craft Operated Within California Waters and 24 Nautical Miles of the California Baseline* (2010).

Data on the average number of engines per vessel, the average annual operating hours per vessel type, and the useful life of each vessel were obtained from CARB's *Emissions Estimation Methodology for Commercial Harbor Craft Operating in California* (2007). Information on the quantity and average horsepower of auxiliary and propulsion engines and the vessel age were estimated from CARB's *Statewide Commercial Harbor Craft Survey* (2004).

The equation used to estimate reactive organic gases (ROG), CO, NOx, or particulate matter (PM) emissions is as follows:

$$E = EF_0 \times F \times \left(1 + D \times \frac{A}{UL}\right) \times HP \times LF \times Hr$$

Where:

E = amount of emissions of a pollutant emitted during one period

EF_0 = the model year, horsepower, and engine use (propulsion or auxiliary) specific zero hour emission factor (when engine is new)

F = fuel correction factor that accounts for emission reduction benefits from burning cleaner fuel

D = horsepower and pollutant specific engine deterioration factor, which is the percentage increase of emission factors at the end of the useful life of the engine

A = age of the engine when the emissions are estimated

UL = vessel type and engine use specific engine useful life

HP = rated horsepower of the engine

LF = vessel type and engine use specific engine load factor

Hr = number of annual operating hours of the engine

SO_2 emissions were estimated based on the sulfur content of diesel fuel. The sulfur content for all marine vessels was assumed to be 15 ppm based on requirements in Title 13 California Code of Regulations, Section 2281(a). The equation used to estimate SO_2 emissions from marine vessels is as follows:

SO_2 (grams per brake horsepower-hour [g/bhp-hr]) = (S content in fuel [ppm]/1,000,000) x (2 grams SO_2/grams S) x Brake Specific Fuel Consumption (184 g/bhp-hr) = 0.00552 g/bhp-hr

Barges would be operated under both the tunnel and pipeline options. Dredges would operate in the Lower San Felipe Intake Alternative during construction of the pipeline; dredges would not be used during tunnel construction.

O.2 Required Fugitive Dust Control Measures

The Bay Area Air Quality Management District (BAAQMD) recommends implementing basic construction mitigation measures at all construction sites, regardless of size, to meet the best management practices threshold for fugitive dust. Additionally, additional construction mitigation measures should be implemented if construction-related emissions exceed the significance thresholds described in its California Environmental Quality Act (CEQA) Guidelines. The feasible control measures for PM_{10} construction emissions are summarized below (BAAQMD 2017):

1. Basic Construction Mitigation Measures Recommended for ALL Proposed Projects:

    a. All exposed surfaces (e.g., parking areas, staging areas, soil piles, graded areas, and unpaved access roads) shall be watered two times per day.

    b. All haul trucks transporting soil, sand, or other loose material off-site shall be covered.

    c. All visible mud or dirt track-out onto adjacent public roads shall be removed using wet power vacuum street sweepers at least once per day. The use of dry power sweeping is prohibited.

    d. All vehicle speeds on unpaved roads shall be limited to 15 mph.

    e. All roadways, driveways, and sidewalks to be paved shall be completed as soon as possible. Building pads shall be laid as soon as possible after grading unless seeding or soil binders are used.

    f. Idling times shall be minimized either by shutting equipment off when not in use or reducing the maximum idling time to 5 minutes (as required by the California airborne toxics control measure [13 CCR 2845]). Clear signage shall be provided for construction workers at all access points.

    g. All construction equipment shall be maintained and properly tuned in accordance with manufacturer's specifications. All equipment shall be checked by a certified visible emissions evaluator.

    h. Post a publicly visible sign with the telephone number and person to contact at the lead agency regarding dust complaints. This person shall respond and take corrective action within 48 hours. The BAAQMD's phone number shall also be visible to ensure compliance with applicable regulations.

2. Additional Construction Mitigation Measures Recommended for Projects with Construction Emissions Above Threshold:

    a. All exposed surfaces shall be watered at a frequency adequate to maintain minimum soil moisture of 12 percent. Moisture content can be verified by lab samples or moisture probe.

    b. All excavation, grading, and/or demolition activities shall be suspended when average wind speeds exceed 20 mph.

    c. Wind breaks (e.g., trees, fences) shall be installed on the windward side(s) of actively disturbed areas of construction. Wind breaks should have at maximum 50 percent air porosity.

    d. Vegetative ground cover (e.g., fast-germinating native grass seed) shall be planted in disturbed areas as soon as possible and watered appropriately until vegetation is established.

    e. The simultaneous occurrence of excavation, grading, and ground-disturbing construction activities on the same area at any one time shall be limited. Activities shall be phased to reduce the amount of disturbed surfaces at any one time.

    f. All trucks and equipment, including their tires, shall be washed off prior to leaving the site.

    g. Site accesses to a distance of 100 feet from the paved road shall be treated with a 6- to 12-inch compacted layer of wood chips, mulch, or gravel.

    h. Sandbags or other erosion control measures hall be installed to prevent silt runoff to public roadways from sites with a slope greater than one percent.

    i. Minimizing the idling time of diesel powered construction equipment to two minutes.

    j. The project shall develop a plan demonstrating that the off-road equipment (more than 50 horsepower) to be used in the construction project (i.e., owned, leased, and subcontractor vehicles) would achieve a project wide fleet-average 20 percent NOx reduction and 45 percent PM reduction compared to the most recent CARB fleet average. Acceptable options tor reducing emissions include the use of late model engines, low-emission diesel products, alternative fuels, engine retrofit technology, after-treatment products, add-on devices such as particulate filters, and/or other options as such become available.

    k. Use low VOC (i.e., ROG) coatings beyond the local requirements (i.e., Regulation 8, Rule 3: Architectural Coatings).

l. Requiring that all construction equipment, diesel trucks, and generators be equipped with Best Available Control Technology for emission reductions of NOx and PM.

m. Requiring all contractors to use equipment that meets CARB's most recent certification standard for off-road heavy duty diesel engines.

Additionally, for construction activities occurring in Merced County, the construction contractor must follow the requirements of the San Joaquin Valley Air Pollution Control District (SJVAPCD) Regulation VIII for fugitive PM_{10} prohibitions. Rule 8021 specifies the fugitive dust control measures that are required for all construction, demolition, excavation, extraction, and other earthmoving activities. In addition to general requirements to limit the visible dust emissions to 20 percent opacity by applying water or other stabilizers, the SJVAPCD also requires vehicle speeds to be limited to 15 mph on all uncontrolled unpaved access/haul roads within construction sites.

O.3 References

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San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix O: Attachment A, Detailed Air Quality Emission Calculations Tables

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Operations & Maintenance Emissions

Table A-1. Maximum Daily Operational Emissions (lbs/day)

Alternative	ROG	NOx	CO	SOx	PM10	PM2.5
San Felipe Low Point						
LOX Delivery Trucks	0.02	0.53	0.07	0.002	0.02	0.01
Treatment						
Workers	0.001	0.003	0.03	0.0001	0.007	0.002
Solid Waste Disposal	0.004	0.28	0.21	0.0008	0.006	0.002
Treatment Subtotal	0.005	0.28	0.24	0.0009	0.013	0.004

Table A-2. Annual Operational Emissions (tons per year)

Alternative	ROG	NOx	CO	SOx	PM10	PM2.5
San Felipe Low Point						
LOX Delivery Trucks	0.001	0.02	0.003	0.0001	0.001	0.0004
Treatment						
Workers	0.00011	0.0006	0.006	0.000025	0.00120	0.00037
Solid Waste Disposal	0.00002	0.0012	0.001	0.000004	0.00003	0.00001
Treatment Subtotal	0.00013	0.0018	0.007	0.000029	0.00123	0.00038

Operation & Maintenance Trip Assumptions

Lower San Felipe Intake Alternative

Air Compressor Operation	92	days per year	(Assumes 200 HP operating 25% of year)
Air Flow Rate	1,200	scfm	(Mattei Air Compressor, Model MAXIMA 160 X, 200 hp)
	1,728,000	scf per day	
	158,976,000	scf per year	
Delivery Truck Capacity	20	tons per truck	http://www.uigi.com/delivery.html
	483,200	scf/truck	
Equivalent LOX Truck Trips	4	trucks per day	
	330	trucks per year	

Table A-3. LOX Delivery Truck Emissions

Source	ROG	NOx	CO	SOx	PM10	PM2.5
Emission Factor (g/mi)	0.15	4.53	0.62	0.02	0.21	0.078
Emissions (lbs/day)	0.02	0.53	0.07	0.002	0.02	0.01
Emissions (tons per year)	0.001	0.02	0.003	0.0001	0.001	0.0004

Trip Length 6.6 miles

CAPCOA. 2017. CalEEMod User's Guide, Version 2016.3.2, Appendix D: Default Data Tables, Table 4.2, Merced County, Rural C-NW (Commercial-Nonwork)

CalEEMod User's Guide states that C-NW trips include trips made by delivery vehicles of goods associated with the land use.

Conversions

60	minutes per hour	
24	hours per day	
24,160	scf per ton	(http://www.uigi.com/o2_conv.html)
453.6	grams per pound	
2,000	pounds per ton	

O&M Trip Assumptions
Treatment Alternative

Table A-4. Worker Trips

Source	ROG	NOx	CO	SOx	PM10	PM2.5
Emission Factor (g/mi)	0.01	0.06	0.64	0.003	0.14	0.042
Emissions (lbs/day)	0.00060	0.0030	0.031	0.00014	0.0066	0.0020
Emissions (tons/year)	0.00011	0.00055	0.0056	0.000025	0.0012	0.00037

Trip Length Sources:
CAPCOA. 2017. CalEEMod User's Guide, Version 2016.3.2, Appendix D: Default Data Tables, Table 4.2, Santa Clara County, Urban H-W (Home-Work)
Key: FTE = Full Time Equivalent Employees

Full Time Equivalent Employees	1
Trip Length (miles)	10.8

Maintenance Trips

Treatment

Solids Disposal	10%	increase in solids disposal
Santa Teresa	935	additional pounds per day
	171	additional tons per year

Truck Trips	9	trucks per year

(assumes maximum of one truck per day)

Table A-5. Solid Waste Disposal Truck Trips

Source	ROG	NOx	CO	SOx	PM10	PM2.5
Emission Factor (g/mi)	0.14	8.63	6.40	0.02	0.20	0.07
Emissions (lbs/day)	0.0044	0.28	0.21	0.00079	0.0064	0.0022
Emissions (tons/year)	0.000020	0.0012	0.0009	0.0000036	0.000029	0.000010

Trip Length 7.3 miles
CAPCOA. 2017. CalEEMod User's Guide, Version 2016.3.2, Appendix D: Default Data Tables, Table 4.2, Santa Clara County, Urban C-NW (Commercial-Nonwork).
CalEEMod User's Guide states that C-NW trips include trips made by delivery vehicles of goods associated with the land use.

Conversions

20	tons per truck (CalEEMod User's Guide, Version 2016.3.2)
365	days per year
453.6	grams per pound
2000	pounds per ton

Onroad Motor Vehicle Emission Factors
EMFAC2014

Table A-6. Running Emission Factors

Air Basin	Year	Vehicle Type	(grams per mile)											
			ROG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
San Joaquin Valley	2021	Workers	0.0137	0.0692	0.6917	0.0030	0.0018	0.0080	0.0368	0.0465	0.0017	0.0020	0.0158	0.0194
		Solid Waste Collection Truck	0.1571	9.2475	1.4032	0.0372	0.0127	0.0360	0.0617	0.1104	0.0122	0.0090	0.0265	0.0476
		Haul Truck	0.1478	4.5343	0.6246	0.0152	0.0206	0.0360	0.0617	0.1184	0.0197	0.0090	0.0265	0.0552
	2022	Workers	0.0123	0.0621	0.6401	0.0029	0.0018	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0194
		Solid Waste Collection Truck	0.1477	8.4831	1.4779	0.0368	0.0122	0.0360	0.0617	0.1099	0.0117	0.0090	0.0265	0.0471
		Haul Truck	0.1389	4.0451	0.6105	0.0150	0.0174	0.0360	0.0617	0.1152	0.0167	0.0090	0.0265	0.0521
San Francisco Bay Area	2021	Workers	0.0125	0.0638	0.6437	0.0029	0.0018	0.0080	0.0368	0.0466	0.0017	0.0020	0.0158	0.0194
		Solid Waste Collection Truck	0.1362	8.6253	6.3955	0.0246	0.0099	0.0360	0.0617	0.1077	0.0095	0.0090	0.0265	0.0450
		Haul Truck	0.1530	4.5740	0.6461	0.0153	0.0207	0.0360	0.0617	0.1185	0.0199	0.0090	0.0265	0.0553
	2022	Workers	0.0113	0.0576	0.5996	0.0028	0.0018	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0194
		Solid Waste Collection Truck	0.1311	8.0421	6.9215	0.0230	0.0094	0.0360	0.0617	0.1072	0.0090	0.0090	0.0265	0.0445
		Haul Truck	0.1438	4.0871	0.6319	0.0151	0.0176	0.0360	0.0617	0.1153	0.0168	0.0090	0.0265	0.0523

Criteria Pollutant Construction Emissions Summary

Table A-7. Lower San Felipe Intake Alternative (Tunnel Option) - Maximum Daily Unmitigated Emissions

	Daily Emissions (lbs/day)					
Source	**VOC**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**
Off-Road Construction Equipment	26	262	131	0	11	10
On-Road Haul Trucks and Delivery Vehicles	1	25	3	0	1	0
Construction Worker Commuting	0	1	13	0	2	1
Marine Emissions (Tugboats and Crew/Supply Vessels)	35	547	141	0	25	23
Dredge (Auxiliary Engines)	-	-	-	-	-	-
Total	**62**	**835**	**288**	**1**	**39**	**34**

Table A-8. Lower San Felipe Intake Alternative (Pipeline Option) - Maximum Daily Unmitigated Emissions

	Daily Emissions (lbs/day)					
Source	**VOC**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**
Off-Road Construction Equipment	24	245	120	0	10	9
On-Road Haul Trucks and Delivery Vehicles	0	12	1	0	1	0
Construction Worker Commuting	0	0	4	0	1	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	70	1,095	283	1	50	46
Dredge (Auxiliary Engines)	76	778	284	1	48	44
Total	**170**	**2,130**	**692**	**2**	**109**	**99**

Table A-9. Treatment Alternative - Maximum Daily Unmitigated Emissions

	Daily Emissions (lbs/day)					
Source	**VOC**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**
Off-Road Construction Equipment	4	38	27	0	2	2
On-Road Haul Trucks and Delivery Vehicles	0	3	0	0	0	0
Construction Worker Commuting	0	1	7	0	1	0
Total	**4**	**41**	**35**	**0**	**4**	**2**
Significance Threshold	54	54	n/a	n/a	82	54
Significant?	No	No	n/a	n/a	No	No

Note:

Significance thresholds from Bay Area Air Quality Management District CEQA Air Quality Guidelines (2017).

Table A-10. CVP Enlarged Reservoir Expansion Alternative - Maximum Daily Unmitigated Emissions

	Maximum Daily Emissions (pounds per day)					
Source	**VOC**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**
Onsite Construction Equipment	60	627	358	1	26	24
Construction Worker Commuting	1	3	29	0	6	2
Haul Truck Trips	4	175	18	1	9	3
Fugitive Dust						
Material Handling	--	--	--	--	8	1
Bulldozing	--	--	--	--	6	3
Grading	--	--	--	--	85	9
Paved Road Dust - Haul Roads	--	--	--	--	8	2
Unpaved Road Dust - Haul Roads	--	--	--	--	4,529	453
Total	**65**	**805**	**405**	**2**	**4,677**	**497**

Criteria Pollutant Construction Emissions Summary

Table A-11. New Pacheco Reservoir Alternative - Maximum Daily Unmitigated Emissions

Source	Maximum Daily Emissions (pounds per day)					
	VOC	NOx	CO	SOx	PM10	PM2.5
Onsite Construction Equipment	2,100	2,640	2,848	2,026	2,051	2,048
Construction Worker Commuting	0	3	28	0	8	2
Haul Truck Trips	1	28	8	0	4	1
Total	**2,101**	**2,671**	**2,884**	**2,026**	**2,064**	**2,052**
Significance Threshold	54	54	n/a	n/a	82	54
Significant?	Yes	Yes	n/a	n/a	Yes	Yes

Note:
Significance thresholds from Bay Area Air Quality Management District CEQA Air Quality Guidelines (2017).

References

Bay Area Air Quality Management District. 2017. California Environmental Quality Act Air Quality Guidelines. May. Available online at: http://www.baaqmd.gov/~/media/files/planning-and-research/ceqa/ceqa_guidelines_may2017-pdf.pdf?la=en [Accessed October 22, 2018].

San Joaquin Valley Air Pollution Control District. 2015. Guidance for Assessing and Mitigating Air Quality Impacts. March 19. Available online at: http://www.valleyair.org/transportation/GAMAQI_3-19-15.pdf [Accessed October 22, 2018].

San Luis Low Point Improvement Project
Criteria Pollutant Construction Emissions Summary

Table A-12. Lower San Felipe Intake Alternative (Tunnel Option) - Annual Unmitigated Emissions

Source	Annual Emissions (tons per year)					
	VOC	NOx	CO	SO2	PM10	PM2.5
	2020					
Off-Road Construction Equipment	5	52	25	0	2	2
On-Road Haul Trucks and Delivery Vehicles	0	1	0	0	0	0
Construction Worker Commuting	0	0	1	0	0	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	-	-	-	-	-	-
Dredge (Auxiliary Engines)	-	-	-	-	-	-
Total	**5**	**53**	**26**	**0**	**2**	**2**
	2021					
Off-Road Construction Equipment	5	50	25	0	2	2
On-Road Haul Trucks and Delivery Vehicles	0	1	0	0	0	0
Construction Worker Commuting	0	0	1	0	0	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	1	13	3	0	1	1
Dredge (Auxiliary Engines)	-	-	-	-	-	-
Total	**6**	**64**	**29**	**0**	**3**	**2**
	2022					
Off-Road Construction Equipment	4	41	24	0	2	2
On-Road Haul Trucks and Delivery Vehicles	0	1	0	0	0	0
Construction Worker Commuting	0	0	1	0	0	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	1	22	6	0	1	1
Dredge (Auxiliary Engines)	-	-	-	-	-	-
Total	**6**	**64**	**31**	**0**	**3**	**3**
	2023					
Off-Road Construction Equipment	4	36	24	0	2	1
On-Road Haul Trucks and Delivery Vehicles	0	0	0	0	0	0
Construction Worker Commuting	0	0	1	0	0	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	0	2	0	0	0	0
Dredge (Auxiliary Engines)	-	-	-	-	-	-
Total	**4**	**38**	**25**	**0**	**2**	**2**
Maximum Annual Emissions	**6**	**64**	**31**	**<1**	**3**	**3**
General Conformity De Minimis Threshold	10	10	n/a	100	100	100
Significant?	No	Yes	n/a	No	No	No
SJVAPCD Significance Threshold	10	10	100	27	15	15
Significant?	No	Yes	No	No	No	No

Note:

Although Merced County is an attainment area for NO2 and SO2, it is a nonattainment area for PM2.5. As a result, it is necessary to provide de minimis thresholds for NO2 and SO2 as precursors to PM2.5 formation.

Table A-13. Lower San Felipe Intake Alternative (Pipeline Option) - Annual Unmitigated Emissions

Source	Annual Emissions (tons per year)					
	VOC	NOx	CO	SO2	PM10	PM2.5
	2020					
Off-Road Construction Equipment	4	42	20	0	2	2
On-Road Haul Trucks and Delivery Vehicles	0	0	0	0	0	0
Construction Worker Commuting	0	0	0	0	0	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	-	-	-	-	-	-
Dredge (Auxiliary Engines)	-	-	-	-	-	-
Total	**4**	**42**	**21**	**0**	**2**	**2**
	2021					
Off-Road Construction Equipment	4	40	20	0	2	2
On-Road Haul Trucks and Delivery Vehicles	0	0	0	0	0	0
Construction Worker Commuting	0	0	0	0	0	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	12	185	48	0	8	8
Dredge (Auxiliary Engines)	0	4	2	0	0	0
Total	**16**	**230**	**70**	**0**	**10**	**10**
	2022					
Off-Road Construction Equipment	3	33	19	0	1	1
On-Road Haul Trucks and Delivery Vehicles	0	0	0	0	0	0
Construction Worker Commuting	0	0	0	0	0	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	1	17	4	0	1	1
Dredge (Auxiliary Engines)	0	0	0	0	0	0
Total	**4**	**50**	**24**	**0**	**2**	**2**
Maximum Annual Emissions	**16**	**230**	**70**	**<1**	**10**	**10**
De minimis Threshold	10	10	n/a	100	100	100
Significant?	Yes	Yes	n/a	No	No	No
SJVAPCD Significance Threshold	10	10	100	27	15	15
Significant?	Yes	Yes	No	No	No	No

Note:

Although Merced County is an attainment area for NO2 and SO2, it is a nonattainment area for PM2.5. As a result, it is necessary to provide de minimis thresholds for NO2 and SO2 as precursors to PM2.5 formation.

Table A-14. Treatment Alternative - Annual Unmitigated Emissions

Source	Annual Emissions (tons per year)					
	VOC	NOx	CO	SO2	PM10	PM2.5
	2020					
Off-Road Construction Equipment	1	7	5	0	0	0
On-Road Haul Trucks and Delivery Vehicles	0	0	0	0	0	0
Construction Worker Commuting	0	0	0	0	0	0
Total	**1**	**7**	**5**	**0**	**0**	**0**
	2021					
Off-Road Construction Equipment	1	7	5	0	0	0
On-Road Haul Trucks and Delivery Vehicles	0	0	0	0	0	0
Construction Worker Commuting	0	0	0	0	0	0
Total	**1**	**7**	**5**	**0**	**0**	**0**
	2022					
Off-Road Construction Equipment	1	6	4	0	0	0
On-Road Haul Trucks and Delivery Vehicles	0	0	0	0	0	0
Construction Worker Commuting	0	0	0	0	0	0
Total	**1**	**6**	**5**	**0**	**0**	**0**
Maximum Annual Emissions	**1**	**7**	**5**	**<1**	**<1**	**<1**
De minimis Threshold	100	100	100	100	n/a	100
Significant?	No	No	No	No	n/a	No

Note:

Although Santa Clara County is an attainment area for NO2 and SO2, it is a nonattainment area for PM2.5. As a result, it is necessary to provide de minimis thresholds for NO2 and SO2 as precursors to PM2.5 formation.

Table A-15. CVP Enlarged Reservoir Expansion Alternative - Annual Unmitigated Emissions

Source	Annual Emissions (tons per year)					
	VOC	NOx	CO	SOx	PM10	PM2.5
Onsite Construction Equipment	11	114	65	0	5	4
Construction Worker Commuting	0	1	5	0	1	0
Haul Truck Trips	1	32	3	0	2	1
Fugitive Dust						
Material Handling	--	--	--	--	2	0
Bulldozing	--	--	--	--	1	1
Grading	--	--	--	--	16	2
Paved Road Dust - Haul Roads	--	--	--	--	1	0
Unpaved Road Dust - Haul Roads	--	--	--	--	716	72
Total	**12**	**147**	**74**	**0**	**743**	**80**
General Conformity Threshold	10	10	n/a	100	100	100
CEQA Significance Threshold	10	10	100	27	15	15
Exceed De Minimis Threshold?	Yes	Yes	No	No	Yes	No
Exceed CEQA Threshold?	Yes	Yes	No	No	Yes	Yes

Table A-16. New Pacheco Reservoir Alternative - Annual Unmitigated Emissions

Source	Annual Emissions (tons per year)					
	VOC	NOx	CO	SOx	PM10	PM2.5
Onsite Construction Equipment	2,038	2,136	2,174	2,024	2,029	2,028
Construction Worker Commuting	0	0	4	0	1	0
Haul Truck Trips	0	3	1	0	0	0
Total	**2,038**	**2,140**	**2,179**	**2,024**	**2,030**	**2,029**
General Conformity Threshold	100	100	100	100	n/a	100
Exceed De Minimis Threshold?	Yes	Yes	Yes	Yes	No	Yes

References

"Subpart B - Determining Conformity of General Federal Actions to State or Federal Implementation Plans." Title 40 Code of

United States Environmental Protection Agency. 2012. The Green Book Nonattainment Areas for Criteria Pollutants (as of July 20, 2012). Available online at: http://www.epa.gov/oaqps001/greenbk/index.html [Accessed on: August 7, 2012].

Criteria Pollutant Construction Emissions Summary

Table A-17. Lower San Felipe Intake Alternative (Tunnel Option) - Maximum Daily Mitigated Emissions

	Daily Emissions (lbs/day)					
Source	**VOC**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**
Off-Road Construction Equipment	11	26	100	0	2	1
On-Road Haul Trucks and Delivery Vehicles	0	5	2	0	1	0
Construction Worker Commuting	0	1	13	0	2	1
Marine Emissions (Tugboats and Crew/Supply Vessels)	20	22	138	0	3	3
Dredge (Auxiliary Engines)	-	-	-	-	-	-
Total	**31**	**53**	**254**	**1**	**8**	**5**

Table A-18. Lower San Felipe Intake Alternative (Pipeline Option) - Maximum Daily Mitigated Emissions

	Daily Emissions (lbs/day)					
Source	**VOC**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**
Off-Road Construction Equipment	9	21	90	0	2	1
On-Road Haul Trucks and Delivery Vehicles	0	2	1	0	1	0
Construction Worker Commuting	0	0	4	0	1	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	39	43	277	1	6	6
Dredge (Auxiliary Engines)	5	99	77	1	1	1
Total	**53**	**166**	**449**	**2**	**10**	**8**

Table A-19. CVP Enlarged Reservoir Expansion Alternative - Maximum Daily Mitigated Emissions

	Maximum Daily Emissions (pounds per day)					
Source	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**
Onsite Construction Equipment	17	12	224	1	2	2
Construction Worker Commuting	1	3	29	0	6	2
Haul Truck Trips	2	32	13	1	9	3
Fugitive Dust						
Material Handling	--	--	--	--	8	1
Bulldozing	--	--	--	--	6	3
Grading	--	--	--	--	85	9
Paved Road Dust - Haul Roads	--	--	--	--	8	2
Unpaved Road Dust - Haul Roads	--	--	--	--	116	12
Total	**20**	**47**	**266**	**2**	**240**	**33**

Table A-20. New Pacheco Reservoir Alternative - Maximum Daily Mitigated Emissions

	Maximum Daily Emissions (pounds per day)					
Source	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**
Onsite Construction Equipment	2,069	2,195	2,705	2,029	2,034	2,033
Construction Worker Commuting	1	3	37	0	12	4
Haul Truck Trips	2	35	14	1	8	2
Total	**2,072**	**2,233**	**2,755**	**2,029**	**2,054**	**2,039**
Significance Threshold	54	54	n/a	n/a	82	54
Significant?	Yes	Yes	n/a	n/a	Yes	Yes

Note:
Significance thresholds from Bay Area Air Quality Management District CEQA Air Quality Guidelines (2017).

Criteria Pollutant Construction Emissions Summary

Table A-21. Lower San Felipe Intake Alternative (Tunnel Option) - Annual Mitigated Emissions

Source	Annual Emissions (tons per year)					
	VOC	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**
	2020					
Off-Road Construction Equipment	2	5	17	0	0	0
On-Road Haul Trucks and Delivery Vehicles	0	0	0	0	0	0
Construction Worker Commuting	0	0	1	0	0	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	-	-	-	-	-	-
Dredge (Auxiliary Engines)	-	-	-	-	-	-
Total	**2**	**5**	**18**	**0**	**0**	**0**
	2021					
Off-Road Construction Equipment	2	4	17	0	0	0
On-Road Haul Trucks and Delivery Vehicles	0	0	0	0	0	0
Construction Worker Commuting	0	0	1	0	0	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	0	1	3	0	0	0
Dredge (Auxiliary Engines)	-	-	-	-	-	-
Total	**2**	**5**	**21**	**0**	**1**	**0**
	2022					
Off-Road Construction Equipment	2	5	17	0	0	0
On-Road Haul Trucks and Delivery Vehicles	0	0	0	0	0	0
Construction Worker Commuting	0	0	1	0	0	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	1	1	6	0	0	0
Dredge (Auxiliary Engines)	-	-	-	-	-	-
Total	**3**	**7**	**23**	**0**	**1**	**0**
	2023					
Off-Road Construction Equipment	2	5	17	0	0	0
On-Road Haul Trucks and Delivery Vehicles	0	0	0	0	0	0
Construction Worker Commuting	0	0	1	0	0	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	0	0	0	0	0	0
Dredge (Auxiliary Engines)	-	-	-	-	-	-
Total	**2**	**6**	**19**	**0**	**1**	**0**
Maximum Annual Emissions	**3**	**7**	**23**	**<1**	**1**	**<1**
General Conformity De Minimis Threshold	10	10	n/a	100	100	100
Significant?	No	No	n/a	No	No	No
SJVAPCD Significance Threshold	10	10	100	27	15	15
Significant?	No	No	No	No	No	No

Note:

Although Merced County is an attainment area for NO2 and SO2, it is a nonattainment area for PM2.5. As a result, it is necessary to provide de minimis thresholds for NO2 and SO2 as precursors to PM2.5 formation.

Table A-22. Lower San Felipe Intake Alternative (Pipeline Option) - Annual Mitigated Emissions

Source	Annual Emissions (tons per year)					
	VOC	NOx	CO	SO2	PM10	PM2.5
	2020					
Off-Road Construction Equipment	1	3	12	0	0	0
On-Road Haul Trucks and Delivery Vehicles	0	0	0	0	0	0
Construction Worker Commuting	0	0	0	0	0	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	-	-	-	-	-	-
Dredge (Auxiliary Engines)	-	-	-	-	-	-
Total	**1**	**3**	**13**	**0**	**0**	**0**
	2021					
Off-Road Construction Equipment	1	3	12	0	0	0
On-Road Haul Trucks and Delivery Vehicles	0	0	0	0	0	0
Construction Worker Commuting	0	0	0	0	0	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	5	5	34	0	1	1
Dredge (Auxiliary Engines)	0	1	0	0	0	0
Total	**6**	**9**	**47**	**0**	**1**	**1**
	2022					
Off-Road Construction Equipment	1	4	13	0	0	0
On-Road Haul Trucks and Delivery Vehicles	0	0	0	0	0	0
Construction Worker Commuting	0	0	0	0	0	0
Marine Emissions (Tugboats and Crew/Supply Vessels)	2	3	18	0	0	0
Dredge (Auxiliary Engines)	0	0	0	0	0	0
Total	**4**	**7**	**30**	**0**	**1**	**1**
Maximum Annual Emissions	**6**	**9**	**47**	**<1**	**1**	**1**
De minimis Threshold	10	10	n/a	100	100	100
Significant?	No	No	n/a	No	No	No
SJVAPCD Significance Threshold	10	10	100	27	15	15
Significant?	No	No	No	No	No	No

Note:

Although Merced County is an attainment area for NO2 and SO2, it is a nonattainment area for PM2.5. As a result, it is necessary to provide de minimis thresholds for NO2 and SO2 as precursors to PM2.5 formation.

Table A-23. CVP Enlarged Reservoir Expansion Alternative - Maximum Daily Mitigated Emissions

Source	Annual Emissionsn (tons per year)					
	VOC	NOx	CO	SO2	PM10	PM2.5
Onsite Construction Equipment	3	2	41	0	0	0
Construction Worker Commuting	0	1	5	0	1	0
Haul Truck Trips	0	6	2	0	2	0
Fugitive Dust						
Material Handling	--	--	--	--	2	0
Bulldozing	--	--	--	--	1	1
Grading	--	--	--	--	16	2
Paved Road Dust - Haul Roads	--	--	--	--	1	0
Unpaved Road Dust - Haul Roads	--	--	--	--	18	2
Total	**4**	**9**	**49**	**0**	**41**	**6**
De minimis Threshold	10	10	n/a	100	100	100
Significant?	No	No	n/a	No	No	No
SJVAPCD Significance Threshold	10	10	100	27	15	15
Significant?	No	No	No	No	Yes	No

Table A-24. New Pacheco Reservoir Alternative - Maximum Daily Mitigated Emissions

Source	Annual Emissionsn (tons per year)					
	VOC	NOx	CO	SO2	PM10	PM2.5
Onsite Construction Equipment	2,034	2,057	2,149	2,026	2,027	2,027
Construction Worker Commuting	0	1	6	0	2	1
Haul Truck Trips	0	6	2	0	1	0
Total	**2,034**	**2,063**	**2,158**	**2,026**	**2,031**	**2,028**
De minimis Threshold	100	100	100	100	n/a	100
Significant?	Yes	Yes	Yes	Yes	n/a	Yes

Criteria Pollutant Emissions Summary
Off-Road Construction Equipment

Table A-25. Summary of Peak Daily Emissions by Alternative

	Daily Emissions (lbs/day)					
Alternative	**VOC**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**
Lower San Felipe Intake Alternative						
Tunnel Option	26.34	261.87	131.23	0.47	10.93	9.85
Pipeline Option	23.73	245.14	119.90	0.45	10.04	8.92
Treatment Alternative	4.03	37.66	26.92	0.06	2.01	1.80

Table A-26. Summary of Annual Emissions by Alternative

	Annual Emissions (tons per year)					
Alternative	**VOC**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**
	2020					
Lower San Felipe Intake Alternative						
Tunnel Option	4.98	52.15	25.48	0.08	2.18	1.97
Pipeline Option	3.91	41.77	20.40	0.06	1.79	1.61
Treatment Alternative	0.73	7.03	4.57	0.01	0.36	0.33
	2021					
Lower San Felipe Intake Alternative						
Tunnel Option	4.87	50.41	25.32	0.08	2.10	1.89
Pipeline Option	3.81	40.21	20.20	0.06	1.71	1.54
Treatment Alternative	0.69	6.69	4.55	0.01	0.34	0.31
	2022					
Lower San Felipe Intake Alternative						
Tunnel Option	4.25	40.64	24.30	0.08	1.74	1.56
Pipeline Option	3.30	32.89	19.15	0.06	1.42	1.27
Treatment Alternative	0.61	5.89	4.39	0.01	0.30	0.27
	2023					
Lower San Felipe Intake Alternative						
Tunnel Option	3.96	36.19	23.60	0.08	1.55	1.39
Pipeline Option	-	-	-	-	-	-
Treatment Alternative	-	-	-	-	-	-
	Annual Maximum					
Lower San Felipe Intake Alternative						
Tunnel Option	4.98	52.15	25.48	0.08	2.18	1.97
Pipeline Option	3.91	41.77	20.40	0.06	1.79	1.61
Treatment Alternative	0.73	7.03	4.57	0.01	0.36	0.33

Lower San Felipe Intake Alternative - Tunnel Option

Table A-27. Equipment List

Equipment	Quantity	Mobilization	Site Improvements	Construct Vertical Shaft	Set up TBM	Tunneling and Spreading of Soils	Cofferdam and TBM Out	Connect to Existing Intake	Fabricate Inlet	Set Inlet and Flood Tunnel	Construct Aeration Facility	Fab and Set Air Tubing	Final Work and Testing	Demobilization
Bulldozer	2	X	X											
Concrete Pumpers	2			X				X	X		X			
Cranes	4			X	X		X		X	X	X			
Drill Rig	1			X										
Excavator	1		X	X							X			
Flatbed Trucks (on site)	3	X	X	X	X	X	X	X	X	X	X	X	X	X
Grader	2		X			X					X			X
Loaders	2	X	X								X			
Portable Diesel Generators	7	X	X	X	X	X	X	X	X	X	X	X	X	X
Scraper	1		X			X					X			
Water Truck	2	X	X			X					X			X

Source: Equipment Tables_08012012.docx; EngineeringDataNeeds_July30_2012.xlsx

Table A-28. Peak Daily Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day)					
							VOC	NOx	CO	SO2	PM10	PM2.5
Mobilization	Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	2020	5.85	62.28	30.73	0.04	3.03	2.79
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.08	0.34	0.96	0.02	0.28	0.14
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202		1.78	20.74	8.18	0.03	0.69	0.63
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		13.33	115.86	56.56	0.25	4.44	4.09
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	2	20	n/a		0.05	0.23	0.64	0.02	0.19	0.09
Mobilization Subtotal							**21.08**	**199.45**	**97.08**	**0.36**	**8.63**	**7.74**
Site Improvements	Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	2020	5.85	62.28	30.73	0.04	3.03	2.79
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	1	20	158		0.62	6.09	8.22	0.01	0.30	0.27
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.08	0.34	0.96	0.02	0.28	0.14
	Grader	ConstMin - Graders	2	20	188		2.33	29.11	9.37	0.03	0.97	0.89
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202		1.78	20.74	8.18	0.03	0.69	0.63
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		13.33	115.86	56.56	0.25	4.44	4.09
	Scraper	ConstMin - Scrapers	1	20	367		2.31	27.21	16.56	0.04	1.04	0.95
	Water Truck	N/A - Onroad engine	2	20	n/a		0.05	0.23	0.64	0.02	0.19	0.09
Site Improvements Subtotal							**26.34**	**261.87**	**131.23**	**0.44**	**10.93**	**9.85**

Table A-28. Peak Daily Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day)					
							VOC	NOx	CO	SO2	PM10	PM2.5
Construct Vertical Shaft	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2020	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	20	18		0.73	5.36	3.62	0.01	0.26	0.24
	Cranes	ConstMin - Cranes	4	20	231		4.40	52.85	20.67	0.06	2.16	1.99
	Drill Rig	ConstMin - Bore/Drill Rigs	1	20	221		0.71	9.01	5.28	0.02	0.26	0.24
	Excavator	ConstMin - Excavators	1	20	158		0.62	6.09	8.22	0.01	0.30	0.27
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.08	0.34	0.96	0.02	0.28	0.14
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		13.33	115.86	56.56	0.25	4.44	4.09
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Construct Vertical Shaft Subtotal							**19.87**	**189.52**	**95.32**	**0.37**	**7.71**	**6.97**
Set Up TBM	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	4	20	231		4.18	49.59	20.78	0.06	2.01	1.85
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.07	0.31	0.94	0.02	0.28	0.13
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		13.50	119.49	57.17	0.25	4.51	4.15
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Set Up TBM Subtotal							**17.75**	**169.39**	**78.89**	**0.33**	**6.79**	**6.13**
Tunneling and Spreading of Soils	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.07	0.31	0.94	0.02	0.28	0.13
	Grader	ConstMin - Graders	2	20	188		2.24	27.39	9.11	0.03	0.90	0.83
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		13.50	119.49	57.17	0.25	4.51	4.15
	Scraper	ConstMin - Scrapers	1	20	367		2.17	24.77	15.60	0.04	0.94	0.87
	Water Truck	N/A - Onroad engine	2	20	n/a		0.05	0.20	0.62	0.02	0.19	0.09
Tunneling and Spreading of Soils Subtotal							**18.02**	**172.16**	**83.44**	**0.36**	**6.82**	**6.07**
Cofferdam and TBM Out	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	4	20	231		3.69	40.63	21.17	0.06	1.70	1.57
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.06	0.24	0.89	0.02	0.27	0.13
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		11.20	72.64	58.43	0.25	3.06	2.81
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Cofferdam and TBM Out Subtotal							**14.95**	**113.51**	**80.48**	**0.33**	**5.03**	**4.50**

Table A-28. Peak Daily Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day)					
							VOC	NOx	CO	SO2	PM10	PM2.5
Connect to Existing Intake	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	20	18		0.69	5.19	3.56	0.01	0.23	0.21
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.06	0.24	0.89	0.02	0.27	0.13
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		11.20	72.64	58.43	0.25	3.06	2.81
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Connect to Existing Intake Subtotal							**11.95**	**78.06**	**62.87**	**0.29**	**3.55**	**3.15**
Fabricate Inlet	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	20	18		0.69	5.19	3.56	0.01	0.23	0.21
	Cranes	ConstMin - Cranes	4	20	231		3.69	40.63	21.17	0.06	1.70	1.57
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.06	0.24	0.89	0.02	0.27	0.13
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		11.20	72.64	58.43	0.25	3.06	2.81
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Fabricate Inlet Subtotal							**15.64**	**118.70**	**84.04**	**0.34**	**5.26**	**4.71**
Set Inlet and Flood Tunnel	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	4	20	231		3.69	40.63	21.17	0.06	1.70	1.57
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.06	0.24	0.89	0.02	0.27	0.13
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		11.20	72.64	58.43	0.25	3.06	2.81
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Set Inlet and Flood Tunnel Subtotal							**14.95**	**113.51**	**80.48**	**0.33**	**5.03**	**4.50**
Construct Aeration Facility	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	20	18		0.72	5.28	3.60	0.01	0.25	0.23
	Cranes	ConstMin - Cranes	4	20	231		4.18	49.59	20.78	0.06	2.01	1.85
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	1	20	158		0.58	5.44	8.23	0.01	0.27	0.24
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.07	0.31	0.94	0.02	0.28	0.13
	Grader	ConstMin - Graders	2	20	188		2.24	27.39	9.11	0.03	0.90	0.83
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202		1.74	19.55	8.37	0.03	0.65	0.60
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		13.50	119.49	57.17	0.25	4.51	4.15
	Scraper	ConstMin - Scrapers	1	20	367		2.17	24.77	15.60	0.04	0.94	0.87
	Water Truck	N/A - Onroad engine	2	20	n/a		0.05	0.20	0.62	0.02	0.19	0.09
Construct Aeration Facility Subtotal							**25.24**	**252.03**	**124.42**	**0.47**	**9.99**	**8.99**

Table A-28. Peak Daily Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day)					
							VOC	NOx	CO	SO2	PM10	PM2.5
Fab and Set Air Tubing	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.07	0.31	0.94	0.02	0.28	0.13
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		13.50	119.49	57.17	0.25	4.51	4.15
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Fab and Set Air Tubing Subtotal							**13.57**	**119.80**	**58.11**	**0.27**	**4.79**	**4.28**
Final Work and Testing	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.06	0.24	0.89	0.02	0.27	0.13
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		11.20	72.64	58.43	0.25	3.06	2.81
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Final Work and Testing Subtotal							**11.26**	**72.88**	**59.31**	**0.28**	**3.33**	**2.94**
Demobilization	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.06	0.24	0.89	0.02	0.27	0.13
	Grader	ConstMin - Graders	2	20	188		1.93	21.93	8.73	0.03	0.73	0.67
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		11.20	72.64	58.43	0.25	3.06	2.81
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	2	20	n/a		0.04	0.16	0.59	0.01	0.18	0.08
Demobilization Subtotal							**13.23**	**94.97**	**68.63**	**0.32**	**4.24**	**3.70**

Peak Day Analysis (Overlapping Phases)						
Mobilization + Site Improvements	26.34	261.87	131.23	0.44	10.93	9.85
Tunneling and Spreading of Soils + Construct Aeration Facility	25.24	252.03	124.42	0.47	9.99	8.99
Tunneling and Spreading of Soils + Construct Aeration Facility + Fab and Set Air Tubing	25.24	252.03	124.42	0.47	9.99	8.99
Cofferdam and TBM Out + Connect to Existing Intake + Fabricate Inlet	15.64	118.70	84.04	0.34	5.26	4.71
Maximum Daily Emissions (lbs/day)	**26.34**	**261.87**	**131.23**	**0.47**	**10.93**	**9.85**

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of grams per hour (g/hr). Emission factors from EMFAC2014 for diesel-fueled medium-duty vehicles in San Joaquin Valley Air Basin.
Peak daily emissions based on construction start year because that would represent worst-case (highest) emissions. Emissions typically decrease in future years with improvements in engine technology and as older vehicles are rotated out of service.

Onroad Vehicle Speed
40 mph

Air Basin
San Joaquin Valley

Conversions
453.6 grams per pound

Lower San Felipe Intake Alternative - Pipeline Option

Table A-29. Annual Emissions from Construction Equipment

Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Annual Emissions - 2020 (tons per year)					
					VOC	NOx	CO	SO2	PM10	PM2.5
Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	1.05	11.21	5.53	0.01	0.55	0.50
Concrete Pumpers	OFF - Light Commercial - Pumps	2	20	18	0.13	0.97	0.65	0.00	0.05	0.04
Cranes	ConstMin - Cranes	4	20	231	0.79	9.51	3.72	0.01	0.39	0.36
Drill Rig	ConstMin - Bore/Drill Rigs	1	20	221	0.13	1.62	0.95	0.00	0.05	0.04
Excavator	ConstMin - Excavators	1	20	158	0.11	1.10	1.48	0.00	0.05	0.05
Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a	0.01	0.06	0.17	0.00	0.05	0.02
Grader	ConstMin - Graders	2	20	188	0.42	5.24	1.69	0.01	0.17	0.16
Loaders	ConstMin - Rubber Tired Loaders	2	20	202	0.32	3.73	1.47	0.01	0.12	0.11
Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	369	1.58	13.77	6.72	0.03	0.53	0.49
Scraper	ConstMin - Scrapers	1	20	367	0.42	4.90	2.98	0.01	0.19	0.17
Water Truck	N/A - Onroad engine	2	20	n/a	0.01	0.04	0.12	0.00	0.03	0.02
			Grand Total (tons per year)		**4.98**	**52.15**	**25.48**	**0.08**	**2.18**	**1.97**

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of grams per hour (g/hr). Emission factors from EMFAC2014 for diesel-fueled medium-duty vehicles in San Joaquin Valley Air Basin.
Calculations assume that equipment quantity is the total pieces of equipment that could operate at a given time, regardless of the phase.

Onroad Vehicle Speed

40 mph

Air Basin
San Joaquin Valley

Conversions

453.6 grams per pound
2,000 pounds per ton
7 days per week
30 days per month

Lower San Felipe Intake Alternative - Pipeline Option

Table A-29. Annual Emissions from Construction Equipment

Equipment	OFFROAD Description	Annual Emissions - 2021 (tons per year)						Annual Emissions - 2022 (tons per year)						Annual Emissions - 2023 (tons per year)					
		VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5
Bulldozer	ConstMin - Rubber Tired Dozers	1.03	10.94	5.48	0.01	0.53	0.49	0.83	9.22	4.73	0.01	0.42	0.39	0.71	7.71	4.10	0.01	0.34	0.32
Concrete Pumpers	OFF - Light Commercial - Pumps	0.13	0.95	0.65	0.00	0.04	0.04	0.13	0.94	0.64	0.00	0.04	0.04	0.13	0.93	0.64	0.00	0.04	0.04
Cranes	ConstMin - Cranes	0.75	8.93	3.74	0.01	0.36	0.33	0.69	7.89	3.81	0.01	0.33	0.30	0.66	7.31	3.81	0.01	0.31	0.28
Drill Rig	ConstMin - Bore/Drill Rigs	0.12	1.41	0.94	0.00	0.04	0.04	0.11	1.11	0.94	0.00	0.04	0.03	0.10	1.05	0.93	0.00	0.03	0.03
Excavator	ConstMin - Excavators	0.10	0.98	1.48	0.00	0.05	0.04	0.09	0.81	1.47	0.00	0.04	0.04	0.09	0.71	1.47	0.00	0.03	0.03
Flatbed Trucks (on site)	N/A - Onroad engine	0.01	0.06	0.17	0.00	0.05	0.02	0.01	0.05	0.16	0.00	0.05	0.02	0.01	0.04	0.16	0.00	0.05	0.02
Grader	ConstMin - Graders	0.40	4.93	1.64	0.01	0.16	0.15	0.37	4.39	1.59	0.01	0.15	0.13	0.35	3.95	1.57	0.01	0.13	0.12
Loaders	ConstMin - Rubber Tired Loaders	0.31	3.52	1.51	0.01	0.12	0.11	0.26	2.69	1.43	0.01	0.09	0.08	0.24	2.35	1.39	0.01	0.08	0.07
Portable Diesel Generators	Portable Equipment - Non-Rental Generator	1.60	14.20	6.79	0.03	0.54	0.49	1.39	9.79	6.87	0.03	0.41	0.38	1.33	8.63	6.94	0.03	0.36	0.33
Scraper	ConstMin - Scrapers	0.39	4.46	2.81	0.01	0.17	0.16	0.34	3.72	2.55	0.01	0.14	0.13	0.33	3.48	2.47	0.01	0.13	0.12
Water Truck	N/A - Onroad engine	0.01	0.04	0.11	0.00	0.03	0.02	0.01	0.03	0.11	0.00	0.03	0.02	0.01	0.03	0.11	0.00	0.03	0.02
		4.87	**50.41**	**25.32**	**0.08**	**2.10**	**1.89**	**4.25**	**40.64**	**24.30**	**0.08**	**1.74**	**1.56**	**3.96**	**36.19**	**23.60**	**0.08**	**1.55**	**1.39**

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of gram
Calculations assume that equipment quantity is the total pieces of equipment that could operate at a gi

Onroad Vehicle Speed

40 mph

Air Basin
San Joaquin Valley

Conversions

453.6 grams per pound
2,000 pounds per ton
7 days per week
30 days per month

Lower San Felipe Intake Alternative - Pipeline Option

Table A-30. Equipment List

Equipment	Quantity	Mobilization	Site Improvements	Fabricate Inlet	Build Cofferdam and Set Lower Inlet	Lay Pipe	Connect to Existing Intake	Construct Aeration Facility	Fab and Set Air Tubing	Final Work and Testing	Demobilization
Bulldozer	2	X	X								
Concrete Pumpers	1		X					X			
Cranes	3			X	X	X	X	X			
Excavator	1		X					X			
Flatbed Trucks (on site)	3	X	X	X	X	X	X	X	X	X	X
Grader	2	X	X					X			X
Loaders	2	X	X					X			
Portable Diesel Generators	4	X	X	X	X	X	X	X	X	X	X
Scraper	1		X					X			
Water Truck	2	X	X					X			X

Source: Equipment Tables_08012012.docx; EngineeringDataNeeds_July30_2012.xlsx

Table A-31. Peak Daily Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day)					
							VOC	NOx	CO	SO2	PM10	PM2.5
Mobilization	Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	2020	5.85	62.28	30.73	0.04	3.03	2.79
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.08	0.34	0.96	0.02	0.28	0.14
	Grader	ConstMin - Graders	2	20	188		2.33	29.11	9.37	0.03	0.97	0.89
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202		1.78	20.74	8.18	0.03	0.69	0.63
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		5.03	43.70	21.33	0.09	1.68	1.54
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	2	20	n/a		0.05	0.23	0.64	0.02	0.19	0.09
Mobilization Subtotal							**15.11**	**156.41**	**71.22**	**0.24**	**6.83**	**6.08**
Site Improvements	Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	2020	5.85	62.28	30.73	0.04	3.03	2.79
	Concrete Pumpers	OFF - Light Commercial - Pumps	1	20	18		0.37	2.68	1.81	0.00	0.13	0.12
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	1	20	158		0.62	6.09	8.22	0.01	0.30	0.27
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.08	0.34	0.96	0.02	0.28	0.14
	Grader	ConstMin - Graders	2	20	188		2.33	29.11	9.37	0.03	0.97	0.89
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202		1.78	20.74	8.18	0.03	0.69	0.63
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		5.03	43.70	21.33	0.09	1.68	1.54
	Scraper	ConstMin - Scrapers	1	20	367		2.31	27.21	16.56	0.04	1.04	0.95
	Water Truck	N/A - Onroad engine	2	20	n/a		0.05	0.23	0.64	0.02	0.19	0.09
Site Improvements Subtotal							**18.41**	**192.39**	**97.81**	**0.29**	**8.30**	**7.43**
Fabricate Inlet	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2020	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	3	20	231		3.30	39.64	15.50	0.04	1.62	1.49
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.08	0.34	0.96	0.02	0.28	0.14
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		5.03	43.70	21.33	0.09	1.68	1.54
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Fabricate Inlet Subtotal							**8.41**	**83.69**	**37.80**	**0.16**	**3.58**	**3.17**

Table A-31. Peak Daily Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day)					
							VOC	NOx	CO	SO2	PM10	PM2.5
Build Cofferdam and Set Lower Inlet	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2020	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	3	20	231		3.30	39.64	15.50	0.04	1.62	1.49
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.08	0.34	0.96	0.02	0.28	0.14
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		5.03	43.70	21.33	0.09	1.68	1.54
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Build Cofferdam and Set Lower Inlet Subtotal							**8.41**	**83.69**	**37.80**	**0.16**	**3.58**	**3.17**
Lay Pipe	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	3	20	231		3.14	37.19	15.59	0.04	1.51	1.38
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.07	0.31	0.94	0.02	0.28	0.13
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		5.09	45.07	21.57	0.09	1.70	1.56
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Lay Pipe Subtotal							**8.30**	**82.57**	**38.09**	**0.16**	**3.48**	**3.08**
Connect to Existing Intake	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2022	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	3	20	231		2.90	32.88	15.88	0.04	1.36	1.25
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.06	0.27	0.91	0.02	0.27	0.13
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		4.43	31.08	21.80	0.09	1.31	1.20
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Connect to Existing Intake Subtotal							**7.39**	**64.23**	**38.59**	**0.16**	**2.94**	**2.58**
Construct Aeration Facility	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	1	20	18		0.36	2.64	1.80	0.00	0.12	0.11
	Cranes	ConstMin - Cranes	3	20	231		3.14	37.19	15.59	0.04	1.51	1.38
	Excavator	ConstMin - Excavators	1	20	158		0.58	5.44	8.23	0.01	0.27	0.24
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.07	0.31	0.94	0.02	0.28	0.13
	Grader	ConstMin - Graders	2	20	188		2.24	27.39	9.11	0.03	0.90	0.83
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202		1.74	19.55	8.37	0.03	0.65	0.60
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		5.09	45.07	21.57	0.09	1.70	1.56
	Scraper	ConstMin - Scrapers	1	20	367		2.17	24.77	15.60	0.04	0.94	0.87
	Water Truck	N/A - Onroad engine	2	20	n/a		0.05	0.20	0.62	0.02	0.19	0.09
Construct Aeration Facility Subtotal							**15.43**	**162.57**	**81.81**	**0.29**	**6.56**	**5.83**
Fab and Set Air Tubing	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.07	0.31	0.94	0.02	0.28	0.13
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		5.09	45.07	21.57	0.09	1.70	1.56
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Fab and Set Air Tubing Subtotal							**5.16**	**45.38**	**22.50**	**0.12**	**1.98**	**1.70**

Table A-31. Peak Daily Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day) VOC	NOx	CO	SO2	PM10	PM2.5
Final Work and Testing	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2022	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.06	0.27	0.91	0.02	0.27	0.13
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		4.43	31.08	21.80	0.09	1.31	1.20
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Final Work and Testing Subtotal							**4.49**	**31.35**	**22.71**	**0.12**	**1.58**	**1.33**
Demobilization	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2022	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.06	0.27	0.91	0.02	0.27	0.13
	Grader	ConstMin - Graders	2	20	188		2.07	24.37	8.82	0.03	0.81	0.74
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		4.43	31.08	21.80	0.09	1.31	1.20
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	2	20	n/a		0.04	0.18	0.61	0.01	0.18	0.09
Demobilization Subtotal							**6.60**	**55.91**	**32.14**	**0.16**	**2.57**	**2.16**

Peak Day Analysis (Overlapping Phases)						
Mobilization + Site Improvements	18.41	192.39	97.81	0.29	8.30	7.43
Site Improvements + Fabricate Inlet	21.71	232.03	113.32	0.34	9.92	8.92
Fabricate Inlet + Build Cofferdam and Set Lower Inlet	8.41	83.69	37.80	0.16	3.58	3.17
Lay Pipe + Construct Aeration Facility	23.73	245.14	119.90	0.45	10.04	8.91
Lay Pipe + Construct Aeration Facility + Fab and Set Air Tubing	23.73	245.14	119.90	0.45	10.04	8.91
Maximum Daily Emissions (lbs/day)	**23.73**	**245.14**	**119.90**	**0.45**	**10.04**	**8.92**

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of grams per hour (g/hr). Emission factors from EMFAC2014 for diesel-fueled medium-duty vehicles in San Joaquin Valley Air Basin.
Peak daily emissions based on construction start year because that would represent worst-case (highest) emissions. Emissions typically decrease in future years with improvements in engine technology and as older vehicles are rotated out of service.

Onroad Vehicle Speed

40 mph

Air Basin
San Joaquin Valley

Conversions

453.6 grams per pound

Lower San Felipe Intake Alternative - Tunnel Option

Table A-32. Annual Emissions from Construction Equipment

Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Annual Emissions - 2020 (tons per year)					
					VOC	NOx	CO	SO2	PM10	PM2.5
Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	1.05	11.21	5.53	0.01	0.55	0.50
Concrete Pumpers	OFF - Light Commercial - Pumps	1	20	18	0.07	0.48	0.33	0.00	0.02	0.02
Cranes	ConstMin - Cranes	3	20	231	0.59	7.13	2.79	0.01	0.29	0.27
Excavator	ConstMin - Excavators	1	20	158	0.11	1.10	1.48	0.00	0.05	0.05
Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a	0.01	0.06	0.17	0.00	0.05	0.02
Grader	ConstMin - Graders	2	20	188	0.42	5.24	1.69	0.01	0.17	0.16
Loaders	ConstMin - Rubber Tired Loaders	2	20	202	0.32	3.73	1.47	0.01	0.12	0.11
Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369	0.90	7.87	3.84	0.02	0.30	0.28
Scraper	ConstMin - Scrapers	1	20	367	0.42	4.90	2.98	0.01	0.19	0.17
Water Truck	N/A - Onroad engine	2	20	n/a	0.01	0.04	0.12	0.00	0.03	0.02
			Grand Total (tons per year)		**3.91**	**41.77**	**20.40**	**0.06**	**1.79**	**1.61**

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of grams per hour (g/hr). Emission factors from EMFAC2014 for diesel-fueled medium-duty vehicles in San Joaquin Valley Air Basin.
Calculations assume that equipment quantity is the total pieces of equipment that could operate at a given time, regardless of the phase.

Onroad Vehicle Speed

40 mph

Air Basin
San Joaquin Valley

Conversions

453.6	grams per pound
2,000	pounds per ton
7	days per week
30	days per month

Lower San Felipe Intake Alternative - Tunnel Option

Table A-32. Annual Emissions from Construction Equipment

Equipment	OFFROAD Description	Annual Emissions - 2021 (tons per year)						Annual Emissions - 2022 (tons per year)					
		VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5
Bulldozer	ConstMin - Rubber Tired Dozers	1.03	10.94	5.48	0.01	0.53	0.49	0.83	9.22	4.73	0.01	0.42	0.39
Concrete Pumpers	OFF - Light Commercial - Pumps	0.06	0.48	0.32	0.00	0.02	0.02	0.06	0.47	0.32	0.00	0.02	0.02
Cranes	ConstMin - Cranes	0.56	6.69	2.81	0.01	0.27	0.25	0.52	5.92	2.86	0.01	0.25	0.23
Excavator	ConstMin - Excavators	0.10	0.98	1.48	0.00	0.05	0.04	0.09	0.81	1.47	0.00	0.04	0.04
Flatbed Trucks (on site)	N/A - Onroad engine	0.01	0.06	0.17	0.00	0.05	0.02	0.01	0.05	0.16	0.00	0.05	0.02
Grader	ConstMin - Graders	0.40	4.93	1.64	0.01	0.16	0.15	0.37	4.39	1.59	0.01	0.15	0.13
Loaders	ConstMin - Rubber Tired Loaders	0.31	3.52	1.51	0.01	0.12	0.11	0.26	2.69	1.43	0.01	0.09	0.08
Portable Diesel Generators	Portable Equipment - Non-Rental Generator	0.92	8.11	3.88	0.02	0.31	0.28	0.80	5.59	3.92	0.02	0.24	0.22
Scraper	ConstMin - Scrapers	0.39	4.46	2.81	0.01	0.17	0.16	0.34	3.72	2.55	0.01	0.14	0.13
Water Truck	N/A - Onroad engine	0.01	0.04	0.11	0.00	0.03	0.02	0.01	0.03	0.11	0.00	0.03	0.02
		3.81	**40.21**	**20.20**	**0.06**	**1.71**	**1.54**	**3.30**	**32.89**	**19.15**	**0.06**	**1.42**	**1.27**

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of grams per h
Calculations assume that equipment quantity is the total pieces of equipment that could operate at a given tim

Onroad Vehicle Speed

40 mph

Air Basin
San Joaquin Valley

Conversions

453.6	grams per pound
2,000	pounds per ton
7	days per week
30	days per month

Treatment Alternative

Table A-33. Equipment List (Santa Teresa WTP)

Equipment	Quantity	Mobilization and Site Improvements	Retrofit Existing Facilities	Starting and Testing	Demobilization
Bulldozer	1	X			
Concrete Pumpers	2		X		
Concrete Saw Cutters	2		X		
Cranes	2		X		
Excavator	1		X		
Flatbed Trucks (on site)	4	X	X		X
Loaders	1	X	X		
Water Truck	2	X	X		
Wheel Trencher	2		X		

Table A-34. Peak Daily Emissions from Construction Equipment (Santa Teresa WTP)

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day)					
							VOC	NOx	CO	SO2	PM10	PM2.5
Mobilization and Site Improvements	Bulldozer	ConstMin - Rubber Tired Dozers	1	10	249	2020	1.46	15.57	7.68	0.01	0.76	0.70
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	10	18		-	-	-	-	-	-
	Concrete Saw Cutters	OFF - ConstMin - Concrete/Industrial Saws	-	10	31		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	10	231		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	10	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	4	10	n/a		0.10	0.13	1.80	0.01	0.07	0.04
	Loaders	ConstMin - Rubber Tired Loaders	1	10	202		0.45	5.18	2.05	0.01	0.17	0.16
	Water Truck	N/A - Onroad engine	2	10	n/a		0.05	0.06	0.90	0.00	0.04	0.02
	Wheel Trencher	ConstMin - Trenchers	-	10	79		-	-	-	-	-	-
Mobilization and Site Improvements Subtotal							**2.06**	**20.94**	**12.42**	**0.03**	**1.04**	**0.91**
Retrofit Existing Facilities (1)	Bulldozer	ConstMin - Rubber Tired Dozers	-	10	249	2020	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	10	18		0.36	2.65	1.80	0.00	0.13	0.12
	Concrete Saw Cutters	OFF - ConstMin - Concrete/Industrial Saws	2	10	31		0.66	4.20	4.56	0.01	0.21	0.20
	Cranes	ConstMin - Cranes	2	10	231		1.10	13.21	5.17	0.01	0.54	0.50
	Excavator	ConstMin - Excavators	1	10	158		0.31	3.05	4.11	0.01	0.15	0.14
	Flatbed Trucks (on site)	N/A - Onroad engine	4	10	n/a		0.10	0.13	1.80	0.01	0.07	0.04
	Loaders	ConstMin - Rubber Tired Loaders	1	10	202		0.45	5.18	2.05	0.01	0.17	0.16
	Water Truck	N/A - Onroad engine	2	10	n/a		0.05	0.06	0.90	0.00	0.04	0.02
	Wheel Trencher	ConstMin - Trenchers	2	10	79		1.00	9.18	6.55	0.01	0.70	0.64
Retrofit Existing Facilities (1) Subtotal							**4.03**	**37.66**	**26.92**	**0.06**	**2.01**	**1.80**
Retrofit Existing Facilities (2)	Bulldozer	ConstMin - Rubber Tired Dozers	-	10	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	10	18		0.35	2.61	1.79	0.00	0.12	0.11
	Concrete Saw Cutters	OFF - ConstMin - Concrete/Industrial Saws	2	10	31		0.60	4.07	4.49	0.01	0.18	0.17
	Cranes	ConstMin - Cranes	2	10	231		1.05	12.40	5.20	0.01	0.50	0.46
	Excavator	ConstMin - Excavators	1	10	158		0.29	2.72	4.11	0.01	0.13	0.12
	Flatbed Trucks (on site)	N/A - Onroad engine	4	10	n/a		0.10	0.11	1.76	0.01	0.07	0.04
	Loaders	ConstMin - Rubber Tired Loaders	1	10	202		0.44	4.89	2.09	0.01	0.16	0.15
	Water Truck	N/A - Onroad engine	2	10	n/a		0.05	0.06	0.88	0.00	0.04	0.02
	Wheel Trencher	ConstMin - Trenchers	2	10	79		0.92	8.58	6.51	0.01	0.63	0.58
Retrofit Existing Facilities (2) Subtotal							**3.79**	**35.44**	**26.83**	**0.06**	**1.84**	**1.65**
Starting and Testing (1)	Bulldozer	ConstMin - Rubber Tired Dozers	-	10	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	10	18		-	-	-	-	-	-
	Concrete Saw Cutters	OFF - ConstMin - Concrete/Industrial Saws	-	10	31		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	10	231		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	10	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	-	10	n/a		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	10	202		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	10	n/a		-	-	-	-	-	-
	Wheel Trencher	ConstMin - Trenchers	-	10	79		-	-	-	-	-	-
Starting and Testing (1) Subtotal							**-**	**-**	**-**	**-**	**-**	**-**

Table A-34. Peak Daily Emissions from Construction Equipment (Santa Teresa WTP)

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day)					
							VOC	NOx	CO	SO2	PM10	PM2.5
Starting and Testing (2)	Bulldozer	ConstMin - Rubber Tired Dozers	-	10	249	2022	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	10	18		-	-	-	-	-	-
	Concrete Saw Cutters	OFF - ConstMin - Concrete/Industrial Saws	-	10	31		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	10	231		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	10	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	-	10	n/a		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	10	202		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	10	n/a		-	-	-	-	-	-
	Wheel Trencher	ConstMin - Trenchers	-	10	79		-	-	-	-	-	-
Starting and Testing (2) Subtotal							**-**	**-**	**-**	**-**	**-**	**-**
Demobilization	Bulldozer	ConstMin - Rubber Tired Dozers	-	10	249	2022	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	10	18		-	-	-	-	-	-
	Concrete Saw Cutters	OFF - ConstMin - Concrete/Industrial Saws	-	10	31		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	10	231		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	10	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	4	10	n/a		0.09	0.10	1.73	0.01	0.07	0.04
	Loaders	ConstMin - Rubber Tired Loaders	-	10	202		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	10	n/a		-	-	-	-	-	-
	Wheel Trencher	ConstMin - Trenchers	-	10	79		-	-	-	-	-	-
Demobilization Subtotal							**0.09**	**0.10**	**1.73**	**0.01**	**0.07**	**0.04**

Notes:
Emission factors for onroad engines (flatbed trucks and water trucks) shown in units of grams per hour (g/hr). Emission factors from EMFAC2014 for diesel-fueled medium-duty vehicles in San Francisco Bay Area Air Basin.
Peak daily emissions based on construction start year because that would represent worst-case (highest) emissions. Emissions typically decrease in future years with improvements in engine technology and as older vehicles are rotated out of service.

Peak Day Analysis (Overlapping Phases)						
Starting and Testing (2) + Demobilization	0.09	0.10	1.73	0.01	0.07	0.04
Maximum Daily Emissions (lbs/day)	**4.03**	**37.66**	**26.92**	**0.06**	**2.01**	**1.80**

Onroad Vehicle Speed
15 mph

Air Basin
San Francisco Bay Area

Conversions
453.6 grams per pound

Treatment Alternative

Table A-35. Annual Emissions from Construction Equipment (Santa Teresa WTP)

Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Annual Emissions - 2020 (tons per year)						Annual Emissions - 2021 (tons per year)					
					VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5
Bulldozer	ConstMin - Rubber Tired Dozers	1	10	249	0.19	2.06	1.01	0.00	0.10	0.09	0.19	2.01	1.00	0.00	0.10	0.09
Concrete Pumpers	OFF - Light Commercial - Pumps	2	10	18	0.05	0.35	0.24	0.00	0.02	0.02	0.05	0.35	0.24	0.00	0.02	0.01
Concrete Saw Cutters	OFF - ConstMin - Concrete/Industrial Saws	2	10	31	0.09	0.55	0.60	0.00	0.03	0.03	0.08	0.54	0.59	0.00	0.02	0.02
Cranes	ConstMin - Cranes	2	10	231	0.15	1.74	0.68	0.00	0.07	0.07	0.14	1.64	0.69	0.00	0.07	0.06
Excavator	ConstMin - Excavators	1	10	158	0.04	0.40	0.54	0.00	0.02	0.02	0.04	0.36	0.54	0.00	0.02	0.02
Flatbed Trucks (on site)	N/A - Onroad engine	4	10	n/a	0.01	0.02	0.24	0.00	0.01	0.01	0.01	0.02	0.23	0.00	0.01	0.00
Loaders	ConstMin - Rubber Tired Loaders	1	10	202	0.06	0.68	0.27	0.00	0.02	0.02	0.06	0.65	0.28	0.00	0.02	0.02
Water Truck	N/A - Onroad engine	2	10	n/a	0.01	0.01	0.12	0.00	0.00	0.00	0.01	0.01	0.12	0.00	0.00	0.00
Wheel Trencher	ConstMin - Trenchers	2	10	79	0.13	1.21	0.86	0.00	0.09	0.08	0.12	1.13	0.86	0.00	0.08	0.08
				Grand Total	**0.73**	**7.03**	**4.57**	**0.01**	**0.36**	**0.33**	**0.69**	**6.69**	**4.55**	**0.01**	**0.34**	**0.31**

Notes:
Emission factors for onroad engines (flatbed trucks and water trucks) shown in units of grams per hour (g/hr). Emission factors from EMFAC2014 for diesel-fueled medium-duty vehicles in San Francisco Bay Area Air Basin
Calculations assume that equipment quantity is the total pieces of equipment that could operate at a given time, regardless of the phase.

Onroad Vehicle Speed

15 mph

Air Basin
San Francisco Bay Area

Conversions

453.6 grams per pound
2,000 pounds per ton
5 days per week
22 days per month

Treatment Alternative

Table A-35. Annual Emissions from Construction Equipment (Santa Teresa WTP)

Equipment	OFFROAD Description	Annual Emissions - 2022 (tons per year)					
		VOC	NOx	CO	SO2	PM10	PM2.5
Bulldozer	ConstMin - Rubber Tired Dozers	0.15	1.69	0.87	0.00	0.08	0.07
Concrete Pumpers	OFF - Light Commercial - Pumps	0.05	0.34	0.24	0.00	0.02	0.01
Concrete Saw Cutters	OFF - ConstMin - Concrete/Industrial Saws	0.07	0.52	0.58	0.00	0.02	0.02
Cranes	ConstMin - Cranes	0.13	1.45	0.70	0.00	0.06	0.06
Excavator	ConstMin - Excavators	0.03	0.30	0.54	0.00	0.01	0.01
Flatbed Trucks (on site)	N/A - Onroad engine	0.01	0.01	0.23	0.00	0.01	0.00
Loaders	ConstMin - Rubber Tired Loaders	0.05	0.49	0.26	0.00	0.02	0.02
Water Truck	N/A - Onroad engine	0.01	0.01	0.11	0.00	0.00	0.00
Wheel Trencher	ConstMin - Trenchers	0.12	1.09	0.86	0.00	0.08	0.07
		0.61	**5.89**	**4.39**	**0.01**	**0.30**	**0.27**

Notes:
Emission factors for onroad engines (flatbed trucks and water trucks) shown in units of grams per hour (g/hr).
Calculations assume that equipment quantity is the total pieces of equipment that could operate at a given tim

Onroad Vehicle Speed

15 mph

Air Basin
San Francisco Bay Area

Conversions

453.6 grams per pound
2,000 pounds per ton
5 days per week
22 days per month

Tunnel Option Start Date 1/1/2020
Pipeline Option Start Date 1/1/2020

Table A-36. Lower San Felipe Intake Alternative Schedule

	Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
Tunnel Option																																																
Mobilization	6																																															
Site Improvements	6																																															
Construct Vertical Shaft	6																																														
Set Up TBM	2																																														
Tunneling and Spreading of Soils	20																																														
Cofferdam and TBM Out	3																																														
Connect to Existing Intake	3																																														
Fabricate Inlet	3																																														
Set Inlet and Flood Tunnel	1																																														
Construct Aeration Facility	10																																														
Fab and Set Air Tubing	6																																														
Final Work and Testing	4																																														
Demobilization	2																																														
Pipeline Option																																															
Mobilization	6																																															
Site Improvements	6																																															
Fabricate Inlet	3																																														
Build Cofferdam and Set Lower Inlet	4																																														
Lay Pipe	12																																														
Connect to Existing Intake	2																																														
Construct Aeration Facility	10																																														
Fab and Set Air Tubing	6																																														
Final Work and Testing	4																																														
Demobilization	2																																														

Source: SLLPIP_PD_06082012.pdf

Tunnel Option Start Date 1/1/2020
Pipeline Option Start Date 1/1/2020

Table A-36. Lower San Felipe Intake Alternative

	Months	Dates		Year		Months by Year				
Tunnel Option		**Start**	**End**	**Start**	**End**	**2020**	**2021**	**2022**	**2023**	**Total**
Mobilization	6	1/1/2020	6/30/2020	2020	2020	6	0	0	0	6
Site Improvements	6	4/1/2020	9/30/2020	2020	2020	6	0	0	0	6
Construct Vertical Shaft	6	10/1/2020	3/31/2021	2020	2021	3	3	0	0	6
Set Up TBM	2	4/1/2021	5/31/2021	2021	2021	0	2	0	0	2
Tunneling and Spreading of Soils	20	6/1/2021	1/31/2023	2021	2023	0	7	12	1	20
Cofferdam and TBM Out	3	2/1/2023	4/30/2023	2023	2023	0	0	0	3	3
Connect to Existing Intake	3	2/1/2023	4/30/2023	2023	2023	0	0	0	3	3
Fabricate Inlet	3	2/1/2023	4/30/2023	2023	2023	0	0	0	3	3
Set Inlet and Flood Tunnel	1	5/1/2023	5/31/2023	2023	2023	0	0	0	1	1
Construct Aeration Facility	10	6/1/2021	3/31/2022	2021	2022	0	7	3	0	10
Fab and Set Air Tubing	6	10/1/2021	3/31/2022	2021	2022	0	3	3	0	6
Final Work and Testing	4	6/1/2023	9/30/2023	2023	2023	0	0	0	4	4
Demobilization	2	10/1/2023	11/30/2023	2023	2023	0	0	0	2	2
Pipeline Option										
Mobilization	6	1/1/2020	6/30/2020	2020	2020	6	0	0	0	6
Site Improvements	6	4/1/2020	9/30/2020	2020	2020	6	0	0	0	6
Fabricate Inlet	3	8/1/2020	10/31/2020	2020	2020	3	0	0	0	3
Build Cofferdam and Set Lower Inlet	4	10/1/2020	1/31/2021	2020	2021	3	1	0	0	4
Lay Pipe	12	2/1/2021	1/31/2022	2021	2022	0	11	1	0	12
Connect to Existing Intake	2	2/1/2022	3/31/2022	2022	2022	0	0	2	0	2
Construct Aeration Facility	10	2/1/2021	11/30/2021	2021	2021	0	10	0	0	10
Fab and Set Air Tubing	6	6/1/2021	11/30/2021	2021	2021	0	6	0	0	6
Final Work and Testing	4	4/1/2022	7/31/2022	2022	2022	0	0	4	0	4
Demobilization	2	8/1/2022	9/30/2022	2022	2022	0	0	2	0	2

Source: SLLPIP_PD_06082012.pdf

Table A-37. Santa Teresa WTP - Construction Schedule

	Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Dates		Year		Months by Year		
																																						Start	End	Start	End	2020	2021	2022
Mobilization and Site Improvements	2																																					1/1/2020	2/29/2020	2020	2020	2	0	0
Retrofit Existing Facilities (1)	14																																					3/1/2020	4/30/2021	2020	2021	10	4	0
Retrofit Existing Facilities (2)	14																																					7/1/2021	8/31/2022	2021	2022	0	6	8
Starting and Testing (1)	2																																					5/1/2021	6/30/2021	2021	2021	0	2	0
Starting and Testing (2)	2																																					9/1/2022	10/31/2022	2022	2022	0	0	2
Demobilization	2																																					11/1/2022	12/31/2022	2022	2022	0	0	2
																																								Total	12	12	12

Source: Equipment Tables_08012012.docx

Note: Construction duration originally estimated to be 15 months; however, schedule updated to 36 months after completion of Feasibility Report. Therefore, current schedule scaled up to reflect 36-month construction schedule.

OFFROAD2017 Emission Factor Summary

Table A-38. In-Use Off-Road Construction Equipment Emission Factors (San Joaquin Valley Air Basin)

Equipment Type	Average HP	Emission Factors - 2020 (g/bhp-hr)						Emission Factors - 2021 (g/bhp-hr)						Emission Factors - 2022 (g/bhp-hr)					
		VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5
ConstMin - Bore/Drill Rigs	221	0.0729	0.9242	0.5423	0.0024	0.0269	0.0247	0.0681	0.8037	0.5381	0.0024	0.0245	0.0225	0.0611	0.6313	0.5342	0.0024	0.0206	0.0190
ConstMin - Cranes	231	0.1081	1.2973	0.5074	0.0014	0.0530	0.0488	0.1027	1.2171	0.5101	0.0014	0.0493	0.0453	0.0948	1.0761	0.5198	0.0014	0.0446	0.0410
ConstMin - Crawler Tractors	212	0.1786	2.2157	0.9385	0.0021	0.0889	0.0818	0.1676	2.0551	0.8820	0.0021	0.0820	0.0754	0.1518	1.8029	0.8403	0.0021	0.0725	0.0667
ConstMin - Excavators	158	0.0890	0.8749	1.1795	0.0019	0.0425	0.0391	0.0833	0.7814	1.1807	0.0019	0.0380	0.0350	0.0736	0.6459	1.1748	0.0019	0.0314	0.0289
ConstMin - Graders	188	0.1404	1.7558	0.5651	0.0020	0.0582	0.0536	0.1350	1.6520	0.5495	0.0020	0.0545	0.0501	0.1248	1.4702	0.5320	0.0020	0.0487	0.0448
ConstMin - Off-Highway Tractors	124	0.1177	1.2557	1.3968	0.0021	0.0609	0.0560	0.1138	1.1662	1.4018	0.0021	0.0567	0.0522	0.1019	0.9840	1.3876	0.0021	0.0475	0.0437
ConstMin - Off-Highway Trucks	403	0.0941	0.9032	0.5454	0.0019	0.0330	0.0303	0.0861	0.7535	0.5150	0.0019	0.0277	0.0255	0.0744	0.5687	0.4711	0.0019	0.0206	0.0189
ConstMin - Other Construction Equipment	172	0.1618	1.7137	1.3459	0.0020	0.0906	0.0833	0.1377	1.4348	1.3247	0.0020	0.0752	0.0692	0.1234	1.2503	1.3134	0.0020	0.0654	0.0601
ConstMin - Pavers	129	0.1160	1.2319	1.2545	0.0020	0.0608	0.0559	0.1084	1.1356	1.2564	0.0020	0.0556	0.0511	0.0909	0.9181	1.2469	0.0020	0.0441	0.0406
ConstMin - Paving Equipment	131	0.0980	0.9774	1.0956	0.0017	0.0527	0.0485	0.0857	0.8624	1.0908	0.0017	0.0431	0.0397	0.0857	0.8125	1.0998	0.0017	0.0430	0.0396
ConstMin - Rollers	80	0.1420	1.4269	1.3144	0.0018	0.0908	0.0835	0.1291	1.3187	1.3059	0.0018	0.0803	0.0739	0.1120	1.1729	1.2896	0.0018	0.0671	0.0617
ConstMin - Rough Terrain Forklifts	100	0.0605	0.8975	1.2949	0.0020	0.0298	0.0274	0.0565	0.8394	1.2940	0.0020	0.0255	0.0235	0.0522	0.7751	1.2921	0.0020	0.0208	0.0192
ConstMin - Rubber Tired Dozers	249	0.2663	2.8364	1.3995	0.0019	0.1381	0.1271	0.2601	2.7691	1.3859	0.0019	0.1338	0.1231	0.2111	2.3322	1.1964	0.0019	0.1067	0.0982
ConstMin - Rubber Tired Loaders	202	0.1001	1.1642	0.4594	0.0018	0.0387	0.0356	0.0979	1.0975	0.4698	0.0018	0.0368	0.0338	0.0814	0.8385	0.4466	0.0018	0.0283	0.0260
ConstMin - Scrapers	367	0.1426	1.6817	1.0236	0.0024	0.0641	0.0590	0.1339	1.5308	0.9638	0.0024	0.0583	0.0537	0.1180	1.2781	0.8743	0.0024	0.0488	0.0449
ConstMin - Skid Steer Loaders	65	0.0693	0.9185	1.2065	0.0018	0.0392	0.0361	0.0654	0.8670	1.2065	0.0018	0.0348	0.0320	0.0601	0.8006	1.2030	0.0018	0.0293	0.0269
ConstMin - Surfacing Equipment	263	0.0684	1.0334	0.4306	0.0015	0.0334	0.0307	0.0673	0.9777	0.4316	0.0015	0.0322	0.0296	0.0628	0.8783	0.4031	0.0015	0.0290	0.0267
ConstMin - Sweepers/Scrubbers	64	0.3153	2.5963	1.8350	0.0022	0.2092	0.1924	0.2431	2.1422	1.7523	0.0022	0.1519	0.1398	0.2314	1.9740	1.7375	0.0022	0.1449	0.1333
ConstMin - Tractors/Loaders/Backhoes	98	0.1167	1.1857	1.3147	0.0018	0.0742	0.0683	0.1042	1.0668	1.3039	0.0018	0.0620	0.0571	0.0909	0.9372	1.2904	0.0018	0.0492	0.0453
ConstMin - Trenchers	79	0.2876	2.6346	1.8809	0.0024	0.1998	0.1838	0.2652	2.4637	1.8683	0.0025	0.1805	0.1660	0.2505	2.3614	1.8617	0.0024	0.1685	0.1550
Industrial - Aerial Lifts	63	0.0360	0.5560	0.9793	0.0015	0.0153	0.0140	0.0328	0.5032	0.9761	0.0015	0.0115	0.0105	0.0329	0.5102	0.9811	0.0015	0.0093	0.0085
Industrial - Forklifts	89	0.0904	0.8175	0.7529	0.0010	0.0607	0.0559	0.0808	0.7403	0.7445	0.0010	0.0524	0.0482	0.0707	0.6603	0.7356	0.0010	0.0435	0.0400
Industrial - Other General Industrial Equipment	88	0.2996	2.2541	1.4409	0.0017	0.2078	0.1912	0.2969	2.2308	1.4498	0.0017	0.2036	0.1873	0.2628	2.0725	1.4380	0.0017	0.1788	0.1645
Industrial - Other Material Handling Equipment	167	0.1379	1.1713	1.3122	0.0019	0.0797	0.0733	0.1288	1.0935	1.3213	0.0019	0.0712	0.0655	0.1108	0.9004	1.2990	0.0019	0.0583	0.0536
OFF - ConstMin - Bore/Drill Rigs	15	0.4244	3.2402	1.9149	0.0057	0.1220	0.1122	0.4238	3.2355	1.9121	0.0056	0.1218	0.1121	0.4248	3.2431	1.9166	0.0057	0.1221	0.1124
OFF - ConstMin - Cement and Mortar Mixers	10	0.3135	2.3657	1.8325	0.0048	0.0940	0.0865	0.3126	2.3634	1.8309	0.0048	0.0931	0.0857	0.3114	2.3584	1.8272	0.0048	0.0926	0.0852
OFF - ConstMin - Concrete/Industrial Saws	31	0.4887	3.1112	3.3745	0.0054	0.1571	0.1446	0.4419	3.0124	3.3213	0.0054	0.1365	0.1256	0.4016	2.9004	3.2578	0.0054	0.1168	0.1075
OFF - ConstMin - Dumpers/Tenders	16	0.2165	1.6560	0.8936	0.0028	0.0631	0.0581	0.2164	1.6551	0.8937	0.0028	0.0626	0.0576	0.2156	1.6486	0.8904	0.0027	0.0620	0.0570
OFF - ConstMin - Excavators	23	0.3226	2.4669	1.3324	0.0041	0.0922	0.0848	0.3234	2.4731	1.3358	0.0041	0.0924	0.0850	0.3229	2.4688	1.3335	0.0041	0.0922	0.0849
OFF - ConstMin - Other Construction Equipment	14	0.3414	2.5916	2.0259	0.0053	0.1004	0.0924	0.3414	2.5910	2.0254	0.0053	0.1004	0.0924	0.3414	2.5917	2.0260	0.0053	0.1004	0.0924
OFF - ConstMin - Pavers	24	0.3599	2.7562	1.4841	0.0046	0.1064	0.0979	0.3591	2.7479	1.4818	0.0046	0.1052	0.0967	0.3593	2.7483	1.4833	0.0046	0.1043	0.0960
OFF - ConstMin - Paving Equipment	19	0.3042	2.3257	1.2562	0.0039	0.0869	0.0799	0.3031	2.3174	1.2517	0.0039	0.0866	0.0797	0.3012	2.3029	1.2438	0.0038	0.0860	0.0792
OFF - ConstMin - Plate Compactors	8	0.2350	1.7807	1.4915	0.0038	0.0696	0.0640	0.2350	1.7809	1.4917	0.0038	0.0696	0.0640	0.2352	1.7819	1.4925	0.0038	0.0696	0.0641
OFF - ConstMin - Rollers	12	0.3113	2.3690	1.6460	0.0045	0.0906	0.0834	0.3114	2.3697	1.6465	0.0045	0.0906	0.0834	0.3115	2.3704	1.6469	0.0045	0.0907	0.0834
OFF - ConstMin - Rubber Tired Loaders	25	0.3069	2.3463	1.2673	0.0039	0.0877	0.0807	0.3090	2.3627	1.2762	0.0039	0.0883	0.0812	0.3090	2.3625	1.2760	0.0039	0.0883	0.0812
OFF - ConstMin - Signal Boards	6	0.4483	3.3972	2.8455	0.0073	0.1327	0.1221	0.4483	3.3971	2.8454	0.0073	0.1327	0.1221	0.4483	3.3970	2.8454	0.0073	0.1327	0.1221
OFF - ConstMin - Skid Steer Loaders	20	0.3206	2.4241	1.3023	0.0040	0.0986	0.0907	0.3174	2.4139	1.2963	0.0040	0.0962	0.0885	0.3152	2.4060	1.2922	0.0040	0.0946	0.0871
OFF - ConstMin - Tractors/Loaders/Backhoes	23	0.3116	2.3823	1.2867	0.0040	0.0897	0.0825	0.3117	2.3832	1.2872	0.0040	0.0892	0.0821	0.3116	2.3829	1.2871	0.0040	0.0890	0.0819
OFF - ConstMin - Trenchers	22	0.4226	3.2258	1.9239	0.0057	0.1216	0.1119	0.4221	3.2222	1.9218	0.0056	0.1214	0.1117	0.4224	3.2243	1.9231	0.0057	0.1215	0.1118
OFF - Industrial - Aerial Lifts	17	0.2649	1.9941	1.2588	0.0036	0.0808	0.0744	0.2623	1.9867	1.2539	0.0036	0.0791	0.0728	0.2604	1.9803	1.2501	0.0036	0.0780	0.0718
OFF - Industrial - Other General Industrial Equipment	18	0.2792	2.1852	1.3293	0.0039	0.0825	0.0759	0.2791	2.1846	1.3289	0.0039	0.0825	0.0759	0.2792	2.1852	1.3292	0.0039	0.0825	0.0759
OFF - Industrial - Sweepers/Scrubbers	18	0.3671	2.9152	1.8936	0.0054	0.1108	0.1019	0.3674	2.9177	1.8952	0.0054	0.1109	0.1020	0.3653	2.9013	1.8846	0.0053	0.1102	0.1014
OFF - Light Commercial - Air Compressors	35	0.4153	2.1321	2.5113	0.0035	0.1260	0.1159	0.3667	2.0431	2.4351	0.0035	0.1065	0.0979	0.3364	1.9808	2.4033	0.0035	0.0919	0.0846
OFF - Light Commercial - Generator Sets	21	0.4230	3.3680	2.1882	0.0059	0.1569	0.1444	0.4164	3.3233	2.1711	0.0059	0.1490	0.1371	0.4119	3.2939	2.1576	0.0059	0.1430	0.1315
OFF - Light Commercial - Pressure Washers	21	0.1723	1.4166	1.0221	0.0026	0.0668	0.0614	0.1698	1.3997	1.0200	0.0026	0.0635	0.0584	0.1677	1.3843	1.0147	0.0026	0.0609	0.0560
OFF - Light Commercial - Pumps	18	0.4613	3.3778	2.2813	0.0060	0.1664	0.1531	0.4515	3.3293	2.2661	0.0060	0.1569	0.1444	0.4441	3.2956	2.2532	0.0060	0.1496	0.1376
OFF - Light Commercial - Welders	33	0.3655	1.9573	2.2095	0.0033	0.1126	0.1036	0.3223	1.8756	2.1429	0.0033	0.0956	0.0879	0.2946	1.8185	2.1130	0.0033	0.0829	0.0763
Portable Equipment - Non-Rental Compressor	210	0.0454	0.6882	0.2996	0.0014	0.0229	0.0211	0.0436	0.6262	0.3029	0.0014	0.0211	0.0194	0.0377	0.4444	0.3062	0.0015	0.0154	0.0142
Portable Equipment - Non-Rental Generator	559	0.0772	0.6715	0.3278	0.0014	0.0257	0.0237	0.0782	0.6926	0.3314	0.0014	0.0261	0.0240	0.0680	0.4775	0.3350	0.0015	0.0201	0.0185
Portable Equipment - Non-Rental Other Portable Equipment	382	0.0387	0.5085	0.2911	0.0014	0.0177	0.0163	0.0382	0.4829	0.2943	0.0014	0.0173	0.0159	0.0307	0.2294	0.2975	0.0015	0.0095	0.0087
Portable Equipment - Non-Rental Pump	593	0.0368	0.5472	0.2858	0.0014	0.0205	0.0188	0.0355	0.5025	0.2889	0.0014	0.0192	0.0177	0.0319	0.3820	0.2920	0.0015	0.0154	0.0142
Portable Equipment - Rental Compressor	233	0.0371	0.3732	0.2991	0.0014	0.0143	0.0132	0.0375	0.3772	0.3024	0.0014	0.0145	0.0133	0.0355	0.3131	0.3057	0.0015	0.0122	0.0113
Portable Equipment - Rental Generator	232	0.0644	0.4404	0.3469	0.0014	0.0174	0.0160	0.0573	0.2601	0.3507	0.0014	0.0114	0.0105	0.0552	0.2024	0.3545	0.0015	0.0095	0.0087
Portable Equipment - Rental Other Portable Equipment	169	0.0731	0.6709	0.9868	0.0014	0.0387	0.0356	0.0711	0.6281	0.9976	0.0014	0.0341	0.0314	0.0640	0.4928	1.0085	0.0015	0.0255	0.0234
Portable Equipment - Rental Pump	212	0.0518	0.4949	0.3185	0.0014	0.0178	0.0164	0.0519	0.4838	0.3232	0.0014	0.0175	0.0161	0.0504	0.4320	0.3267	0.0015	0.0161	0.0148

Source:
California Air Resources Board (CARB). 2017. OFFROAD2017 - ORION Web Database. Available online at https://www.arb.ca.gov/orion/ [Accessesd October 17, 2018].
Notes:
1. Horsepower used in modeling is average calculated from OFFROAD2017 (e.g., "Horsepower_Hours_hhpy" divided by "Total_Activity_hpy.")

OFFROAD2017 Emission Factor Summary

Table A-38. In-Use Off-Road Construction Equipment Emission Factors

Equipment Type	Average HP	Emission Factors - 2023 (g/bhp-hr)						Emission Factors - 2024 (g/bhp-hr)					
		VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5
ConstMin - Bore/Drill Rigs	221	0.0592	0.5975	0.5298	0.0024	0.0191	0.0176	0.0582	0.5618	0.5316	0.0024	0.0182	0.0168
ConstMin - Cranes	231	0.0906	0.9974	0.5197	0.0014	0.0418	0.0385	0.0847	0.9076	0.4853	0.0014	0.0379	0.0348
ConstMin - Crawler Tractors	212	0.1394	1.5759	0.8203	0.0021	0.0653	0.0601	0.1319	1.4539	0.7805	0.0021	0.0602	0.0554
ConstMin - Excavators	158	0.0687	0.5637	1.1758	0.0019	0.0277	0.0255	0.0656	0.5109	1.1778	0.0019	0.0253	0.0233
ConstMin - Graders	188	0.1166	1.3229	0.5265	0.0020	0.0442	0.0407	0.1089	1.1890	0.5160	0.0020	0.0397	0.0365
ConstMin - Off-Highway Tractors	124	0.0873	0.7750	1.3650	0.0021	0.0371	0.0341	0.0779	0.6344	1.3567	0.0021	0.0302	0.0278
ConstMin - Off-Highway Trucks	403	0.0711	0.5061	0.4624	0.0019	0.0182	0.0168	0.0701	0.4719	0.4563	0.0019	0.0169	0.0156
ConstMin - Other Construction Equipment	172	0.1144	1.1275	1.3078	0.0020	0.0588	0.0541	0.1095	1.0570	1.3119	0.0020	0.0548	0.0505
ConstMin - Pavers	129	0.0845	0.8254	1.2468	0.0020	0.0393	0.0362	0.0816	0.7701	1.2523	0.0020	0.0366	0.0337
ConstMin - Paving Equipment	131	0.0812	0.7491	1.1022	0.0017	0.0391	0.0359	0.0798	0.7121	1.1092	0.0017	0.0374	0.0345
ConstMin - Rollers	80	0.1032	1.0919	1.2843	0.0018	0.0595	0.0547	0.0975	1.0316	1.2827	0.0018	0.0539	0.0496
ConstMin - Rough Terrain Forklifts	100	0.0502	0.7380	1.2932	0.0020	0.0181	0.0166	0.0503	0.7212	1.2962	0.0020	0.0173	0.0160
ConstMin - Rubber Tired Dozers	249	0.1789	1.9495	1.0377	0.0019	0.0871	0.0802	0.2077	2.2834	1.4959	0.0019	0.1017	0.0936
ConstMin - Rubber Tired Loaders	202	0.0753	0.7330	0.4335	0.0018	0.0246	0.0226	0.0698	0.6454	0.4227	0.0018	0.0214	0.0197
ConstMin - Scrapers	367	0.1141	1.1936	0.8495	0.0024	0.0457	0.0421	0.1103	1.1055	0.8253	0.0024	0.0427	0.0393
ConstMin - Skid Steer Loaders	65	0.0562	0.7484	1.2013	0.0018	0.0253	0.0232	0.0524	0.7069	1.1996	0.0018	0.0218	0.0201
ConstMin - Surfacing Equipment	263	0.0619	0.8295	0.4064	0.0015	0.0281	0.0258	0.0581	0.7636	0.3980	0.0015	0.0254	0.0234
ConstMin - Sweepers/Scrubbers	64	0.3579	2.7606	1.9205	0.0022	0.2396	0.2204	0.4344	3.1850	1.9920	0.0022	0.2867	0.2638
ConstMin - Tractors/Loaders/Backhoes	98	0.0829	0.8540	1.2851	0.0018	0.0408	0.0375	0.0792	0.8076	1.2879	0.0018	0.0358	0.0329
ConstMin - Trenchers	79	0.2381	2.2557	1.8580	0.0025	0.1574	0.1448	0.2187	2.0737	1.8404	0.0025	0.1399	0.1287
Industrial - Aerial Lifts	63	0.0335	0.5217	0.9713	0.0015	0.0116	0.0107	0.0339	0.5060	0.9759	0.0015	0.0113	0.0104
Industrial - Forklifts	89	0.0636	0.5991	0.7297	0.0010	0.0367	0.0337	0.0586	0.5529	0.7265	0.0010	0.0316	0.0291
Industrial - Other General Industrial Equipment	88	0.1873	1.5512	1.3363	0.0017	0.1152	0.1060	0.1485	1.2511	1.2787	0.0017	0.0873	0.0803
Industrial - Other Material Handling Equipment	167	0.1017	0.8359	1.2986	0.0019	0.0476	0.0438	0.0969	0.7765	1.3122	0.0019	0.0423	0.0389
OFF - ConstMin - Bore/Drill Rigs	15	0.4218	3.2198	1.9029	0.0056	0.1213	0.1116	0.4229	3.2286	1.9080	0.0056	0.1216	0.1119
OFF - ConstMin - Cement and Mortar Mixers	10	0.3105	2.3540	1.8241	0.0048	0.0921	0.0848	0.3105	2.3559	1.8259	0.0048	0.0920	0.0846
OFF - ConstMin - Concrete/Industrial Saws	31	0.3700	2.8194	3.2304	0.0054	0.0996	0.0916	0.3419	2.7268	3.1904	0.0054	0.0853	0.0785
OFF - ConstMin - Dumpers/Tenders	16	0.2157	1.6489	0.8906	0.0027	0.0617	0.0568	0.2165	1.6555	0.8942	0.0028	0.0619	0.0569
OFF - ConstMin - Excavators	23	0.3241	2.4778	1.3383	0.0041	0.0926	0.0852	0.3233	2.4722	1.3353	0.0041	0.0924	0.0850
OFF - ConstMin - Other Construction Equipment	14	0.3413	2.5909	2.0253	0.0053	0.1004	0.0924	0.3412	2.5901	2.0247	0.0053	0.1004	0.0923
OFF - ConstMin - Pavers	24	0.3605	2.7565	1.4886	0.0046	0.1039	0.0956	0.3599	2.7517	1.4863	0.0046	0.1033	0.0950
OFF - ConstMin - Paving Equipment	19	0.3010	2.3017	1.2432	0.0038	0.0860	0.0791	0.3013	2.3037	1.2443	0.0038	0.0861	0.0792
OFF - ConstMin - Plate Compactors	8	0.2351	1.7812	1.4920	0.0038	0.0696	0.0640	0.2352	1.7819	1.4926	0.0038	0.0696	0.0641
OFF - ConstMin - Rollers	12	0.3116	2.3711	1.6474	0.0045	0.0907	0.0834	0.3114	2.3702	1.6468	0.0045	0.0907	0.0834
OFF - ConstMin - Rubber Tired Loaders	25	0.3055	2.3356	1.2615	0.0039	0.0873	0.0803	0.3062	2.3409	1.2644	0.0039	0.0875	0.0805
OFF - ConstMin - Signal Boards	6	0.4483	3.3971	2.8454	0.0073	0.1327	0.1221	0.4483	3.3972	2.8455	0.0073	0.1327	0.1221
OFF - ConstMin - Skid Steer Loaders	20	0.3135	2.3987	1.2891	0.0040	0.0933	0.0859	0.3126	2.3940	1.2877	0.0040	0.0922	0.0849
OFF - ConstMin - Tractors/Loaders/Backhoes	23	0.3114	2.3813	1.2862	0.0040	0.0889	0.0818	0.3117	2.3830	1.2871	0.0040	0.0890	0.0819
OFF - ConstMin - Trenchers	22	0.4225	3.2248	1.9234	0.0057	0.1215	0.1118	0.4228	3.2273	1.9248	0.0057	0.1216	0.1119
OFF - Industrial - Aerial Lifts	17	0.2590	1.9742	1.2469	0.0036	0.0771	0.0709	0.2580	1.9692	1.2446	0.0036	0.0763	0.0702
OFF - Industrial - Other General Industrial Equipment	18	0.2793	2.1864	1.3300	0.0039	0.0826	0.0759	0.2791	2.1848	1.3290	0.0039	0.0825	0.0759
OFF - Industrial - Sweepers/Scrubbers	18	0.3661	2.9071	1.8883	0.0053	0.1105	0.1016	0.3657	2.9041	1.8864	0.0053	0.1103	0.1015
OFF - Light Commercial - Air Compressors	35	0.3107	1.9228	2.3795	0.0035	0.0789	0.0726	0.2894	1.8692	2.3631	0.0035	0.0684	0.0629
OFF - Light Commercial - Generator Sets	21	0.4082	3.2684	2.1457	0.0059	0.1378	0.1268	0.4048	3.2450	2.1350	0.0059	0.1344	0.1236
OFF - Light Commercial - Pressure Washers	21	0.1658	1.3703	1.0098	0.0026	0.0585	0.0539	0.1631	1.3489	0.9988	0.0026	0.0566	0.0521
OFF - Light Commercial - Pumps	18	0.4376	3.2668	2.2422	0.0060	0.1431	0.1317	0.4316	3.2394	2.2316	0.0060	0.1386	0.1275
OFF - Light Commercial - Welders	33	0.2708	1.7654	2.0894	0.0033	0.0713	0.0656	0.2505	1.7155	2.0709	0.0033	0.0619	0.0569
Portable Equipment - Non-Rental Compressor	210	0.0375	0.4328	0.3096	0.0015	0.0150	0.0138	0.0347	0.3492	0.3129	0.0015	0.0122	0.0112
Portable Equipment - Non-Rental Generator	559	0.0649	0.4210	0.3386	0.0015	0.0177	0.0163	0.0663	0.4377	0.3423	0.0015	0.0186	0.0171
Portable Equipment - Non-Rental Other Portable Equipment	382	0.0302	0.2119	0.3007	0.0015	0.0088	0.0081	0.0307	0.2149	0.3040	0.0015	0.0089	0.0082
Portable Equipment - Non-Rental Pump	593	0.0318	0.3737	0.2952	0.0015	0.0152	0.0140	0.0310	0.3421	0.2984	0.0015	0.0141	0.0129
Portable Equipment - Rental Compressor	233	0.0303	0.1708	0.3090	0.0015	0.0072	0.0066	0.0306	0.1727	0.3124	0.0015	0.0073	0.0067
Portable Equipment - Rental Generator	232	0.0541	0.1748	0.3584	0.0015	0.0084	0.0077	0.0522	0.1381	0.3623	0.0015	0.0068	0.0062
Portable Equipment - Rental Other Portable Equipment	169	0.0614	0.4463	1.0195	0.0015	0.0227	0.0209	0.0571	0.3718	1.0306	0.0015	0.0185	0.0170
Portable Equipment - Rental Pump	212	0.0480	0.3582	0.3303	0.0015	0.0141	0.0130	0.0459	0.3105	0.3339	0.0015	0.0124	0.0114

Source:
California Air Resources Board (CARB). 2017. OFFROAD2017 - ORION Web Databa
Notes:
1. Horsepower used in modeling is average calculated from OFFROAD2017 (e.g., "H

Table A-39. In-Use Off-Road Construction Equipment Emission Factors (San Francisco Bay Area Air Basin)

Equipment Type	Average HP	Emission Factors - 2020 (g/bhp-hr)						Emission Factors - 2021 (g/bhp-hr)						Emission Factors - 2022 (g/bhp-hr)					
		VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5
ConstMin - Bore/Drill Rigs	221	0.0729	0.9242	0.5423	0.0024	0.0269	0.0247	0.0681	0.8037	0.5381	0.0024	0.0245	0.0225	0.0611	0.6313	0.5342	0.0024	0.0206	0.0190
ConstMin - Cranes	231	0.1081	1.2973	0.5074	0.0014	0.0530	0.0488	0.1027	1.2171	0.5101	0.0014	0.0493	0.0453	0.0948	1.0761	0.5198	0.0014	0.0446	0.0410
ConstMin - Crawler Tractors	212	0.1786	2.2157	0.9385	0.0021	0.0889	0.0818	0.1676	2.0551	0.8820	0.0021	0.0820	0.0754	0.1518	1.8029	0.8403	0.0021	0.0725	0.0667
ConstMin - Excavators	158	0.0890	0.8749	1.1795	0.0019	0.0425	0.0391	0.0833	0.7814	1.1807	0.0019	0.0380	0.0350	0.0736	0.6459	1.1748	0.0019	0.0314	0.0289
ConstMin - Graders	188	0.1404	1.7558	0.5651	0.0020	0.0582	0.0536	0.1350	1.6520	0.5495	0.0020	0.0545	0.0501	0.1248	1.4702	0.5320	0.0020	0.0487	0.0448
ConstMin - Off-Highway Tractors	124	0.1177	1.2557	1.3968	0.0021	0.0609	0.0560	0.1138	1.1662	1.4018	0.0021	0.0567	0.0522	0.1019	0.9840	1.3876	0.0021	0.0475	0.0437
ConstMin - Off-Highway Trucks	403	0.0941	0.9032	0.5454	0.0019	0.0330	0.0303	0.0861	0.7535	0.5150	0.0019	0.0277	0.0255	0.0744	0.5687	0.4711	0.0019	0.0206	0.0189
ConstMin - Other Construction Equipment	172	0.1618	1.7137	1.3459	0.0020	0.0906	0.0833	0.1377	1.4348	1.3247	0.0020	0.0752	0.0692	0.1234	1.2503	1.3134	0.0020	0.0654	0.0601
ConstMin - Pavers	129	0.1160	1.2319	1.2545	0.0020	0.0608	0.0559	0.1084	1.1356	1.2564	0.0020	0.0556	0.0511	0.0909	0.9181	1.2469	0.0020	0.0441	0.0406
ConstMin - Paving Equipment	131	0.0980	0.9774	1.0956	0.0017	0.0527	0.0485	0.0857	0.8624	1.0908	0.0017	0.0431	0.0397	0.0857	0.8125	1.0998	0.0017	0.0430	0.0396
ConstMin - Rollers	80	0.1420	1.4269	1.3144	0.0018	0.0908	0.0835	0.1291	1.3187	1.3059	0.0018	0.0803	0.0739	0.1120	1.1729	1.2896	0.0018	0.0671	0.0617
ConstMin - Rough Terrain Forklifts	100	0.0605	0.8975	1.2949	0.0020	0.0298	0.0274	0.0565	0.8394	1.2940	0.0020	0.0255	0.0235	0.0522	0.7751	1.2921	0.0020	0.0208	0.0192
ConstMin - Rubber Tired Dozers	249	0.2663	2.8364	1.3995	0.0019	0.1381	0.1271	0.2601	2.7691	1.3859	0.0019	0.1338	0.1231	0.2111	2.3322	1.1964	0.0019	0.1067	0.0982
ConstMin - Rubber Tired Loaders	202	0.1001	1.1642	0.4594	0.0018	0.0387	0.0356	0.0979	1.0975	0.4698	0.0018	0.0368	0.0338	0.0814	0.8385	0.4466	0.0018	0.0283	0.0260
ConstMin - Scrapers	367	0.1426	1.6817	1.0236	0.0024	0.0641	0.0590	0.1339	1.5308	0.9638	0.0024	0.0583	0.0537	0.1180	1.2781	0.8743	0.0024	0.0488	0.0449
ConstMin - Skid Steer Loaders	65	0.0693	0.9185	1.2065	0.0018	0.0392	0.0361	0.0654	0.8670	1.2065	0.0018	0.0348	0.0320	0.0601	0.8006	1.2030	0.0018	0.0293	0.0269
ConstMin - Surfacing Equipment	263	0.0684	1.0334	0.4306	0.0015	0.0334	0.0307	0.0673	0.9777	0.4316	0.0015	0.0322	0.0296	0.0628	0.8783	0.4031	0.0015	0.0290	0.0267
ConstMin - Sweepers/Scrubbers	64	0.3153	2.5963	1.8350	0.0022	0.2092	0.1924	0.2431	2.1422	1.7523	0.0022	0.1519	0.1398	0.2314	1.9740	1.7375	0.0022	0.1449	0.1333
ConstMin - Tractors/Loaders/Backhoes	98	0.1167	1.1857	1.3147	0.0018	0.0742	0.0683	0.1042	1.0668	1.3039	0.0018	0.0620	0.0571	0.0909	0.9372	1.2904	0.0018	0.0492	0.0453
ConstMin - Trenchers	79	0.2876	2.6346	1.8809	0.0024	0.1998	0.1838	0.2652	2.4637	1.8683	0.0025	0.1805	0.1660	0.2505	2.3614	1.8617	0.0024	0.1685	0.1550
Industrial - Aerial Lifts	63	0.0360	0.5560	0.9793	0.0015	0.0153	0.0140	0.0328	0.5032	0.9761	0.0015	0.0115	0.0105	0.0329	0.5102	0.9811	0.0015	0.0093	0.0085
Industrial - Forklifts	89	0.0904	0.8175	0.7529	0.0010	0.0607	0.0559	0.0808	0.7403	0.7445	0.0010	0.0524	0.0482	0.0707	0.6603	0.7356	0.0010	0.0435	0.0400
Industrial - Other General Industrial Equipment	88	0.2996	2.2541	1.4409	0.0017	0.2078	0.1912	0.2969	2.2308	1.4498	0.0017	0.2036	0.1873	0.2628	2.0725	1.4380	0.0017	0.1788	0.1645
Industrial - Other Material Handling Equipment	167	0.1379	1.1713	1.3122	0.0019	0.0797	0.0733	0.1288	1.0935	1.3213	0.0019	0.0712	0.0655	0.1108	0.9004	1.2990	0.0019	0.0583	0.0536
OFF - ConstMin - Bore/Drill Rigs	16	0.4222	3.2236	1.9051	0.0056	0.1213	0.1116	0.4222	3.2233	1.9049	0.0056	0.1214	0.1117	0.4230	3.2296	1.9087	0.0056	0.1216	0.1119
OFF - ConstMin - Cement and Mortar Mixers	10	0.3120	2.3544	1.8238	0.0048	0.0936	0.0861	0.3113	2.3536	1.8233	0.0048	0.0927	0.0853	0.3108	2.3532	1.8232	0.0048	0.0924	0.0850
OFF - ConstMin - Concrete/Industrial Saws	31	0.4828	3.0734	3.3337	0.0054	0.1553	0.1428	0.4370	2.9780	3.2835	0.0054	0.1350	0.1242	0.3991	2.8818	3.2370	0.0054	0.1161	0.1068
OFF - ConstMin - Dumpers/Tenders	16	0.2151	1.6459	0.8881	0.0027	0.0627	0.0577	0.2157	1.6495	0.8907	0.0027	0.0624	0.0574	0.2164	1.6549	0.8939	0.0028	0.0622	0.0572
OFF - ConstMin - Excavators	23	0.3230	2.4696	1.3339	0.0041	0.0923	0.0849	0.3228	2.4682	1.3332	0.0041	0.0922	0.0848	0.3230	2.4696	1.3339	0.0041	0.0923	0.0849
OFF - ConstMin - Other Construction Equipment	14	0.3412	2.5898	2.0245	0.0053	0.1004	0.0923	0.3413	2.5904	2.0250	0.0053	0.1004	0.0924	0.3412	2.5898	2.0245	0.0053	0.1004	0.0923
OFF - ConstMin - Pavers	24	0.3522	2.6976	1.4526	0.0045	0.1041	0.0958	0.3522	2.6953	1.4535	0.0045	0.1031	0.0949	0.3529	2.6996	1.4571	0.0045	0.1025	0.0943
OFF - ConstMin - Paving Equipment	19	0.3005	2.2980	1.2412	0.0038	0.0858	0.0790	0.3011	2.3025	1.2437	0.0038	0.0860	0.0791	0.3009	2.3008	1.2427	0.0038	0.0860	0.0791
OFF - ConstMin - Plate Compactors	8	0.2351	1.7816	1.4922	0.0038	0.0696	0.0640	0.2351	1.7817	1.4923	0.0038	0.0696	0.0641	0.2351	1.7817	1.4923	0.0038	0.0696	0.0641
OFF - ConstMin - Rollers	12	0.3114	2.3695	1.6463	0.0045	0.0906	0.0834	0.3114	2.3696	1.6464	0.0045	0.0906	0.0834	0.3114	2.3698	1.6465	0.0045	0.0907	0.0834
OFF - ConstMin - Rubber Tired Loaders	25	0.3059	2.3391	1.2634	0.0039	0.0874	0.0804	0.3067	2.3452	1.2667	0.0039	0.0876	0.0806	0.3064	2.3430	1.2655	0.0039	0.0875	0.0805
OFF - ConstMin - Signal Boards	6	0.4483	3.3971	2.8454	0.0073	0.1327	0.1221	0.4483	3.3971	2.8454	0.0073	0.1327	0.1221	0.4483	3.3971	2.8454	0.0073	0.1327	0.1221
OFF - ConstMin - Skid Steer Loaders	20	0.3206	2.4241	1.3023	0.0040	0.0986	0.0907	0.3174	2.4136	1.2961	0.0040	0.0962	0.0885	0.3152	2.4058	1.2921	0.0040	0.0946	0.0870
OFF - ConstMin - Tractors/Loaders/Backhoes	23	0.3116	2.3823	1.2867	0.0040	0.0897	0.0825	0.3117	2.3833	1.2872	0.0040	0.0892	0.0821	0.3117	2.3830	1.2871	0.0040	0.0890	0.0819
OFF - ConstMin - Trenchers	22	0.4220	3.2216	1.9214	0.0056	0.1214	0.1117	0.4222	3.2228	1.9221	0.0057	0.1215	0.1117	0.4217	3.2192	1.9200	0.0056	0.1213	0.1116
OFF - Industrial - Aerial Lifts	17	0.2638	1.9897	1.2567	0.0036	0.0799	0.0735	0.2615	1.9832	1.2524	0.0036	0.0784	0.0722	0.2600	1.9782	1.2496	0.0036	0.0775	0.0713
OFF - Industrial - Other General Industrial Equipment	18	0.2794	2.1867	1.3302	0.0039	0.0826	0.0760	0.2793	2.1864	1.3300	0.0039	0.0826	0.0759	0.2794	2.1867	1.3302	0.0039	0.0826	0.0760
OFF - Industrial - Sweepers/Scrubbers	18	0.3646	2.8955	1.8809	0.0053	0.1100	0.1012	0.3648	2.8970	1.8818	0.0053	0.1101	0.1013	0.3647	2.8960	1.8811	0.0053	0.1100	0.1012
OFF - Light Commercial - Air Compressors	35	0.3682	2.0698	2.4193	0.0035	0.1111	0.1022	0.3329	2.0034	2.3790	0.0035	0.0959	0.0882	0.3056	1.9427	2.3507	0.0035	0.0824	0.0758
OFF - Light Commercial - Generator Sets	21	0.4175	3.3275	2.1715	0.0059	0.1509	0.1389	0.4123	3.2924	2.1583	0.0059	0.1446	0.1331	0.4085	3.2665	2.1467	0.0059	0.1392	0.1281
OFF - Light Commercial - Pressure Washers	21	0.1644	1.3529	0.9845	0.0025	0.0621	0.0572	0.1624	1.3388	0.9821	0.0025	0.0596	0.0548	0.1604	1.3245	0.9769	0.0025	0.0572	0.0526
OFF - Light Commercial - Pumps	18	0.4520	3.3331	2.2663	0.0060	0.1587	0.1460	0.4442	3.2940	2.2539	0.0060	0.1511	0.1390	0.4379	3.2650	2.2432	0.0060	0.1445	0.1330
OFF - Light Commercial - Welders	33	0.3218	1.8990	2.1241	0.0033	0.0991	0.0911	0.2903	1.8382	2.0880	0.0033	0.0858	0.0790	0.2654	1.7824	2.0610	0.0033	0.0740	0.0680
Portable Equipment - Non-Rental Compressor	167	0.0411	0.5402	0.8851	0.0014	0.0213	0.0196	0.0410	0.5264	0.8948	0.0014	0.0210	0.0193	0.0371	0.4165	0.9045	0.0015	0.0159	0.0146
Portable Equipment - Non-Rental Generator	369	0.0755	0.6484	0.3566	0.0014	0.0265	0.0243	0.0745	0.6317	0.3539	0.0014	0.0257	0.0236	0.0626	0.3928	0.3578	0.0015	0.0173	0.0159
Portable Equipment - Non-Rental Other Portable Equipment	407	0.0427	0.4955	0.3361	0.0014	0.0189	0.0174	0.0413	0.5146	0.3018	0.0014	0.0188	0.0173	0.0379	0.4260	0.3051	0.0015	0.0161	0.0148
Portable Equipment - Non-Rental Pump	197	0.0344	0.4188	0.2944	0.0014	0.0147	0.0135	0.0340	0.4005	0.2977	0.0014	0.0139	0.0128	0.0309	0.2942	0.3009	0.0015	0.0105	0.0096
Portable Equipment - Rental Compressor	361	0.0261	0.1638	0.2881	0.0014	0.0077	0.0071	0.0257	0.1477	0.2913	0.0014	0.0070	0.0065	0.0255	0.1325	0.2944	0.0015	0.0064	0.0059
Portable Equipment - Rental Generator	406	0.0593	0.4314	0.3174	0.0014	0.0186	0.0171	0.0547	0.3480	0.3208	0.0014	0.0150	0.0138	0.0501	0.2471	0.3243	0.0015	0.0110	0.0101
Portable Equipment - Rental Other Portable Equipment	657	0.0700	0.4722	0.3328	0.0014	0.0201	0.0185	0.0599	0.2194	0.3365	0.0014	0.0139	0.0127	0.0494	0.0508	0.3401	0.0015	0.0051	0.0047
Portable Equipment - Rental Pump	165	0.0451	0.4339	0.9448	0.0014	0.0156	0.0144	0.0447	0.4161	0.9551	0.0014	0.0148	0.0136	0.0426	0.3373	0.9655	0.0015	0.0119	0.0109

Source:
California Air Resources Board (CARB). 2017. OFFROAD2017 - ORION Web Database. Available online at https://www.arb.ca.gov/orion/ [Accessesd October 17, 2018].
Notes:
1. Horsepower used in modeling is average calculated from OFFROAD2017 (e.g., "Horsepower_Hours_hhpy" divided by "Total_Activity_hpy.")

Table A-39. In-Use Off-Road Construction Equipment Emission Factors

Equipment Type	Average HP	Emission Factors - 2023 (g/bhp-hr)						Emission Factors - 2024 (g/bhp-hr)					
		VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5
ConstMin - Bore/Drill Rigs	221	0.0592	0.5975	0.5298	0.0024	0.0191	0.0176	0.0582	0.5618	0.5316	0.0024	0.0182	0.0168
ConstMin - Cranes	231	0.0906	0.9974	0.5197	0.0014	0.0418	0.0385	0.0847	0.9076	0.4853	0.0014	0.0379	0.0348
ConstMin - Crawler Tractors	212	0.1394	1.5759	0.8203	0.0021	0.0653	0.0601	0.1319	1.4539	0.7805	0.0021	0.0602	0.0554
ConstMin - Excavators	158	0.0687	0.5637	1.1758	0.0019	0.0277	0.0255	0.0656	0.5109	1.1778	0.0019	0.0253	0.0233
ConstMin - Graders	188	0.1166	1.3229	0.5265	0.0020	0.0442	0.0407	0.1089	1.1890	0.5160	0.0020	0.0397	0.0365
ConstMin - Off-Highway Tractors	124	0.0873	0.7750	1.3650	0.0021	0.0371	0.0341	0.0779	0.6344	1.3567	0.0021	0.0302	0.0278
ConstMin - Off-Highway Trucks	403	0.0711	0.5061	0.4624	0.0019	0.0182	0.0168	0.0701	0.4719	0.4563	0.0019	0.0169	0.0156
ConstMin - Other Construction Equipment	172	0.1144	1.1275	1.3078	0.0020	0.0588	0.0541	0.1095	1.0570	1.3119	0.0020	0.0548	0.0505
ConstMin - Pavers	129	0.0845	0.8254	1.2468	0.0020	0.0393	0.0362	0.0816	0.7701	1.2523	0.0020	0.0366	0.0337
ConstMin - Paving Equipment	131	0.0812	0.7491	1.1022	0.0017	0.0391	0.0359	0.0798	0.7121	1.1092	0.0017	0.0374	0.0345
ConstMin - Rollers	80	0.1032	1.0919	1.2843	0.0018	0.0595	0.0547	0.0975	1.0316	1.2827	0.0018	0.0539	0.0496
ConstMin - Rough Terrain Forklifts	100	0.0502	0.7380	1.2932	0.0020	0.0181	0.0166	0.0503	0.7212	1.2962	0.0020	0.0173	0.0160
ConstMin - Rubber Tired Dozers	249	0.1789	1.9495	1.0377	0.0019	0.0871	0.0802	0.2077	2.2834	1.4959	0.0019	0.1017	0.0936
ConstMin - Rubber Tired Loaders	202	0.0753	0.7330	0.4335	0.0018	0.0246	0.0226	0.0698	0.6454	0.4227	0.0018	0.0214	0.0197
ConstMin - Scrapers	367	0.1141	1.1936	0.8495	0.0024	0.0457	0.0421	0.1103	1.1055	0.8253	0.0024	0.0427	0.0393
ConstMin - Skid Steer Loaders	65	0.0562	0.7484	1.2013	0.0018	0.0253	0.0232	0.0524	0.7069	1.1996	0.0018	0.0218	0.0201
ConstMin - Surfacing Equipment	263	0.0619	0.8295	0.4064	0.0015	0.0281	0.0258	0.0581	0.7636	0.3980	0.0015	0.0254	0.0234
ConstMin - Sweepers/Scrubbers	64	0.3579	2.7606	1.9205	0.0022	0.2396	0.2204	0.4344	3.1850	1.9920	0.0022	0.2867	0.2638
ConstMin - Tractors/Loaders/Backhoes	98	0.0829	0.8540	1.2851	0.0018	0.0408	0.0375	0.0792	0.8076	1.2879	0.0018	0.0358	0.0329
ConstMin - Trenchers	79	0.2381	2.2557	1.8580	0.0025	0.1574	0.1448	0.2187	2.0737	1.8404	0.0025	0.1399	0.1287
Industrial - Aerial Lifts	63	0.0335	0.5217	0.9713	0.0015	0.0116	0.0107	0.0339	0.5060	0.9759	0.0015	0.0113	0.0104
Industrial - Forklifts	89	0.0636	0.5991	0.7297	0.0010	0.0367	0.0337	0.0586	0.5529	0.7265	0.0010	0.0316	0.0291
Industrial - Other General Industrial Equipment	88	0.1873	1.5512	1.3363	0.0017	0.1152	0.1060	0.1485	1.2511	1.2787	0.0017	0.0873	0.0803
Industrial - Other Material Handling Equipment	167	0.1017	0.8359	1.2986	0.0019	0.0476	0.0438	0.0969	0.7765	1.3122	0.0019	0.0423	0.0389
OFF - ConstMin - Bore/Drill Rigs	16	0.4234	3.2325	1.9103	0.0056	0.1217	0.1120	0.4227	3.2272	1.9072	0.0056	0.1215	0.1118
OFF - ConstMin - Cement and Mortar Mixers	10	0.3100	2.3502	1.8212	0.0048	0.0920	0.0846	0.3093	2.3471	1.8191	0.0048	0.0917	0.0843
OFF - ConstMin - Concrete/Industrial Saws	31	0.3668	2.7946	3.2020	0.0054	0.0987	0.0908	0.3398	2.7095	3.1703	0.0054	0.0848	0.0780
OFF - ConstMin - Dumpers/Tenders	16	0.2163	1.6536	0.8931	0.0028	0.0619	0.0570	0.2168	1.6581	0.8956	0.0028	0.0619	0.0570
OFF - ConstMin - Excavators	23	0.3228	2.4683	1.3332	0.0041	0.0922	0.0849	0.3231	2.4707	1.3345	0.0041	0.0923	0.0849
OFF - ConstMin - Other Construction Equipment	14	0.3412	2.5898	2.0245	0.0053	0.1004	0.0923	0.3411	2.5893	2.0241	0.0053	0.1003	0.0923
OFF - ConstMin - Pavers	24	0.3540	2.7072	1.4619	0.0045	0.1021	0.0939	0.3516	2.6884	1.4520	0.0045	0.1009	0.0928
OFF - ConstMin - Paving Equipment	19	0.2999	2.2931	1.2385	0.0038	0.0857	0.0788	0.3005	2.2975	1.2409	0.0038	0.0858	0.0790
OFF - ConstMin - Plate Compactors	8	0.2351	1.7814	1.4921	0.0038	0.0696	0.0640	0.2351	1.7814	1.4921	0.0038	0.0696	0.0640
OFF - ConstMin - Rollers	12	0.3114	2.3696	1.6464	0.0045	0.0906	0.0834	0.3113	2.3694	1.6462	0.0045	0.0906	0.0834
OFF - ConstMin - Rubber Tired Loaders	25	0.3054	2.3349	1.2612	0.0039	0.0872	0.0803	0.3061	2.3408	1.2643	0.0039	0.0875	0.0805
OFF - ConstMin - Signal Boards	6	0.4483	3.3972	2.8455	0.0073	0.1327	0.1221	0.4483	3.3971	2.8454	0.0073	0.1327	0.1221
OFF - ConstMin - Skid Steer Loaders	20	0.3135	2.3990	1.2892	0.0040	0.0933	0.0859	0.3125	2.3938	1.2875	0.0040	0.0922	0.0848
OFF - ConstMin - Tractors/Loaders/Backhoes	23	0.3116	2.3823	1.2867	0.0040	0.0890	0.0818	0.3117	2.3832	1.2872	0.0040	0.0890	0.0819
OFF - ConstMin - Trenchers	22	0.4219	3.2202	1.9206	0.0056	0.1214	0.1117	0.4215	3.2174	1.9189	0.0056	0.1213	0.1116
OFF - Industrial - Aerial Lifts	17	0.2589	1.9742	1.2476	0.0036	0.0768	0.0706	0.2582	1.9709	1.2464	0.0036	0.0761	0.0700
OFF - Industrial - Other General Industrial Equipment	18	0.2794	2.1869	1.3303	0.0039	0.0826	0.0760	0.2794	2.1866	1.3301	0.0039	0.0826	0.0760
OFF - Industrial - Sweepers/Scrubbers	18	0.3652	2.9004	1.8840	0.0053	0.1102	0.1014	0.3647	2.8959	1.8811	0.0053	0.1100	0.1012
OFF - Light Commercial - Air Compressors	35	0.2830	1.8870	2.3303	0.0035	0.0703	0.0647	0.2645	1.8352	2.3156	0.0035	0.0606	0.0558
OFF - Light Commercial - Generator Sets	21	0.4052	3.2439	2.1364	0.0059	0.1345	0.1238	0.4024	3.2241	2.1276	0.0059	0.1316	0.1210
OFF - Light Commercial - Pressure Washers	21	0.1583	1.3083	0.9695	0.0025	0.0550	0.0506	0.1573	1.3007	0.9680	0.0025	0.0538	0.0495
OFF - Light Commercial - Pumps	18	0.4322	3.2393	2.2335	0.0060	0.1388	0.1277	0.4273	3.2169	2.2253	0.0060	0.1349	0.1241
OFF - Light Commercial - Welders	33	0.2443	1.7310	2.0401	0.0033	0.0633	0.0582	0.2268	1.6832	2.0240	0.0033	0.0546	0.0502
Portable Equipment - Non-Rental Compressor	167	0.0331	0.3063	0.9144	0.0015	0.0116	0.0107	0.0340	0.3201	0.9244	0.0015	0.0119	0.0110
Portable Equipment - Non-Rental Generator	369	0.0613	0.3663	0.3617	0.0015	0.0159	0.0147	0.0613	0.3609	0.3656	0.0015	0.0159	0.0146
Portable Equipment - Non-Rental Other Portable Equipment	407	0.0362	0.3630	0.3084	0.0015	0.0143	0.0131	0.0362	0.3487	0.3118	0.0015	0.0139	0.0127
Portable Equipment - Non-Rental Pump	197	0.0299	0.2591	0.3042	0.0015	0.0096	0.0088	0.0289	0.2191	0.3075	0.0015	0.0083	0.0076
Portable Equipment - Rental Compressor	361	0.0252	0.1081	0.2976	0.0015	0.0058	0.0053	0.0252	0.0957	0.3009	0.0015	0.0053	0.0049
Portable Equipment - Rental Generator	406	0.0499	0.2370	0.3278	0.0015	0.0106	0.0098	0.0479	0.2008	0.3314	0.0015	0.0092	0.0085
Portable Equipment - Rental Other Portable Equipment	657	0.0499	0.0513	0.3439	0.0015	0.0051	0.0047	0.0505	0.0519	0.3476	0.0015	0.0052	0.0048
Portable Equipment - Rental Pump	165	0.0424	0.3251	0.9761	0.0015	0.0114	0.0105	0.0414	0.2810	0.9867	0.0015	0.0094	0.0086

Source:
California Air Resources Board (CARB). 2017. OFFROAD2017 - ORION Web Database. Availab
Notes:
1. Horsepower used in modeling is average calculated from OFFROAD2017 (e.g., "Horsepower_

EMFAC2014 Emission Factor Summary

Table A-40. On-Road Medium-Duty Vehicle Diesel Emission Factors (San Joaquin Valley Air Basin), grams per hour

Calendar Year	Speed	VOC	NOx	CO	SO2	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
2020	5	1.1152	0.8467	18.5053	0.0219	0.1445	0.0400	0.1838	0.3682	0.1382	0.0100	0.0788	0.2270
2020	10	1.6599	1.4585	27.6260	0.0439	0.2221	0.0800	0.3675	0.6696	0.2125	0.0200	0.1575	0.3900
2020	15	1.2707	1.5896	20.5190	0.0658	0.2490	0.1200	0.5513	0.9203	0.2383	0.0300	0.2363	0.5045
2020	20	0.7813	1.6713	11.1247	0.0878	0.2936	0.1600	0.7350	1.1886	0.2809	0.0400	0.3150	0.6359
2020	25	0.6285	1.8019	8.5668	0.1097	0.2878	0.2000	0.9188	1.4066	0.2754	0.0500	0.3938	0.7191
2020	30	0.5648	1.8868	7.8038	0.1317	0.2763	0.2400	1.1025	1.6188	0.2643	0.0600	0.4725	0.7968
2020	35	0.5653	2.2084	7.4534	0.1536	0.3084	0.2800	1.2863	1.8746	0.2950	0.0700	0.5513	0.9163
2020	40	0.5754	2.6071	7.2952	0.1756	0.3420	0.3200	1.4700	2.1320	0.3272	0.0800	0.6300	1.0372
2020	45	0.5722	2.8126	7.1359	0.1975	0.3578	0.3600	1.6538	2.3716	0.3423	0.0900	0.7088	1.1411
2020	50	0.5896	3.1055	7.1638	0.2195	0.3880	0.4000	1.8375	2.6255	0.3712	0.1000	0.7875	1.2587
2020	55	0.6607	3.6487	7.5607	0.2414	0.4590	0.4400	2.0213	2.9203	0.4392	0.1100	0.8663	1.4154
2020	60	0.7080	3.9272	8.2243	0.2634	0.5009	0.4800	2.2050	3.1859	0.4793	0.1200	0.9450	1.5443
2020	65	0.7520	3.9095	9.1127	0.2853	0.5256	0.5200	2.3888	3.4344	0.5029	0.1300	1.0238	1.6566
2020	70	0.8227	4.1168	10.1156	0.3073	0.5774	0.5600	2.5725	3.7099	0.5524	0.1400	1.1025	1.7949
2021	5	1.0532	0.7766	18.2780	0.0214	0.1319	0.0400	0.1838	0.3556	0.1262	0.0100	0.0788	0.2149
2021	10	1.5726	1.3462	27.2845	0.0427	0.2102	0.0800	0.3675	0.6577	0.2011	0.0200	0.1575	0.3786
2021	15	1.1913	1.4416	20.2208	0.0641	0.2244	0.1200	0.5513	0.8957	0.2147	0.0300	0.2363	0.4810
2021	20	0.7242	1.5030	10.9108	0.0855	0.2641	0.1600	0.7350	1.1591	0.2526	0.0400	0.3150	0.6076
2021	25	0.5821	1.6158	8.3752	0.1068	0.2620	0.2000	0.9188	1.3808	0.2507	0.0500	0.3938	0.6945
2021	30	0.5231	1.6871	7.6247	0.1282	0.2521	0.2400	1.1025	1.5946	0.2411	0.0600	0.4725	0.7736
2021	35	0.5208	1.9659	7.2615	0.1496	0.2801	0.2800	1.2863	1.8463	0.2680	0.0700	0.5513	0.8892
2021	40	0.5304	2.3216	7.0863	0.1710	0.3119	0.3200	1.4700	2.1019	0.2984	0.0800	0.6300	1.0084
2021	45	0.5240	2.4905	6.9059	0.1923	0.3241	0.3600	1.6538	2.3379	0.3101	0.0900	0.7088	1.1089
2021	50	0.5374	2.7382	6.8949	0.2137	0.3506	0.4000	1.8375	2.5881	0.3355	0.1000	0.7875	1.2230
2021	55	0.5839	3.1346	7.1481	0.2351	0.4010	0.4400	2.0213	2.8622	0.3836	0.1100	0.8663	1.3599
2021	60	0.6479	3.5006	7.8562	0.2564	0.4557	0.4800	2.2050	3.1407	0.4360	0.1200	0.9450	1.5010
2021	65	0.6777	3.4062	8.5922	0.2778	0.4712	0.5200	2.3888	3.3799	0.4508	0.1300	1.0238	1.6046
2021	70	0.7465	3.6261	9.5601	0.2992	0.5211	0.5600	2.5725	3.6536	0.4986	0.1400	1.1025	1.7411
2022	5	0.9930	0.7120	18.0415	0.0208	0.1186	0.0400	0.1838	0.3423	0.1134	0.0100	0.0788	0.2022
2022	10	1.4815	1.2302	26.9245	0.0416	0.1892	0.0800	0.3675	0.6367	0.1810	0.0200	0.1575	0.3585
2022	15	1.1193	1.3124	19.9210	0.0624	0.2033	0.1200	0.5513	0.8745	0.1945	0.0300	0.2363	0.4607
2022	20	0.6735	1.3581	10.7075	0.0832	0.2385	0.1600	0.7350	1.1335	0.2282	0.0400	0.3150	0.5832
2022	25	0.5392	1.4508	8.1933	0.1040	0.2376	0.2000	0.9188	1.3563	0.2273	0.0500	0.3938	0.6710
2022	30	0.4848	1.5125	7.4568	0.1248	0.2294	0.2400	1.1025	1.5719	0.2194	0.0600	0.4725	0.7519
2022	35	0.4810	1.7557	7.0844	0.1456	0.2544	0.2800	1.2863	1.8207	0.2434	0.0700	0.5513	0.8647
2022	40	0.4879	2.0650	6.8894	0.1663	0.2828	0.3200	1.4700	2.0728	0.2706	0.0800	0.6300	0.9806
2022	45	0.4815	2.2142	6.7000	0.1871	0.2941	0.3600	1.6538	2.3079	0.2814	0.0900	0.7088	1.0801
2022	50	0.4914	2.4257	6.6572	0.2079	0.3170	0.4000	1.8375	2.5545	0.3033	0.1000	0.7875	1.1908
2022	55	0.5309	2.7685	6.8535	0.2287	0.3612	0.4400	2.0213	2.8225	0.3456	0.1100	0.8663	1.3218
2022	60	0.5891	3.0948	7.4987	0.2495	0.4110	0.4800	2.2050	3.0960	0.3932	0.1200	0.9450	1.4582
2022	65	0.6163	3.0133	8.1887	0.2703	0.4251	0.5200	2.3888	3.3339	0.4067	0.1300	1.0238	1.5605
2022	70	0.6768	3.2012	9.0748	0.2911	0.4687	0.5600	2.5725	3.6012	0.4484	0.1400	1.1025	1.6909
2023	5	0.9374	0.6566	17.8376	0.0202	0.1034	0.0400	0.1838	0.3272	0.0990	0.0100	0.0788	0.1877
2023	10	1.3948	1.1280	26.6129	0.0404	0.1636	0.0800	0.3675	0.6111	0.1566	0.0200	0.1575	0.3341
2023	15	1.0486	1.1960	19.6538	0.0606	0.1775	0.1200	0.5513	0.8488	0.1698	0.0300	0.2363	0.4361
2023	20	0.6201	1.2247	10.5176	0.0808	0.2087	0.1600	0.7350	1.1037	0.1997	0.0400	0.3150	0.5547
2023	25	0.4890	1.2897	8.0139	0.1010	0.2060	0.2000	0.9188	1.3248	0.1971	0.0500	0.3938	0.6409
2023	30	0.4412	1.3431	7.2926	0.1212	0.2013	0.2400	1.1025	1.5438	0.1926	0.0600	0.4725	0.7251
2023	35	0.4357	1.5512	6.9103	0.1414	0.2236	0.2800	1.2863	1.7898	0.2139	0.0700	0.5513	0.8352
2023	40	0.4408	1.8187	6.6980	0.1616	0.2492	0.3200	1.4700	2.0392	0.2384	0.0800	0.6300	0.9484
2023	45	0.4320	1.9415	6.4925	0.1818	0.2581	0.3600	1.6538	2.2718	0.2469	0.0900	0.7088	1.0457
2023	50	0.4385	2.1194	6.4188	0.2020	0.2776	0.4000	1.8375	2.5151	0.2656	0.1000	0.7875	1.1531
2023	55	0.4658	2.3958	6.5449	0.2221	0.3118	0.4400	2.0213	2.7731	0.2983	0.1100	0.8663	1.2746
2023	60	0.5175	2.6888	7.1266	0.2423	0.3563	0.4800	2.2050	3.0413	0.3409	0.1200	0.9450	1.4059
2023	65	0.5369	2.6083	7.7504	0.2625	0.3651	0.5200	2.3888	3.2739	0.3493	0.1300	1.0238	1.5031
2023	70	0.5890	2.7708	8.5576	0.2827	0.4021	0.5600	2.5725	3.5346	0.3847	0.1400	1.1025	1.6272

Table A-41. On-Road Medium-Duty Vehicle Diesel Emission Factors (San Francisco Bay Area Air Basin), grams per hour

Calendar Year	Speed	VOC	NOx	CO	SO2	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
2020	5	1.0595	0.7931	18.3365	0.0217	0.0917	0.0400	0.1838	0.3154	0.0877	0.0100	0.0788	0.1765
2020	10	1.5726	1.3347	27.4888	0.0433	0.1379	0.0800	0.3675	0.5854	0.1320	0.0200	0.1575	0.3095
2020	15	1.1863	1.4325	20.3797	0.0650	0.1712	0.1200	0.5513	0.8424	0.1638	0.0300	0.2363	0.4300
2020	20	0.6502	1.3427	10.6354	0.0867	0.1817	0.1600	0.7350	1.0767	0.1739	0.0400	0.3150	0.5289
2020	25	0.5079	1.3743	8.0922	0.1084	0.1890	0.2000	0.9188	1.3078	0.1809	0.0500	0.3938	0.6246
2020	30	0.4734	1.4988	7.4028	0.1300	0.2016	0.2400	1.1025	1.5441	0.1929	0.0600	0.4725	0.7254
2020	35	0.4544	1.6732	6.9823	0.1517	0.2161	0.2800	1.2863	1.7824	0.2068	0.0700	0.5513	0.8280
2020	40	0.4433	1.8407	6.6684	0.1734	0.2305	0.3200	1.4700	2.0205	0.2206	0.0800	0.6300	0.9306
2020	45	0.4176	1.8574	6.3670	0.1950	0.2285	0.3600	1.6538	2.2422	0.2186	0.0900	0.7088	1.0173
2020	50	0.4242	2.0731	6.2896	0.2167	0.2503	0.4000	1.8375	2.4878	0.2395	0.1000	0.7875	1.1270
2020	55	0.4292	2.2427	6.2910	0.2384	0.2678	0.4400	2.0213	2.7290	0.2562	0.1100	0.8663	1.2325
2020	60	0.4480	2.3163	6.5818	0.2600	0.2858	0.4800	2.2050	2.9708	0.2734	0.1200	0.9450	1.3384
2020	65	0.5459	2.8225	7.7265	0.2817	0.3589	0.5200	2.3888	3.2676	0.3433	0.1300	1.0238	1.4971
2021	5	0.9926	0.7206	18.0047	0.0211	0.0833	0.0400	0.1838	0.3070	0.0797	0.0100	0.0788	0.1684
2021	10	1.4737	1.2117	26.9800	0.0422	0.1265	0.0800	0.3675	0.5740	0.1210	0.0200	0.1575	0.2985
2021	15	1.1098	1.2968	19.9834	0.0632	0.1565	0.1200	0.5513	0.8277	0.1497	0.0300	0.2363	0.4160
2021	20	0.6056	1.2099	10.4072	0.0843	0.1668	0.1600	0.7350	1.0618	0.1596	0.0400	0.3150	0.5146
2021	25	0.4722	1.2353	7.9082	0.1054	0.1738	0.2000	0.9188	1.2925	0.1663	0.0500	0.3938	0.6100
2021	30	0.4394	1.3423	7.2263	0.1265	0.1852	0.2400	1.1025	1.5277	0.1772	0.0600	0.4725	0.7097
2021	35	0.4204	1.4918	6.8012	0.1475	0.1980	0.2800	1.2863	1.7642	0.1894	0.0700	0.5513	0.8106
2021	40	0.4096	1.6377	6.4855	0.1686	0.2112	0.3200	1.4700	2.0012	0.2021	0.0800	0.6300	0.9121
2021	45	0.3872	1.6570	6.1987	0.1897	0.2105	0.3600	1.6538	2.2242	0.2014	0.0900	0.7088	1.0001
2021	50	0.3913	1.8414	6.0982	0.2108	0.2295	0.4000	1.8375	2.4670	0.2196	0.1000	0.7875	1.1071
2021	55	0.3957	1.9912	6.0837	0.2319	0.2457	0.4400	2.0213	2.7069	0.2351	0.1100	0.8663	1.2113
2021	60	0.4123	2.0554	6.3497	0.2529	0.2617	0.4800	2.2050	2.9467	0.2504	0.1200	0.9450	1.3154
2021	65	0.4985	2.4923	7.3894	0.2740	0.3260	0.5200	2.3888	3.2348	0.3119	0.1300	1.0238	1.4656
2022	5	0.9339	0.6587	17.7032	0.0205	0.0765	0.0400	0.1838	0.3002	0.0732	0.0100	0.0788	0.1619
2022	10	1.3863	1.1067	26.5143	0.0409	0.1166	0.0800	0.3675	0.5641	0.1116	0.0200	0.1575	0.2891
2022	15	1.0432	1.1819	19.6215	0.0614	0.1444	0.1200	0.5513	0.8157	0.1382	0.0300	0.2363	0.4044
2022	20	0.5670	1.0983	10.2049	0.0819	0.1538	0.1600	0.7350	1.0488	0.1472	0.0400	0.3150	0.5022
2022	25	0.4415	1.1190	7.7460	0.1024	0.1604	0.2000	0.9188	1.2791	0.1535	0.0500	0.3938	0.5972
2022	30	0.4103	1.2123	7.0724	0.1228	0.1709	0.2400	1.1025	1.5134	0.1635	0.0600	0.4725	0.6960
2022	35	0.3919	1.3428	6.6447	0.1433	0.1825	0.2800	1.2863	1.7487	0.1746	0.0700	0.5513	0.7958
2022	40	0.3814	1.4717	6.3290	0.1638	0.1947	0.3200	1.4700	1.9847	0.1863	0.0800	0.6300	0.8963
2022	45	0.3611	1.4910	6.0535	0.1843	0.1945	0.3600	1.6538	2.2082	0.1861	0.0900	0.7088	0.9848
2022	50	0.3637	1.6515	5.9358	0.2047	0.2114	0.4000	1.8375	2.4489	0.2023	0.1000	0.7875	1.0898
2022	55	0.3675	1.7843	5.9079	0.2252	0.2263	0.4400	2.0213	2.6876	0.2165	0.1100	0.8663	1.1928
2022	60	0.3821	1.8410	6.1545	0.2457	0.2407	0.4800	2.2050	2.9257	0.2303	0.1200	0.9450	1.2953
2022	65	0.4604	2.2263	7.1142	0.2662	0.2988	0.5200	2.3888	3.2076	0.2859	0.1300	1.0238	1.4397
2023	5	0.8821	0.6068	17.4497	0.0199	0.0687	0.0400	0.1838	0.2925	0.0658	0.0100	0.0788	0.1545
2023	10	1.3103	1.0189	26.1214	0.0397	0.1062	0.0800	0.3675	0.5537	0.1016	0.0200	0.1575	0.2791
2023	15	0.9833	1.0838	19.3096	0.0596	0.1313	0.1200	0.5513	0.8025	0.1256	0.0300	0.2363	0.3918
2023	20	0.5309	1.0019	10.0305	0.0794	0.1398	0.1600	0.7350	1.0348	0.1338	0.0400	0.3150	0.4888
2023	25	0.4123	1.0175	7.6046	0.0993	0.1462	0.2000	0.9188	1.2650	0.1399	0.0500	0.3938	0.5837
2023	30	0.3819	1.0969	6.9368	0.1191	0.1555	0.2400	1.1025	1.4980	0.1488	0.0600	0.4725	0.6813
2023	35	0.3643	1.2106	6.5063	0.1390	0.1663	0.2800	1.2863	1.7326	0.1591	0.0700	0.5513	0.7804
2023	40	0.3531	1.3213	6.1880	0.1588	0.1769	0.3200	1.4700	1.9669	0.1693	0.0800	0.6300	0.8793
2023	45	0.3342	1.3385	5.9211	0.1787	0.1770	0.3600	1.6538	2.1908	0.1694	0.0900	0.7088	0.9681
2023	50	0.3361	1.4806	5.7893	0.1985	0.1925	0.4000	1.8375	2.4300	0.1842	0.1000	0.7875	1.0717
2023	55	0.3379	1.5946	5.7446	0.2184	0.2054	0.4400	2.0213	2.6666	0.1965	0.1100	0.8663	1.1728
2023	60	0.3508	1.6455	5.9731	0.2382	0.2182	0.4800	2.2050	2.9032	0.2088	0.1200	0.9450	1.2738
2023	65	0.4205	1.9849	6.8568	0.2581	0.2698	0.5200	2.3888	3.1785	0.2581	0.1300	1.0238	1.4118

Lower San Felipe Intake Alternative - Tunnel Option
Haul Truck and Construction Worker Commuting Emissions

Construction Duration 47 months
3.9 years
Months in Final Year 11

Table A-42. Trip Rate Information

Vehicle Type	Round Trips		One-Way Trips		One-Way Distance	VMT		Annual VMT	
	Max Day Trips	Total Trips	Max Day Trips	Total Trips	(miles)	Daily	Total	2020 - 2022	2023
Dump Truck	6	100	12	200	40	480	8,000	2,043	1,872
Concrete Trucks	15	7,500	30	15,000	40	1,200	600,000	153,191	140,426
Delivery Trucks (non-soil)	5	1,300	10	2,600	40	400	104,000	26,553	24,340
Gravel/paving trucks	3	250	6	500	40	240	20,000	5,106	4,681
Haul trucks (soil)	40	19,420	80	38,840	5	400	194,200	49,583	45,451
Total Truck Trips	69	28,570	138	57,140	165	2,720	926,200	236,476	216,770
Workers	100	43,800	200	87,600	40	8,000	3,504,000	894,638	820,085
Grand Total	**169**	**72,370**	**338**	**144,740**	**205**	**10,720**	**4,430,200**	**1,131,114**	**1,036,855**

Source: EngineeringDataNeeds_July30_2012.xlsx

Table A-43. Maximum Daily Emissions

Truck Emission Factors (g/mi)		0.104	4.124	0.430	0.016	0.209	0.077
Worker Emission Factors (g/mi)		0.015	0.078	0.753	0.003	0.139	0.042
	Maximum Daily VMT	Peak Daily Emissions (lbs/day)					
Truck Type	(miles/day)	ROG	NOx	CO	SOx	PM10	PM2.5
Dump Truck	480	0.11	4.36	0.46	0.02	0.22	0.08
Concrete Trucks	1,200	0.27	10.91	1.14	0.04	0.55	0.20
Delivery Trucks (non-soil)	400	0.09	3.64	0.38	0.01	0.18	0.07
Gravel/paving trucks	240	0.05	2.18	0.23	0.01	0.11	0.04
Haul trucks (soil)	400	0.09	3.64	0.38	0.01	0.18	0.07
Truck Subtotal	2,720	0.62	24.73	2.58	0.09	1.25	0.46
Workers	8,000	0.27	1.37	13.29	0.05	2.44	0.75
Grand Total	**10,720**	**0.89**	**26.10**	**15.87**	**0.15**	**3.69**	**1.21**

Note:
PM_{10} and $PM_{2.5}$ emission factors include exhaust, tire wear, brake wear, and resuspension of loose material on the road surface (paved road dust).

Lower San Felipe Intake Alternative - Tunnel Option
Haul Truck and Construction Worker Commuting Emissions

Table A-44. Annual Emissions

	Truck Emission Factors (g/mi)		0.104	4.124	0.430	0.016	0.206	0.076	0.100	3.639	0.427	0.015	0.204	0.074
	Worker Emission Factors (g/mi)		0.015	0.078	0.753	0.003	0.136	0.042	0.014	0.069	0.692	0.003	0.136	0.042
	Annual VMT (miles/year)		**Annual Emissions - 2020 (tons/year)**						**Annual Emissions - 2021 (tons/year)**					
Truck Type	**2020 - 2022**	**2023**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**
Dump Truck	2,043	1,872	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Concrete Trucks	153,191	140,426	0.02	0.70	0.07	0.00	0.03	0.01	0.02	0.61	0.07	0.00	0.03	0.01
Delivery Trucks (non-soil)	26,553	24,340	0.00	0.12	0.01	0.00	0.01	0.00	0.00	0.11	0.01	0.00	0.01	0.00
Gravel/paving trucks	5,106	4,681	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
Haul trucks (soil)	49,583	45,451	0.01	0.23	0.02	0.00	0.01	0.00	0.01	0.20	0.02	0.00	0.01	0.00
Truck Subtotal	236,476	216,770	0.03	1.08	0.11	0.00	0.05	0.02	0.03	0.95	0.11	0.00	0.05	0.02
Workers	894,638	820,085	0.02	0.08	0.74	0.00	0.13	0.04	0.01	0.07	0.68	0.00	0.13	0.04
Grand Total	**1,131,114**	**1,036,855**	**0.04**	**1.15**	**0.86**	**0.01**	**0.19**	**0.06**	**0.04**	**1.02**	**0.79**	**0.01**	**0.19**	**0.06**

Note:
PM_{10} and $PM_{2.5}$ emission factors include exhaust, tire wear, brake wear, and resuspension of loose material on the road surface (paved road dust). Annual emissions include natural control efficiency from precipitation.

Start Year: 2020
Air Basin: San Joaquin Valley

Conversions

1 pound = 453.6 grams
1 ton = 2000 pounds

Lower San Felipe Intake Alternative - Tunnel Option
Haul Truck and Construction Worker Commuting Em

Table A-44. Annual Emissions

	Truck Emission Factors (g/mi)		0.096	3.225	0.423	0.015	0.201	0.072	0.063	1.295	0.367	0.015	0.192	0.062
	Worker Emission Factors (g/mi)		0.012	0.062	0.640	0.003	0.136	0.042	0.011	0.056	0.594	0.003	0.136	0.042
	Annual VMT (miles/year)		**Annual Emissions - 2022 (tons/year)**						**Annual Emissions - 2023 (tons/year)**					
Truck Type	**2020 - 2022**	**2023**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**
Dump Truck	2,043	1,872	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Concrete Trucks	153,191	140,426	0.02	0.54	0.07	0.00	0.03	0.01	0.01	0.20	0.06	0.00	0.03	0.01
Delivery Trucks (non-soil)	26,553	24,340	0.00	0.09	0.01	0.00	0.01	0.00	0.00	0.03	0.01	0.00	0.01	0.00
Gravel/paving trucks	5,106	4,681	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Haul trucks (soil)	49,583	45,451	0.01	0.18	0.02	0.00	0.01	0.00	0.00	0.06	0.02	0.00	0.01	0.00
Truck Subtotal	236,476	216,770	0.03	0.84	0.11	0.00	0.05	0.02	0.01	0.31	0.09	0.00	0.05	0.01
Workers	894,638	820,085	0.01	0.06	0.63	0.00	0.13	0.04	0.01	0.06	0.59	0.00	0.13	0.04
Grand Total	**1,131,114**	**1,036,855**	**0.04**	**0.90**	**0.74**	**0.01**	**0.19**	**0.06**	**0.03**	**0.36**	**0.67**	**0.01**	**0.18**	**0.06**

Note:
PM_{10} and $PM_{2.5}$ emission factors include exhaust, tire wear, brake wear, and r

Start Year: 2020
Air Basin: San Joaquin Valley

Conversions

1 pound = 453.6 grams
1 ton = 2000 pounds

Lower San Felipe Intake Alternative - Pipeline Option
Haul Truck and Construction Worker Commuting Emissions

Construction Duration	33	months
	2.8	years
Months in Final Year	9	

Table A-45. Trip Rate Information

	Round Trips		One-Way Trips		One-Way Distance	VMT		Annual VMT	
Vehicle Type	**Max Day Trips**	**Total Trips**	**Max Day Trips**	**Total Trips**	**(miles)**	**Daily**	**Total**	**2020 - 2021**	**2022**
Dump Truck	6	100	12	200	40	480	8,000	2,909	2,182
Concrete Trucks	2	5	4	10	40	160	400	145	109
Delivery Trucks (non-soil)	5	1,950	10	3,900	40	400	156,000	56,727	42,545
Gravel/paving trucks	3	250	6	500	40	240	20,000	7,273	5,455
Haul trucks (soil)	2	4,100	4	8,200	5	20	41,000	14,909	11,182
Total Truck Trips	18	6,405	36	12,810	165	1,300	225,400	81,963	61,473
Workers	30	15,000	60	30,000	40	2,400	1,200,000	436,364	327,273
Grand Total	**48**	**21,405**	**96**	**42,810**	**205**	**3,700**	**1,425,400**	**518,327**	**388,746**

Source: EngineeringDataNeeds_July30_2012.xlsx

Table A-46. Maximum Daily Emissions

Truck Emission Factors (g/mi)		0.104	4.124	0.430	0.016	0.209	0.077
Worker Emission Factors (g/mi)		0.015	0.078	0.753	0.003	0.139	0.042
	Maximum Daily VMT	**Peak Daily Emissions (lbs/day)**					
Truck Type	**(miles/day)**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**
Dump Truck	480	0.11	4.36	0.46	0.02	0.22	0.08
Concrete Trucks	160	0.04	1.45	0.15	0.01	0.07	0.03
Delivery Trucks (non-soil)	400	0.09	3.64	0.38	0.01	0.18	0.07
Gravel/paving trucks	240	0.05	2.18	0.23	0.01	0.11	0.04
Haul trucks (soil)	20	0.00	0.18	0.02	0.00	0.01	0.00
Truck Subtotal	1,300	0.30	11.82	1.23	0.04	0.60	0.22
Workers	2,400	0.08	0.41	3.99	0.02	0.73	0.22
Grand Total	**3,700**	**0.38**	**12.23**	**5.22**	**0.06**	**1.33**	**0.44**

Note:
PM_{10} and $PM_{2.5}$ emission factors include exhaust, tire wear, brake wear, and resuspension of loose material on the road surface.

Lower San Felipe Intake Alternative - Pipeline Option
Haul Truck and Construction Worker Commuting Emissions

Table A-47. Annual Emissions

	Truck Emission Factors (g/mi)		0.104	4.124	0.430	0.016	0.206	0.076	0.100	3.639	0.427	0.015	0.204	0.074	0.096	3.225	0.423	0.015	0.201	0.072
	Worker Emission Factors (g/mi)		0.015	0.078	0.753	0.003	0.136	0.042	0.014	0.069	0.692	0.003	0.136	0.042	0.012	0.062	0.640	0.003	0.136	0.042
	Annual VMT (miles/year)		**Annual Emissions - 2020 (tons/year)**						**Annual Emissions - 2021 (tons/year)**						**Annual Emissions - 2022 (tons/year)**					
Truck Type	**2020 - 2021**	**2022**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**
Dump Truck	2,909	2,182	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Concrete Trucks	145	109	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Delivery Trucks (non-soil)	56,727	42,545	0.01	0.26	0.03	0.00	0.01	0.00	0.01	0.23	0.03	0.00	0.01	0.00	0.00	0.15	0.02	0.00	0.01	0.00
Gravel/paving trucks	7,273	5,455	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
Haul trucks (soil)	14,909	11,182	0.00	0.07	0.01	0.00	0.00	0.00	0.00	0.06	0.01	0.00	0.00	0.00	0.00	0.04	0.01	0.00	0.00	0.00
Truck Subtotal	81,963	61,473	0.01	0.37	0.04	0.00	0.02	0.01	0.01	0.33	0.04	0.00	0.02	0.01	0.01	0.22	0.03	0.00	0.01	0.00
Workers	436,364	327,273	0.01	0.04	0.36	0.00	0.07	0.02	0.01	0.03	0.33	0.00	0.07	0.02	0.00	0.02	0.23	0.00	0.05	0.02
Grand Total	**518,327**	**388,746**	**0.02**	**0.41**	**0.40**	**0.00**	**0.08**	**0.03**	**0.02**	**0.36**	**0.37**	**0.00**	**0.08**	**0.03**	**0.01**	**0.24**	**0.26**	**0.00**	**0.06**	**0.02**

Note:
PM_{10} and $PM_{2.5}$ emission factors include exhaust, tire wear, brake wear, and resuspension of loose material on the road surface (paved road dust). Annual emissions include natural control efficiency from precipitation.

Start Year: 2020
County: San Joaquin Valley

Conversions

1 pound = 453.6 grams
1 ton = 2000 pounds

Treatment Alternative
Haul Truck and Construction Worker Commuting Emissions

Construction Duration
Santa Teresa WTP 36 months

Table A-48. Trip Rate Information

Vehicle Type	Round Trips		One-Way Trips		One-Way Distance	VMT		Annual VMT
	Max Day Trips	Total Trips	Max Day Trips	Total Trips	(miles)	Daily	Total	2020-2022
Dump Truck	2	302	4	604	10	40	6,040	2,013
Concrete Trucks	2	155	4	310	10	40	3,100	1,033
Delivery Trucks (non-soil)	3	604	6	1,208	25	150	30,200	10,067
Gravel/paving trucks	2	30	4	60	10	40	600	200
Haul trucks (soil)	2	279	4	558	15	60	8,370	2,790
Total Truck Trips	11	1,370	22	2,740	70	330	48,310	16,103
Workers	80	16,538	160	33,076	30	4,800	992,280	330,760
Grand Total	**91**	**17,908**	**182**	**35,816**	**100**	**5,130**	**1,040,590**	**346,863**

Source: EngineeringDataNeeds_July30_2012.xlsx
Note:
Assume earliest alternative could start would be 2018 (earliest possible date following publication of EIS/EIR and feasibility study).

Table A-49. Maximum Daily Emissions

Truck Emission Factors (g/mi)		0.107	4.144	0.444	0.016	0.209	0.077
Worker Emission Factors (g/mi)		0.014	0.071	0.697	0.003	0.139	0.042
	Maximum Daily VMT	Peak Daily Emissions (lbs/day)					
Truck Type	(miles/day)	ROG	NOx	CO	SOx	PM10	PM2.5
Dump Truck	40	0.01	0.37	0.04	0.00	0.02	0.01
Concrete Trucks	40	0.01	0.37	0.04	0.00	0.02	0.01
Delivery Trucks (non-soil)	150	0.04	1.37	0.15	0.01	0.07	0.03
Gravel/paving trucks	40	0.01	0.37	0.04	0.00	0.02	0.01
Haul trucks (soil)	60	0.01	0.55	0.06	0.00	0.03	0.01
Truck Subtotal	330	0.08	3.02	0.32	0.01	0.15	0.06
Workers	4,800	0.15	0.75	7.37	0.03	1.47	0.45
Grand Total	**5,130**	**0.23**	**3.77**	**7.70**	**0.04**	**1.62**	**0.50**

Note:
PM_{10} and $PM_{2.5}$ emission factors include exhaust, tire wear, brake wear, and resuspension of loose material on the road surface (paved road dust).
Emission factors for 2020 used because the start year has the highest emission factors and represents the worst-case impact.

Treatment Alternative
Haul Truck and Construction Worker Commuting Emissions

Table A-50. Annual Emissions

Truck Emission Factors (g/mi)		0.107	4.144	0.444	0.016	0.205	0.076	0.104	3.662	0.441	0.015	0.203	0.074	0.100	3.249	0.437	0.015	0.200	0.071
Worker Emission Factors (g/mi)		0.014	0.071	0.697	0.003	0.134	0.041	0.013	0.064	0.644	0.003	0.134	0.041	0.011	0.058	0.600	0.003	0.134	0.041
	Annual VMT (miles/year)	**Annual Emissions - 2020 (tons/year)**						**Annual Emissions - 2021 (tons/year)**						**Annual Emissions - 2022 (tons/year)**					
Truck Type	**2020-2022**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**
Dump Truck	2,013	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Concrete Trucks	1,033	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Delivery Trucks (non-soil)	10,067	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
Gravel/paving trucks	200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haul trucks (soil)	2,790	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Truck Subtotal	16,103	0.00	0.07	0.01	0.00	0.00	0.00	0.00	0.07	0.01	0.00	0.00	0.00	0.00	0.06	0.01	0.00	0.00	0.00
Workers	330,760	0.01	0.03	0.25	0.00	0.05	0.02	0.00	0.02	0.23	0.00	0.05	0.02	0.00	0.02	0.22	0.00	0.05	0.02
Grand Total	**346,863**	**0.01**	**0.10**	**0.26**	**0.00**	**0.05**	**0.02**	**0.01**	**0.09**	**0.24**	**0.00**	**0.05**	**0.02**	**0.01**	**0.08**	**0.23**	**0.00**	**0.05**	**0.02**

Note:
PM_{10} and $PM_{2.5}$ emission factors include exhaust, tire wear, brake wear, and resuspension of loose material on the road surface (paved road dust). Annual emissions include natural control efficiency from precipitation.
Mileage assumed to be distributed evenly over each year of construction. Therefore, annual VMT value represents the mileage that would occur in each year of construction.

Start Year: 2020
County: San Francisco Bay Area

Conversions

1 pound = 453.6 grams
1 ton = 2000 pounds

Emission Factors - Weighted Average
Passenger Vehicles (Light duty automobiles and trucks)

Table A-51. Emission Factors for Construction Worker Commutes

		grams per mile												
Air Basin	Year	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
San Joaquin Valley	2020	0.0153	0.0223	0.0776	0.7533	0.0031	0.0018	0.0080	0.0368	0.0466	0.0017	0.0020	0.0158	0.0194
	2021	0.0137	0.0199	0.0692	0.6917	0.0030	0.0018	0.0080	0.0368	0.0465	0.0017	0.0020	0.0158	0.0194
	2022	0.0123	0.0179	0.0621	0.6401	0.0029	0.0018	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0194
	2023	0.0111	0.0161	0.0560	0.5941	0.0028	0.0017	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0193
	2024	0.0100	0.0146	0.0507	0.5567	0.0026	0.0017	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0193
San Francisco Bay Area	2020	0.0139	0.0202	0.0711	0.6967	0.0030	0.0018	0.0080	0.0368	0.0466	0.0017	0.0020	0.0158	0.0195
	2021	0.0125	0.0182	0.0638	0.6437	0.0029	0.0018	0.0080	0.0368	0.0466	0.0017	0.0020	0.0158	0.0194
	2022	0.0113	0.0164	0.0576	0.5996	0.0028	0.0018	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0194
	2023	0.0102	0.0149	0.0522	0.5596	0.0027	0.0017	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0194
	2024	0.0093	0.0135	0.0475	0.5237	0.0025	0.0017	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0193

Note:
Vehicle fleet mix includes gasoline, diesel, and electric automobiles (LDA) and light-duty trucks (LDT1 and LDT2).

Emission Factors - Weighted Average
Heavy-Duty Trucks (Diesel)

Table A-52. Emission Factors for Haul and Delivery Trucks

		grams per mile												
County	Year	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
San Joaquin Valley	2020	0.104	0.118	4.124	0.430	0.016	0.019	0.036	0.062	0.117	0.018	0.009	0.026	0.054
	2021	0.100	0.114	3.639	0.427	0.015	0.017	0.036	0.062	0.115	0.016	0.009	0.026	0.052
	2022	0.096	0.110	3.225	0.423	0.015	0.015	0.036	0.062	0.112	0.014	0.009	0.026	0.049
	2023	0.063	0.071	1.295	0.367	0.015	0.005	0.036	0.062	0.102	0.004	0.009	0.026	0.040
	2024	0.063	0.072	1.277	0.369	0.015	0.005	0.036	0.062	0.102	0.004	0.009	0.026	0.040
San Francisco Bay Area	2020	0.107	0.122	4.144	0.444	0.016	0.019	0.036	0.062	0.117	0.018	0.009	0.026	0.054
	2021	0.104	0.118	3.662	0.441	0.015	0.017	0.036	0.062	0.115	0.016	0.009	0.026	0.052
	2022	0.100	0.114	3.249	0.437	0.015	0.015	0.036	0.062	0.112	0.014	0.009	0.026	0.049
	2023	0.065	0.074	1.328	0.380	0.015	0.005	0.036	0.062	0.102	0.005	0.009	0.026	0.040
	2024	0.065	0.074	1.310	0.382	0.015	0.005	0.036	0.062	0.102	0.004	0.009	0.026	0.040

Emission Factors
Paved Road Dust Emissions

Equation 1:

$$E = k(sL)^{0.91} \times (W)^{1.02}$$

where: E = particulate emission factor (having units matching the units of k),
k = particle size multiplier for particle size range and units of interest (see below),
sL = road surface silt loading (grams per square meter) (g/m2), and
W = average weight (tons) of the vehicles traveling the road.

Equation 2:

$$E_{ext} = [k(sL)^{0.91} \times (W)^{1.02}](1 - P/4N)$$

where: k, sL, and W are as defined in Equation 1 and
E_{ext} = annual or other long-term average emission factor in the same units as k,
P = number of "wet" days with at least 0.254 mm (0.01 in) of precipitation during the averaging period, and
N = number of days in the averaging period (e.g., 365 for annual, 91 for seasonal, 30 for monthly).

Table A-53. Particle Size Multipliers for Paved Road Equation

Size Range [a]	Ref.	Particle Size Multiplier, k [b]		
		g/VKT	g/VMT	lb/VMT
$PM_{2.5}$	[c]	0.15	0.25	0.00054
PM_{10}		0.62	1.00	0.0022
PM_{15}		0.77	1.23	0.0027
PM_{30}	[d]	3.23	5.24	0.011

Source: USEPA. 2011. Compilation of Air Pollutant Emission Factors (AP-42). Fifth Edition, Volume I. Chapter 13.2.1 Paved Roads. January. Available online at: http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf [Accessed October 18, 2018].

Notes:

[a] Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.

[b] Units shown are grams per vehicle kilometer traveled (g/VKT), grams per vehicle mile traveled (g/VMT), and pounds per vehicle mile traveled (lb/VMT). The multiplier k includes unit conversions to produce emission factors in the units shown for the indicated size range from the mixed units required in Equation 1.

[c] The k-factors for $PM_{2.5}$ were based on the average $PM_{2.5}$:PM_{10} ratio of test runs in Reference 30.

[d] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

Default Assumptions

Number precipitation days >0.1 inches

San Joaquin Valley Air Basin	45
San Francisco Bay Area Air Basin	64

Road silt loading	0.03	g/m^2	(AP-42, ADT > 10,000, ubiquitous baseline)
Average vehicle weight	2.2	tons	

Source: CAPCOA. 2017. California Emissions Estimator Model User's Guide, Version 2016.3.2, Appendix D: Default Data Tables. Prepared by BREEZE Software, A Division of Trinity Consultants in collaboration with South Coast Air Quality Management District and the California Air Districts. November. Available online at: http://www.caleemod.com/ [Accessed on October 18, 2018].

Table A-54. Paved Road Dust Emission Factors

Air Basin	Emission Factor (g/VMT)			
	Uncontrolled		Controlled	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
San Joaquin Valley	0.092	0.023	0.089	0.022
San Francisco Bay Area	0.092	0.023	0.088	0.022

Note:

Controlled emission factor only valid for long-term (annual) emissions; uncontrolled emission factor used for daily emissions.

Lower San Felipe Intake Alternative - Tunnel Option
Marine Emissions

Table A-55. Unmitigated Propulsion Engine Emission Factor Equation Variables

Vessel Type	Average HP	Average Age	Model Year	Useful Life	Load Factor	Fuel Correction Factor			Deterioration Factor				Zero-Hour Emission Factor (g/bhp-hr)			
						NOx	PM	ROG	NOx	PM	ROG	CO	NOx	PM	ROG	CO
Tug Boats	1,274	32	1989	21	0.50	0.930	0.720	0.720	0.21	0.67	0.44	0.25	12.98	0.50	0.84	2.99
Crew and Supply	439	27	1994	22	0.45	0.930	0.720	0.720	0.21	0.67	0.44	0.25	12.98	0.50	0.84	2.99

Note:
Barges and dredgers are not typically self-propelled and emissions from barge/dredger propulsion engines are not estimated.
Model year equal to construction start date (year) minus average age of vessel.
A fuel correction factor of 0.72 for hydrocarbon emissions applied to all diesel-powered engines beginning with the 1994 calendar year.

Table A-56. Unmitigated Propulsion Engine Emission Factors

Vessel Type	Aged Emission Factor - 2021 (g/bhp-hr)					Aged Emission Factor - 2022 (g/bhp-hr)					Aged Emission Factor - 2023 (g/bhp-hr)				
	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2
Tug Boats	7.97	0.36	0.51	2.06	0.0055	8.03	0.37	0.51	2.08	0.0055	8.09	0.38	0.52	2.10	0.0055
Crew and Supply	6.83	0.30	0.42	1.76	0.0055	6.88	0.30	0.42	1.77	0.0055	6.94	0.31	0.43	1.79	0.0055

Note:
Starting in 2007, California required the use of ultra low sulfur diesel fuel (ULSD - 15 ppmw sulfur).
SO2 (g/hp-hr) = (S content in X/1,000,000) x (2 SO2/g S) x BSFC (184 g/hp-hr)

Table A-57. Unmitigated Auxiliary Engine Emission Factor Equation Variables

Vessel Type	Average HP	Average Age	Model Year	Useful Life	Load Factor	Fuel Correction Factor			Deterioration Factor				Zero-Hour Emission Factor (g/bhp-hr)			
						NOx	PM	ROG	NOx	PM	ROG	CO	NOx	PM	ROG	CO
Tug Boats	111	32	1989	23	0.31	0.930	0.720	0.720	0.14	0.44	0.28	0.16	15.34	0.80	1.44	3.50
Crew and Supply	79	27	1994	22	0.43	0.930	0.720	0.720	0.14	0.44	0.28	0.16	15.34	0.80	1.44	3.50

Note:
Model year equal to construction start date (year) minus average age of vessel.
A fuel correction factor of 0.72 for hydrocarbon emissions will be applied to all diesel-powered engines beginning with the 1994 calendar year.

Table A-58. Unmitigated Auxiliary Engine Emission Factors

Vessel Type	Aged Emission Factor - 2021 (g/bhp-hr)					Aged Emission Factor - 2022 (g/bhp-hr)					Aged Emission Factor - 2023 (g/bhp-hr)				
	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2
Tug Boats	5.28	0.29	0.45	1.33	0.0055	5.31	0.29	0.45	1.33	0.0055	5.34	0.29	0.45	1.34	0.0055
Crew and Supply	7.19	0.38	0.60	1.80	0.0055	7.23	0.39	0.60	1.81	0.0055	7.27	0.39	0.61	1.82	0.0055

Note:
Starting in 2007, California required the use of ultra low sulfur diesel fuel (ULSD - 15 ppmw sulfur).
SO2 (g/hp-hr) = (S content in X/1,000,000) x (2 SO2/g S) x BSFC (184 g/hp-hr)

Construction Start Date 2021 (Tunneling and Spreading of Spoils)

Table A-59. Maximum Daily Unmitigated Marine Vessel Emissions

Vessel Type	Quantity	Trips per Day	Hours per Trip	No. Propulsion Engines	No. Auxiliary Engines	Propulsion Engine Emissions (lbs/day)						Auxiliary Engine Emissions (lbs/day)						Total Engine Emissions (lbs/day)					
						ROG	NOx	CO	SO2	PM10	PM2.5	ROG	NOx	CO	SO2	PM10	PM2.5	ROG	NOx	CO	SO2	PM10	PM2.5
Tug Boats	2	2	2	2	2	22.70	358.03	92.78	0.25	16.35	15.04	1.75	20.69	5.19	0.02	1.13	1.04	24.45	378.72	97.97	0.27	17.47	16.08
Crew and Supply	2	2	2	3	1	9.74	158.69	40.84	0.13	6.86	6.31	0.83	10.02	2.51	0.01	0.53	0.49	10.57	168.71	43.35	0.14	7.39	6.80
Total	**4**	**4**	**4**	**5**	**3**	**32.44**	**516.72**	**133.62**	**0.38**	**23.20**	**21.35**	**2.58**	**30.70**	**7.70**	**0.03**	**1.66**	**1.53**	**35.02**	**547.43**	**141.32**	**0.41**	**24.86**	**22.87**

Note:
Hours per trip estimated to assume that marine vessels would be operating 8 hours per day.
PM2.5 emissions estimated using PM10 emissions and the California Emission Inventory and Reporting System (CEIDARS) particulate matter (PM) speciation profile no. 425 for diesel vehicle exhaust.
"Trips" represent one-day trips and are double the data provided by the engineers.

Table A-60. Annual Unmitigated Marine Vessel Emissions by Year

	Annual Emissions - 2021 (tons per year)						Annual Emissions - 2022 (tons per year)						Annual Emissions - 2023 (tons per year)					
Vessel Type	**ROG**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**
Tug Boats																		
Propulsion Engines	0.53	8.41	2.18	0.01	0.38	0.35	0.92	14.50	3.76	0.01	0.66	0.61	0.08	1.25	0.32	0.00	0.06	0.05
Auxiliary Engines	0.04	0.49	0.12	0.00	0.03	0.02	0.07	0.84	0.21	0.00	0.05	0.04	0.01	0.07	0.02	0.00	0.00	0.00
Tug Boats Subtotal	0.57	8.90	2.30	0.01	0.41	0.38	0.99	15.34	3.97	0.01	0.71	0.65	0.09	1.33	0.34	0.00	0.06	0.06
Crew and Supply																		
Propulsion Engines	0.23	3.73	0.96	0.00	0.16	0.15	0.39	6.43	1.65	0.01	0.28	0.26	0.03	0.56	0.14	0.00	0.02	0.02
Auxiliary Engines	0.02	0.24	0.06	0.00	0.01	0.01	0.03	0.41	0.10	0.00	0.02	0.02	0.00	0.04	0.01	0.00	0.00	0.00
Crew and Supply Subtotal	0.25	3.96	1.02	0.00	0.17	0.16	0.43	6.83	1.76	0.01	0.30	0.28	0.04	0.59	0.15	0.00	0.03	0.02
Grand Total	**0.82**	**12.86**	**3.32**	**0.01**	**0.58**	**0.54**	**1.42**	**22.17**	**5.72**	**0.02**	**1.01**	**0.93**	**0.12**	**1.92**	**0.49**	**0.00**	**0.09**	**0.08**

Note:
Hours per trip estimated to assume that marine vessels would be operating 8 hours per day.
PM2.5 emissions estimated using PM10 emissions and the California Emission Inventory and Reporting System (CEIDARS) particulate matter (PM) speciation profile no. 425 for diesel vehicle exhaust.
"Trips" represent one-day trips and are double the data provided by the engineers.

ROG, CO, NOx, or PM Emission Estimation Method

$$E = EF_0 \times F \times \left(1 + D \times \frac{A}{UL}\right) \times HP \times LF \times Hr$$

Where:
- E = amount of emissions of a pollutant (PM and NOx) emitted during one period
- EF_0 = the model year, horsepower, and engine use (propulsion or auxiliary) specific zero hour emission factor (when engine is new)
- F = fuel correction factor that accounts for emission reduction benefits from burning cleaner fuel
- D = horsepower and pollutant specific engine deterioration factor, which is the percentage increase of emission factors at the end of the useful life of the engine
- A = age of the engine when the emissions are estimated
- UL = vessel type and engine use specific engine useful life
- HP = rated horsepower of the engine
- LF = vessel type and engine use specific engine load factor
- Hr = number of annual operating hours of the engine

Source: California Air Resources Board. 2010. Staff Report: Initial Statement of Reasons for the Proposed Rulemaking. Amendments to the Regulations to Reduce Emissions from Diesel Engines on Commercial Harbor Craft Operated Within California Waters and 24 Nautical Miles of the California Baseline.
http://www.arb.ca.gov/ports/marinevess/harborcraft/hcdocuments.htm

SOx Emission Estimation Method

$$F_c = HP \times LF \times Hr \times BSFC$$

Where:
- Fc = fuel consumed per engine per year
- HP = rated horsepower of the engine
- Hr = number of annual operating hours of the engine
- LF = vessel type specific engine load factor
- BSFC = brake specific fuel consumption rate; 0.078 gal/kW-hr or 184 g/hp-hr

The sulfur content is assumed to be 15ppm per 13 CCR 2281(a).

Conversion Factors
453.6 grams per pound
2000 pounds per ton

PMSIZE Profile
0.92 PM2.5:PM10
Profile No. 425, Diesel Vehicle Exhaust

Trips per Project

2021	94
2022	162
2023	14
Total	270

Lower San Felipe Intake Alternative - Pipeline Option
Marine Emissions

Table A-61. Unmitigated Propulsion Engine Emission Factor Equation Variables

Vessel Type	Average HP	Average Age	Model Year	Useful Life	Load Factor	Fuel Correction Factor			Deterioration Factor				Zero-Hour Emission Factor (g/bhp-hr)			
						NOx	PM	ROG	NOx	PM	ROG	CO	NOx	PM	ROG	CO
Tug Boats	1,274	32	1989	21	0.50	0.930	0.720	0.720	0.21	0.67	0.44	0.25	12.98	0.50	0.84	2.99
Crew and Supply	439	27	1994	22	0.45	0.930	0.720	0.720	0.21	0.67	0.44	0.25	12.98	0.50	0.84	2.99

Note:
Barges and dredgers are not typically self-propelled and emissions from barge/dredger propulsion engines are not estimated.
Model year equal to construction start date (year) minus average age of vessel.
A fuel correction factor of 0.72 for hydrocarbon emissions applied to all diesel-powered engines beginning with the 1994 calendar year.

Table A-62. Unmitigated Propulsion Engine Emission Factors

Vessel Type	Aged Emission Factor - 2021 (g/bhp-hr)					Aged Emission Factor - 2022 (g/bhp-hr)					Aged Emission Factor - 2023 (g/bhp-hr)				
	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2
Tug Boats	7.97	0.36	0.51	2.06	0.0055	8.03	0.37	0.51	2.08	0.0055	8.09	0.38	0.52	2.10	0.0055
Crew and Supply	6.83	0.30	0.42	1.76	0.0055	6.88	0.30	0.42	1.77	0.0055	6.94	0.31	0.43	1.79	0.0055

Note:
Starting in 2007, California required the use of ultra low sulfur diesel fuel (ULSD - 15 ppmw sulfur).
SO2 (g/hp-hr) = (S content in X/1,000,000) x (2 SO2/g S) x BSFC (184 g/hp-hr)

Table A-63. Unmitigated Auxiliary Engine Emission Factor Equation Variables

Vessel Type	Average HP	Average Age	Model Year	Useful Life	Load Factor	Fuel Correction Factor			Deterioration Factor				Zero-Hour Emission Factor (g/bhp-hr)			
						NOx	PM	ROG	NOx	PM	ROG	CO	NOx	PM	ROG	CO
Tug Boats	111	32	1989	23	0.31	0.930	0.720	0.720	0.14	0.44	0.28	0.16	15.34	0.80	1.44	3.50
Crew and Supply	79	27	1994	22	0.43	0.930	0.720	0.720	0.14	0.44	0.28	0.16	15.34	0.80	1.44	3.50

Note:
Model year equal to construction start date (year) minus average age of vessel.
A fuel correction factor of 0.72 for hydrocarbon emissions will be applied to all diesel-powered engines beginning with the 1994 calendar year.

Table A-64. Unmitigated Auxiliary Engine Emission Factors

Vessel Type	Aged Emission Factor - 2021 (g/bhp-hr)					Aged Emission Factor - 2022 (g/bhp-hr)					Aged Emission Factor - 2023 (g/bhp-hr)				
	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2
Tug Boats	5.28	0.29	0.45	1.33	0.0055	5.31	0.29	0.45	1.33	0.0055	5.34	0.29	0.45	1.34	0.0055
Crew and Supply	7.19	0.38	0.60	1.80	0.0055	7.23	0.39	0.60	1.81	0.0055	7.27	0.39	0.61	1.82	0.0055

Note:
Starting in 2007, California required the use of ultra low sulfur diesel fuel (ULSD - 15 ppmw sulfur).
SO2 (g/hp-hr) = (S content in X/1,000,000) x (2 SO2/g S) x BSFC (184 g/hp-hr)

Construction Start Date 2021 (Lay Pipeline)

Table A-65. Maximum Daily Unmitigated Marine Vessel Emissions

Vessel Type	Quantity	Trips per Day	Hours per Trip	No. Propulsion Engines	No. Auxiliary Engines	Propulsion Engine Emissions (lbs/day)						Auxiliary Engine Emissions (lbs/day)						Total Engine Emissions (lbs/day)					
						ROG	NOx	CO	SO2	PM10	PM2.5	ROG	NOx	CO	SO2	PM10	PM2.5	ROG	NOx	CO	SO2	PM10	PM2.5
Tug Boats	4	2	2	2	2	45.40	716.06	185.55	0.50	32.69	30.08	3.50	41.38	10.39	0.04	2.25	2.07	48.90	757.43	195.94	0.54	34.95	32.15
Crew and Supply	4	2	2	3	1	19.47	317.39	81.68	0.26	13.71	12.62	1.67	20.03	5.02	0.02	1.06	0.98	21.14	337.42	86.70	0.27	14.78	13.59
Total	**8**	**4**	**4**	**5**	**3**	**64.87**	**1,033.44**	**267.24**	**0.75**	**46.41**	**42.70**	**5.17**	**61.41**	**15.40**	**0.06**	**3.32**	**3.05**	**70.04**	**1,094.85**	**282.64**	**0.81**	**49.73**	**45.75**

Note:
Hours per trip estimated to assume that marine vessels would be operating 8 hours per day.
PM2.5 emissions estimated using PM10 emissions and the California Emission Inventory and Reporting System (CEIDARS) particulate matter (PM) speciation profile no. 425 for diesel vehicle exhaust.
"Trips" represent one-day trips and are double the data provided by the engineers.

Table A-66. Annual Unmitigated Marine Vessel Emissions by Year

	Annual Emissions - 2021 (tons per year)						Annual Emissions - 2022 (tons per year)					
Vessel Type	**ROG**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**
Tug Boats												
Propulsion Engines	7.68	121.19	31.40	0.08	5.53	5.09	0.70	11.10	2.88	0.01	0.51	0.47
Auxiliary Engines	0.59	7.00	1.76	0.01	0.38	0.35	0.05	0.64	0.16	0.00	0.03	0.03
Tug Boats Subtotal	8.28	128.20	33.16	0.09	5.92	5.44	0.76	11.74	3.04	0.01	0.54	0.50
Crew and Supply												
Propulsion Engines	3.30	53.72	13.82	0.04	2.32	2.14	0.30	4.92	1.27	0.00	0.21	0.20
Auxiliary Engines	0.28	3.39	0.85	0.00	0.18	0.17	0.03	0.31	0.08	0.00	0.02	0.02
Crew and Supply Subtotal	3.58	57.11	14.67	0.05	2.50	2.30	0.33	5.23	1.34	0.00	0.23	0.21
Grand Total	**11.85**	**185.30**	**47.84**	**0.14**	**8.42**	**7.74**	**1.09**	**16.97**	**4.38**	**0.01**	**0.77**	**0.71**

Note:
Hours per trip estimated to assume that marine vessels would be operating 8 hours per day.
PM2.5 emissions estimated using PM10 emissions and the California Emission Inventory and Reporting System (CEIDARS) particulate matter (PM) speciation profile no. 425 for diesel vehicle exhaust.
"Trips" represent one-day trips and are double the data provided by the engineers.

ROG, CO, NOx, or PM Emission Estimation Method

$$E = EF_0 \times F \times \left(1 + D \times \frac{A}{UL}\right) \times HP \times LF \times Hr$$

Where:
- E = amount of emissions of a pollutant (PM and NOx) emitted during one period
- EF_0 = the model year, horsepower, and engine use (propulsion or auxiliary) specific zero hour emission factor (when engine is new)
- F = fuel correction factor that accounts for emission reduction benefits from burning cleaner fuel
- D = horsepower and pollutant specific engine deterioration factor, which is the percentage increase of emission factors at the end of the useful life of the engine
- A = age of the engine when the emissions are estimated
- UL = vessel type and engine use specific engine useful life
- HP = rated horsepower of the engine
- LF = vessel type and engine use specific engine load factor
- Hr = number of annual operating hours of the engine

Source: California Air Resources Board. 2010. Staff Report: Initial Statement of Reasons for the Proposed Rulemaking. Amendments to the Regulations to Reduce Emissions from Diesel Engines on Commercial Harbor Craft Operated Within California Waters and 24 Nautical Miles of the California Baseline.
http://www.arb.ca.gov/ports/marinevess/harborcraft/hcdocuments.htm

SOx Emission Estimation Method

$$F_c = HP \times LF \times Hr \times BSFC$$

Where:
- Fc = fuel consumed per engine per year
- HP = rated horsepower of the engine
- Hr = number of annual operating hours of the engine
- LF = vessel type specific engine load factor
- BSFC = brake specific fuel consumption rate; 0.078 gal/kW-hr or 184 g/hp-hr

The sulfur content is assumed to be 15ppm per 13 CCR 2281(a).

Conversion Factors

453.6	grams per pound
2000	pounds per ton

Trips per Project

2021	677
2022	62
Total	739

PMSIZE Profile

0.92 PM2.5:PM10
Profile No. 425, Diesel Vehicle Exhaust

Lower San Felipe Intake Alternative
Data Tables

Table A-67. California Commercial Harbor Craft Engine Profile by Vessel Type

	Propulsion Engine			Auxiliary Engine		
Vessel Type	# of Engines per Vessel	Average Annual Operating Hrs	Useful Life	# of Engines per Vessel	Average Annual Operating Hrs	Useful Life
Commercial Fishing	1.12	1,250	21	0.46	1,633	15
Charter Fishing	1.77	1,622	16	0.75	2,077	15
Ferry/excursion Vessels	2.01	1,843	20	1.23	1,254	20
Crew and Supply	2.5	788	22	1.1	3,036	22
Pilot Vessels	1.7	1,031	19	0.14	994	25
Tug Boats	1.92	2,274	21	1.59	2,486	23
Tow Boats	2.1	1,993	26	1.17	2,965	25
Work Boats	1.46	675	17	0.32	750	23
Others	1.11	779	23	0.46	805	22

Source: California Air Resources Board (CARB). Emissions Estimation Methodology for Commercial Harbor Craft Operating in California, Appendix B [2007 Rulemaking], Available online at: http://www.arb.ca.gov/regact/2007/chc07/appb.pdf [Accessed on: June 13, 2016].

Table A-68. Engine Load Factor by Vessel Type and by Engine Use

Vessel Type	Propulsion Engine Load	Auxiliary Engine Load
Commercial Fishing	0.27	0.43
Charter Fishing	0.52	0.43
Ferry/excursion Vessel	0.42	0.43
Crew and Supply	0.45	0.43
Pilot Vessels	0.51	0.43
Tug Boats	0.5	0.31
Tow Boats	0.68	0.43
Work Boats	0.45	0.43
Others	0.52	0.43

Source: CARB. Emissions Estimation Methodology for Commercial Harbor Craft Operating in California, Appendix B [2007 Rulemaking], Available online at: http://www.arb.ca.gov/regact/2007/chc07/appb.pdf [Accessed on: June 13, 2016].

Table A-69. Fuel Correction Factor

Calendar Years	Horsepower Range	Model Years	NOx	PM
1994-2006	<25	Pre-1995	0.930	0.750
	25-50	Pre-1999		
	51-100	Pre-1998		
	101-175	Pre-1997		
	176+	Pre-1996		
	<25	1995+	0.948	0.822
	25-50	1999-2010		
	51-100	1998-2010		
	101-175	1997-2010		
	176+	1996-2010		
2007+	<25	Pre-1995	0.930	0.720
	25-50	Pre-1999		
	51-100	Pre-1998		
	101-175	Pre-1997		
	176+	Pre-1996		
	<25	1995+	0.948	0.800
	25-50	1999-2010		
	51-100	1998-2010		
	101-175	1997-2010		
	176+	1996-2010		
	All	2011+	0.948	0.852

Source: CARB. Emissions Estimation Methodology for Commercial Harbor Craft Operating in California, Appendix B [2007 Rulemaking], Available online at: http://www.arb.ca.gov/regact/2007/chc07/appb.pdf [Accessed on: June 13, 2016].

Table A-70. Engine Deterioration Factor

Horsepower Range	NOx	PM	HC	CO
25-50	0.06	0.31	0.51	0.41
51-250	0.14	0.44	0.28	0.16
>251	0.21	0.67	0.44	0.25

Source: CARB. Emissions Estimation Methodology for Commercial Harbor Craft Operating in California, Appendix B [2007 Rulemaking], Available online at: http://www.arb.ca.gov/regact/2007/chc07/appb.pdf [Accessed on: June 13, 2016].

Table A-71. Commercial Harbor Craft Emission Factor Table (Zero-Hour)

		Main Engines				Auxiliary Engines			
HP Range	Model Year	NOx	PM	ROG	CO	NOx	PM	ROG	CO
25-50 hp	pre-1998	8.14	0.72	1.84	3.65	6.90	0.64	2.19	5.15
	1998-1999	8.14	0.72	1.80	3.65	6.90	0.64	2.14	5.15
	2000-2004	7.31	0.72	1.80	3.65	6.90	0.64	2.14	5.15
	2005-2008	5.32	0.30	1.80	3.73	5.32	0.30	2.14	3.73
	2009-2020	5.32	0.22	1.80	3.73	5.32	0.22	2.14	3.73
51-120 hp	pre-1997	15.34	0.80	1.44	3.50	13.00	0.71	1.71	4.94
	1997-1999	10.33	0.66	0.99	2.55	8.75	0.58	1.18	3.59
	2000-2004	7.31	0.66	0.99	2.55	7.31	0.58	1.18	3.59
	2005-2008	5.32	0.30	0.99	3.73	5.32	0.30	1.18	3.73
	2009-2020	5.32	0.22	0.99	3.73	5.32	0.22	1.18	3.73
121-175 hp	pre-1971	16.52	0.73	1.32	3.21	14.00	0.65	1.57	4.53
	1971-1978	15.34	0.63	1.10	3.21	13.00	0.55	1.31	4.53
	1979-1983	14.16	0.52	1.00	3.21	12.00	0.46	1.19	4.53
	1984-1986	12.98	0.52	0.94	3.14	11.00	0.46	1.12	4.43
	1987-1995	12.98	0.52	0.88	3.07	11.00	0.46	1.05	4.33
	1996-1999	9.64	0.36	0.68	1.97	8.17	0.32	0.81	2.78
	2000-2003	7.31	0.36	0.68	1.97	7.31	0.32	0.81	2.78
	2004-2012	5.10	0.22	0.68	3.73	5.10	0.22	0.81	3.73
	2013-2020	3.80	0.09	0.68	3.73	3.80	0.09	0.81	3.73
176-250 hp	pre-1971	16.52	0.73	1.32	3.21	14.00	0.65	1.57	4.53
	1971-1978	15.34	0.63	1.10	3.21	13.00	0.55	1.31	4.53
	1979-1983	14.16	0.52	1.00	3.21	12.00	0.46	1.19	4.53
	1984-1986	12.98	0.52	0.94	3.14	11.00	0.46	1.12	4.43
	1987-1994	12.98	0.52	0.88	3.07	11.00	0.46	1.05	4.33
	1995-1999	9.64	0.36	0.68	1.97	8.17	0.32	0.81	2.78
	2000-2003	7.31	0.36	0.68	1.97	7.31	0.32	0.81	2.78
	2004-2013	5.10	0.15	0.68	3.73	5.10	0.15	0.81	3.73
	2014-2020	3.99	0.08	0.68	3.73	3.99	0.08	0.81	3.73
251-500 hp	pre-1971	16.52	0.70	1.26	3.07	14.00	0.62	1.50	4.33
	1971-1978	15.34	0.60	1.05	3.07	13.00	0.53	1.25	4.33
	1979-1983	14.16	0.50	0.95	3.07	12.00	0.45	1.13	4.33
	1984-1986	12.98	0.50	0.90	3.07	11.00	0.45	1.07	4.33
	1987-1994	12.98	0.50	0.84	2.99	11.00	0.45	1.00	4.22
	1995-1999	9.64	0.36	0.68	1.97	8.17	0.32	0.81	2.78
	2000-2003	7.31	0.36	0.68	1.97	7.31	0.32	0.81	2.78
	2004-2013	5.10	0.15	0.68	3.73	5.10	0.15	0.81	3.73
	2014-2020	3.99	0.08	0.68	3.73	3.99	0.08	0.81	3.73
501-750 hp	pre-1971	16.52	0.70	1.26	3.07	14.00	0.62	1.50	4.33
	1971-1978	15.34	0.60	1.05	3.07	13.00	0.53	1.25	4.33
	1979-1983	14.16	0.50	0.95	3.07	12.00	0.45	1.13	4.33
	1984-1986	12.98	0.50	0.90	3.07	11.00	0.45	1.07	4.33
	1987-1994	12.98	0.50	0.84	2.99	11.00	0.45	1.00	4.22
	1995-1999	9.64	0.36	0.68	1.97	8.17	0.32	0.81	2.78
	2000-2006	7.31	0.36	0.68	1.97	7.31	0.32	0.81	2.78
	2007-2012	5.10	0.15	0.68	3.73	5.10	0.15	0.81	3.73
	2013-2020	3.99	0.08	0.68	3.73	3.99	0.08	0.81	3.73

Table A-71. Commercial Harbor Craft Emission Factor Table (Zero-Hour)

HP Range	Model Year	Main Engines				Auxiliary Engines			
		NOx	PM	ROG	CO	NOx	PM	ROG	CO
751-1900 hp	pre-1971	16.52	0.70	1.26	3.07	14.00	0.62	1.50	4.33
	1971-1978	15.34	0.60	1.05	3.07	13.00	0.53	1.25	4.33
	1979-1983	14.16	0.50	0.95	3.07	12.00	0.45	1.13	4.33
	1984-1986	12.98	0.50	0.90	3.07	11.00	0.45	1.07	4.33
	1987-1998	12.98	0.50	0.84	2.99	11.00	0.45	1.00	4.22
	1999	9.64	0.36	0.68	1.97	8.17	0.32	0.81	2.78
	2000-2006	7.31	0.36	0.68	1.97	7.31	0.32	0.81	2.78
	2007-2011	5.53	0.20	0.68	3.73	5.53	0.20	0.81	3.73
	2012-2016	4.09	0.08	0.68	3.73	4.09	0.08	0.81	3.73
	2017-2020	1.30	0.03	0.18	3.73	1.30	0.03	0.18	3.73
1901-3300 hp	pre-1971	16.52	0.70	1.26	3.07	14.00	0.62	1.50	4.33
	1971-1978	15.34	0.60	1.05	3.07	13.00	0.53	1.25	4.33
	1979-1983	14.16	0.50	0.95	3.07	12.00	0.45	1.13	4.33
	1984-1986	12.98	0.50	0.90	3.07	11.00	0.45	1.07	4.33
	1987-1998	12.98	0.50	0.84	2.99	11.00	0.45	1.00	4.22
	1999	9.64	0.36	0.68	1.97	8.17	0.32	0.81	2.78
	2000-2006	7.31	0.36	0.68	1.97	7.31	0.32	0.81	2.78
	2007-2012	5.53	0.20	0.68	3.73	5.53	0.20	0.81	3.73
	2013-2015	4.37	0.10	0.68	3.73	4.37	0.10	0.81	3.73
	2016-2020	1.30	0.03	0.18	3.73	1.30	0.03	0.18	3.73
3301-5000 hp	pre-1971	16.52	0.70	1.26	3.07	14.00	0.62	1.50	4.33
	1971-1978	15.34	0.60	1.05	3.07	13.00	0.53	1.25	4.33
	1979-1983	14.16	0.50	0.95	3.07	12.00	0.45	1.13	4.33
	1984-1986	12.98	0.50	0.90	3.07	11.00	0.45	1.07	4.33
	1987-1998	12.98	0.50	0.84	2.99	11.00	0.45	1.00	4.22
	1999	9.64	0.36	0.68	1.97	8.17	0.32	0.81	2.78
	2000-2006	7.31	0.36	0.68	1.97	7.31	0.32	0.81	2.78
	2007-2013	5.53	0.20	0.68	3.73	5.53	0.20	0.81	3.73
	2014-2015	4.94	0.25	0.68	3.73	4.94	0.25	0.81	3.75
	2016-2020	1.30	0.03	0.18	3.73	1.30	0.03	0.18	3.75

Source: CARB. Emissions Estimation Methodology for Commercial Harbor Craft Operating in California, Appendix B [2007 Rulemaking], Available online at: http://www.arb.ca.gov/regact/2007/chc07/appb.pdf [Accessed on: June 13, 2016].

Table A-72. Quantity of Auxiliary Engines and Average Horsepower

Vessel Category	# Auxiliary Engines	Horsepower	
		Range	Average
Commercial Fishing	212	6 - 300	71
Tug Boats	120	7 - 300	111
Ferry/excursion Vessels	98	10 - 400	94
Charter Fishing	82	4 - 185	50
Others	34	10 - 240	56
Work Boats	26	9 - 221	101
Crew and Supply	22	16 - 110	79
Tow Boats	21	18 - 175	79
Pilot Vessels	1	N/A	30

min	max
30	111

Source: CARB. 2004. Statewide Commercial Harbor Craft Survey, Final Report. March. Available online at: http://www.arb.ca.gov/ports/marinevess/documents/hcsurveyrep0304.pdf [Accessed on: June 13, 2016].

Note:

Vessel categories changed from cited document to be consistent with names used in 2007 and 2010 rulemaking documents to assist with VLOOKUP formulas.

Table A-73. Quantity of Propulsion Engines and Average Horsepower

Vessel Category	# Propulsion Engines	Horsepower		min	max
		Range	Average		
Commercial Fishing	516	8 – 1,485	230	230	1274
Charter Fishing	192	80 – 1,400	381		
Ferry/excursion Vessels	164	35 – 3,110	733		
Tug Boats	144	24 – 3,600	1,274		
Work Boats	99	15 – 1,300	239		
Others	89	28 - 764	281		
Crew and Supply	50	225 - 750	439		
Tow Boats	38	24 – 1,500	500		
Pilot Vessels	15	230 - 550	408		

Source: CARB. 2004. Statewide Commercial Harbor Craft Survey, Final Report. March. Available online at: http://www.arb.ca.gov/ports/marinevess/documents/hcsurveyrep0304.pdf [Accessed on: June 13, 2016].

Note:

Vessel categories changed from cited document to be consistent with names used in 2007 and 2010 rulemaking documents to assist with VLOOKUP formulas.

Table A-74. Vessel Age

Vessel Category	Age
Charter Fishing	27
Ferry/excursion Vessels	27
Tug Boats	32
Commercial Fishing	32
Pilot Vessels	24
Work Boats	27
Crew and Supply	27
Tow Boats	39

Source: CARB. 2004. Statewide Commercial Harbor Craft Survey, Final Report. March. Available online at: http://www.arb.ca.gov/ports/marinevess/documents/hcsurveyrep0304.pdf [Accessed on: June 13, 2016].

Note:

Vessel categories changed from cited document to be consistent with names used in 2007 and 2010 rulemaking documents to assist with VLOOKUP formulas.

Lower San Felipe Intake Alternative - Pipeline Option
Dredge Emissions

Table A-75. Unmitigated Emission Factor Equation Variables

Engine Type	Average HP	Average Age	Model Year	Useful Life	Load Factor	Fuel Correction Factor			Deterioration Factor				Zero-Hour Emission Factor (g/bhp-hr)			
						NOx	PM	ROG	NOx	PM	ROG	CO	NOx	PM	ROG	CO
Compressor	353	20	2001	19.5	0.5384	0.948	0.8	0.72	0.21	0.67	0.44	0.25	4.95	0.12	0.2299	0.92
Crane	377	43	1978	9	0.42016	0.93	0.72	0.72	0.21	0.67	0.44	0.25	13	0.63	1.2705	4.2
Deck door engine	86	51	1970	16	0.88989	0.93	0.72	0.72	0.14	0.44	0.28	0.16	13	0.84	1.7424	4.8
Generator	464	22	1999	22.5	0.74576	0.948	0.8	0.72	0.21	0.67	0.44	0.25	8.17	0.38	0.8228	2.7
Hoist swing winch	379	33	1988	27	0.31182	0.93	0.72	0.72	0.21	0.67	0.44	0.25	11	0.53	1.0164	4.1
Other	390	24	1997	16	0.80208	0.948	0.8	0.72	0.21	0.67	0.44	0.25	8.17	0.38	0.8228	2.7
Pump	518	21	2000	21	0.71213	0.948	0.8	0.72	0.21	0.67	0.44	0.25	8.17	0.38	0.8228	2.7

Note:
Model year equal to construction start date (year) minus average age of vessel.
A fuel correction factor of 0.72 for hydrocarbon emissions will be applied to all diesel-powered engines beginning with the 1994 calendar year.

Table A-76. Unmitigated Dredging Auxiliary Engine Emission Factors

Engine Type	Aged Emission Factor - 2021 (g/bhp-hr)					Aged Emission Factor - 2022 (g/bhp-hr)				
	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2
Compressor	3.07	0.09	0.13	0.62	0.0055	3.10	0.09	0.13	0.63	0.0055
Crane	10.18	0.80	1.19	3.87	0.0055	10.29	0.81	1.21	3.92	0.0055
Deck door engine	15.56	1.29	2.11	6.45	0.0055	15.65	1.31	2.13	6.49	0.0055
Generator	6.96	0.38	0.63	2.51	0.0055	7.02	0.38	0.64	2.53	0.0055
Hoist swing winch	4.01	0.22	0.35	1.67	0.0055	4.03	0.22	0.35	1.68	0.0055
Other	8.17	0.49	0.79	2.98	0.0055	8.25	0.50	0.80	3.01	0.0055
Pump	6.67	0.36	0.61	2.40	0.0055	6.73	0.37	0.62	2.43	0.0055

Note:
Starting in 2007, California required the use of ultra low sulfur diesel fuel (ULSD - 15 ppmw sulfur).
SO2 (g/hp-hr) = (S content in X/1,000,000) x (2 SO2/g S) x BSFC (184 g/hp-hr)

Construction Start Date 2021 (Lay Pipeline)

Table A-77. Unmitigated Maximum Daily Emissions

Type	Quantity	Hours/ Day	Daily Emissions (lbs/day)					
			ROG	NOx	CO	SO2	PM10	PM2.5
Compressor	1	20	2.01	47.79	9.69	0.09	1.36	1.25
Crane	1	20	19.82	169.16	64.37	0.09	13.31	12.24
Deck door engine	1	20	8.01	59.00	24.46	0.02	4.90	4.51
Generator	1	20	12.93	142.43	51.26	0.11	7.68	7.06
Hoist swing winch	1	20	5.86	66.99	27.89	0.09	3.62	3.33
Other	1	20	13.56	140.47	51.20	0.09	8.41	7.73
Pump	1	20	13.88	152.43	54.89	0.13	8.26	7.60
		Total	**76.07**	**778.27**	**283.77**	**0.62**	**47.53**	**43.72**

Note: Emissions based on 2021 calendar year because this would represent the worst-case (highest) emissions scenario.

Table A-78. Unmitigated Annual Emissions

Type	Trips/ Project	Trips per Year 2021	Trips per Year 2022	Hours/ Day	Annual Emissions - 2021 (tons/year) ROG	NOx	CO	SO2	PM10	PM2.5	Annual Emissions - 2022 (tons/year) ROG	NOx	CO	SO2	PM10	PM2.5
Compressor	12	11	1	20	0.01	0.26	0.05	0.00	0.01	0.01	0.00	0.02	0.00	0.00	0.00	0.00
Crane	12	11	1	20	0.11	0.93	0.35	0.00	0.07	0.07	0.01	0.09	0.03	0.00	0.01	0.01
Deck door engine	12	11	1	20	0.04	0.32	0.13	0.00	0.03	0.02	0.00	0.03	0.01	0.00	0.00	0.00
Generator	12	11	1	20	0.07	0.78	0.28	0.00	0.04	0.04	0.01	0.07	0.03	0.00	0.00	0.00
Hoist swing winch	12	11	1	20	0.03	0.37	0.15	0.00	0.02	0.02	0.00	0.03	0.01	0.00	0.00	0.00
Other	12	11	1	20	0.07	0.77	0.28	0.00	0.05	0.04	0.01	0.07	0.03	0.00	0.00	0.00
Pump	12	11	1	20	0.08	0.84	0.30	0.00	0.05	0.04	0.01	0.08	0.03	0.00	0.00	0.00
				Total	**0.42**	**4.28**	**1.56**	**0.00**	**0.26**	**0.24**	**0.04**	**0.39**	**0.14**	**0.00**	**0.02**	**0.02**

Conversions
453.6 g/lb
2,000 lbs/ton

PMSIZE Ratio
0.92 PM2.5:PM10
Profile No. 425, Diesel Vehicle Exhaust

Dredge Trips
1 dredge (1 trip per day)
12 trips per project

Lower San Felipe Intake Alternative - Pipeline Optin

Table A-79. Sample Auxiliary Engine Data

Engine Use	Model Year	Engine_tier	HP	Annual Hours	Sulfur Content
Generator	2001	1	95	890	15
Pump	2001	1	156	991	15
Pump	2001	1	156	1,077	15
Pump	2001	1	255	1,420	15
Pump	2001	1	255	726	15
Pump	2001	1	371	350	15
Pump	2001	1	371	412	15
Pump	2001	1	371	444	15
Pump	2001	1	371	408	15
Generator	2001	1	95	205	15
Pump	2001	1	156	1,276	15
Pump	2001	1	156	571	15
Pump	2001	1	255	851	15
Pump	2001	1	255	932	15
Pump	2001	1	371	510	15
Pump	2001	1	371	79	15
Pump	2001	1	371	87	15
Pump	2001	1	371	546	15
Generator	2001	1	95	1,853	15
Pump	2001	1	156	1,511	15
Pump	2001	1	156	953	15
Pump	2001	1	255	111	15
Pump	2001	1	255	1,362	15
Pump	2001	1	371	583	15
Pump	2001	1	371	213	15
Pump	2001	1	371	207	15
Pump	2001	1	371	764	15
Generator	2001	1	95	273	15
Pump	2001	1	156	1,330	15
Pump	2001	1	156	637	15
Pump	2001	1	255	994	15
Pump	2001	1	255	1,220	15
Pump	2001	1	371	589	15
Pump	2001	1	371	148	15
Pump	2001	1	371	159	15
Pump	2001	1	371	751	15
Generator	2004	1	95	220	15
Pump	2004	1	1,900	1,500	15
Pump	2004	1	1,900	1,500	15
Generator	2006	2	95	250	15
Pump	2006	1	1,900	1,500	15
Pump	2006	1	1,900	1,500	15
Generator	2008	3	95	1	15
Pump	2008	2	1,900	1	15
Pump	2008	2	1,900	1	15
Generator	1976	0	46	1	15
Pump	1976	0	160	1	15
Pump	1976	0	200	1	15
Pump	1976	0	200	1	15
Pump	1976	0	200	1	15
Pump	1990	0	160	1	15
Pump	1990	0	160	1	15

Table A-79. Sample Auxiliary Engine Data

Engine Use	Model Year	Engine_tier	HP	Annual Hours	Sulfur Content
Pump	1990	0	160	1	15
Pump	1990	0	160	1	15
Pump	1990	0	160	1	15
Pump	1990	0	160	1	15
Generator	1999	1	202	1	15
Compressor	1997	1	80	91	15
Crane	1978	0	287	290	15
Other	1996	0	90	670	15
Hoist_swing_winch	1960	0	120	8	15
Hoist_swing_winch	1988	0	185	12	15
Compressor	1969	0	250	17	15
Crane	1966	0	185	450	15
Hoist_swing_winch	1960	0	45	30	15
Hoist_swing_winch	1988	0	110	24	15
Hoist_swing_winch	1974	0	270	0	15
Hoist_swing_winch	1988	0	291	0	15
Hoist_swing_winch	1988	0	318	0	15
Compressor	2001	1	71	160	15
Crane	1945	0	316	59	15
Hoist_swing_winch	1988	0	185	6	15
Hoist_swing_winch	1969	0	194	5	15
Generator	1998	1	77	55	15
Crane	2005	2	445	1,050	15
Hoist_swing_winch	1988	0	120	26	15
Hoist_swing_winch	1988	0	210	2	15
Compressor	2007	2	65	360	15
Pump	2008	3	665	800	15
Pump	2008	3	665	1,210	15
Pump	2008	3	665	625	15
Pump	2008	3	665	520	15
Pump	2008	3	665	0	15
Pump	2008	3	665	0	15
Other	1999		126	620	15
Hoist_swing_winch	1988		160	90	15
Hoist_swing_winch	1978		100	528	15
Other	1999		65	637	15
Other	1999		350	445	15
Other	1999		350	445	15
Pump	2000		409	1,497	15
Pump	2000		409	562	15
Other	1999		65	858	15
Other	1999		65	912	15
Other	2002		126	1,536	15
Other	2002		440	193	15
Other	2002		440	180	15
Other	2001		1,100	600	15
Dredger	2006		665	0	15
Dredger	2006		665	0	15
Dredger	2006		665	0	15
Dredger	2003		425	0	15
Dredger	2003		425	0	15
Dredger	2003		425	0	15
Dredger	2003		425	0	15
Other	1984		265	4,284	15

Table A-79. Sample Auxiliary Engine Data

Engine Use	Model Year	Engine_tier	HP	Annual Hours	Sulfur Content
Other	1984		304	257	15
Other	1984		375	600	15
Other	1983		1,000	1,390	15
Other	2007		765	183	15
Other	2006		300	5	15
Other	2007		700	183	15
Other	2006		540	183	15
Other	2006		300	5	15
Other	1999		210	150	15
Other	2001		2,934	1,300	15
Other	2003		106	1,300	15
Other	2006		225	213	15
Other	2005		440	213	15
Other	2006		350	213	15
Other	2006		225	15	15
Other	1999		180	60	15
Other	1999		180	60	15
Hoist_swing_winch	2007		185	24	15
Deck_door_engine	1970		86	1,400	15
Generator	1999		349	2,209	15
Other	2002		425	1,531	15
Hoist_swing_winch	1997		180	200	15
Pump	1997		60	200	15
Hoist_swing_winch	1997		228	200	15
Hoist_swing_winch	1997		180	200	15
Deck_door_engine	1970		86	1,400	15
Other	2006		375	500	15
Hoist_swing_winch	1970		238	280	15
Generator	2000		49	100	15
Pump	2003		460	1,325	15
Other	1998		400	1,865	15
Generator	1991		685	1,825	15
Pump	1966		1,846	1,410	15
Pump	1986		1,325	0	15
Other	1991		390	0	15
Pump	2002		425	471	15
Pump	2002		425	354	15
Pump	2002		425	121	15
Pump	2002		425	55	15
Generator	2002		190	589	15
Generator	2002		190	1,319	15
Pump	2002		500	388	15
Pump	2002		500	415	15
Generator	2002		166	589	15
Generator	2002		166	1,319	15
Pump	2005		500	229	15
Pump	2005		500	247	15
Compressor	2005		500	180	15
Compressor	2005		500	169	15
Generator	2005		219	1,618	15
Generator	2005		219	713	15
Pump	2006		425	606	15
Pump	2006		425	276	15
Pump	2006		425	654	15

Table A-79. Sample Auxiliary Engine Data

Engine Use	Model Year	Engine_tier	HP	Annual Hours	Sulfur Content
Pump	2006		425	213	15
Generator	2005		219	1,798	15
Generator	2005		219	628	15
Compressor	2006		425	391	15
Compressor	2006		425	483	15
Compressor	2003		425	346	15
Pump	2006		425	189	15
Pump	2006		425	195	15
Pump	2006		425	546	15
Pump	2006		425	535	15
Generator	2007		237	628	15
Generator	2007		237	1,074	15
Compressor	2006		500	468	15
Compressor	2006		500	451	15
Compressor	2003		500	428	15
Pump	2003		500	1,487	15
Pump	2003		500	1,464	15
Generator	2004		219	1,626	15
Generator	2004		219	734	15
Other	1997		225	520	15
Other	2000		210	0	15
Crane	1998		650	1	15
Generator	1985		38	0	15
Hoist_swing_winch	1999		120	0	15
Hoist_swing_winch	1985		365	0	15
Other	2004		72	6,710	15
Other	2004		72	806	15
Other	2004		325	90	15
Other	2004		325	266	15
Other	2003		5	3,500	15
Other	2003		15	250	15
Other	2003		15	250	15
Other	1983		325	468	15
Other	1983		325	468	15
Other	1993		160	1,076	15
Other	1999		300	0	15
Other	1999		300	0	15
Other	1999		277	0	15
Other	1999		277	0	15
Other	1999		277	0	15
Other	2003		72	0	15
Other	2003		72	0	15
Other	2003		300	0	15
Other	2003		300	0	15
Other	1999		325	519	15
Other	1999		325	519	15
Other	1999		90	580	15
Other	2003		90	684	15
Other	2003		325	80	15
Other	2003		325	84	15
Other	1993		250	290	15
Other	1993		250	290	15
Other	1993		277	758	15
Other	1993		277	1,778	15

Table A-79. Sample Auxiliary Engine Data

Engine Use	Model Year	Engine_tier	HP	Annual Hours	Sulfur Content
Other	1993		250	375	15
Other	1992		250	504	15
Other	2001		325	265	15
Other	2001		325	265	15
Other	2006		40	280	15
Other	1975		210	135	15
Other	1975		120	135	15
Other	1975		96	322	15
Other	1975		120	322	15
Other	1984		211	191	15
Other	1984		211	191	15
Other	1984		211	406	15
Other	1984		211	406	15
Other	1980		260	103	15
Other	1980		260	103	15
Other	1971		120	69	15
Other	1971		96	69	15
Other	2008		225	83	15
Other	2008		225	83	15
Other	1975		120	200	15
Other	1975		120	90	15
Other	1975		120	50	15
Other	1975		120	50	15
Other	1975		96	550	15
Other	1975		210	550	15
Pump	2007		155	200	15
Pump	2007		280	580	15
Pump	2007		518	1,300	15
Pump	2003		100	185	15
Pump	2003		100	190	15
Generator	1999		31	375	15
Pump	2007		173	130	15
Pump	2007		173	400	15
Generator	2006		55	500	15
Pump	2000		170	500	15
Pump	2000		170	500	15
Generator	2006		32	300	15
Other	1999		100	159	15
Hoist_swing_winch	1982		478	82	15
Generator	2002		440	748	15
Other	1999		500	771	15
Other	1999		500	771	15
Pump	1999		1,500	561	15
Pump	1999		1,500	561	15
Generator	1999		359	748	15
Generator	1995		230	748	15
Generator	1999		359	748	15
Pump	2001		2,500	561	15
Hoist_swing_winch	1980		400	82	15
Generator	2002		335	748	15
Generator	2002		425	748	15
Hoist_swing_winch	2002		440	82	15
Hoist_swing_winch	1997		290	82	15
Hoist_swing_winch	2004		300	82	15

Table A-79. Sample Auxiliary Engine Data

Engine Use	Model Year	Engine_tier	HP	Annual Hours	Sulfur Content
Generator	2000		550	748	15
Hoist_swing_winch	2000		211	82	15
Generator	1998		2,600	748	15
Generator	1998		2,600	748	15
Generator	1998		2,600	748	15
Generator	1998		550	748	15
Generator	1998		2,600	748	15
Generator	1989		500	748	15
Generator	1974		245	748	15
Hoist_swing_winch	1974		243	82	15
Hoist_swing_winch	2000		1,650	82	15
Other	2007		174	771	15
Hoist_swing_winch	1976		182	82	15
Hoist_swing_winch	1969		180	82	15
Hoist_swing_winch	1974		400	82	15
Generator	2007		197	748	15
Generator	1994		500	748	15
Hoist_swing_winch	2008		300	82	15
Generator	2000		205	748	15
Hoist_swing_winch	1997		250	82	15
Hoist_swing_winch	1997		250	82	15
Generator	2005		2,686	748	15
Hoist_swing_winch	2007		202	82	15
Generator	2004		425	748	15
Generator	2008		235	748	15
Generator	2002		440	748	15
Generator	1979		180	748	15
Generator	1982		425	748	15
Hoist_swing_winch	1999		599	82	15
Hoist_swing_winch	1999		599	82	15
Generator	2000		550	748	15
Hoist_swing_winch	2000		2,935	82	15
Hoist_swing_winch	2000		250	82	15
Generator	2002		440	748	15
Hoist_swing_winch	2007		173	82	15
Hoist_swing_winch	2007		173	82	15
Hoist_swing_winch	2003		425	82	15
Generator	2008		80	748	15
Hoist_swing_winch	1956		300	82	15
Hoist_swing_winch	2000		860	82	15
Generator	2000		635	748	15
Generator	2002		112	748	15
Generator	2004		275	748	15
Hoist_swing_winch	1982		239	82	15
Hoist_swing_winch	1982		239	82	15
Generator	2005		500	748	15
Hoist_swing_winch	1989		1,200	82	15
Hoist_swing_winch	2000		250	82	15
Generator	1995		350	748	15
Generator	2007		2,206	748	15
Generator	2008		384	748	15
Pump	2008		630	561	15
Pump	2007		630	561	15
Generator	1974		180	748	15

Table A-79. Sample Auxiliary Engine Data

Engine Use	Model Year	Engine_tier	HP	Annual Hours	Sulfur Content
Hoist_swing_winch	1954		400	82	15
Hoist_swing_winch	1970		400	82	15
Hoist_swing_winch	1980		475	82	15
Generator	1963		700	748	15
Other	1982		235	1,200	15
Other	1982		280	1,200	15
Other	1982		280	1,200	15
Other	2006		425	1,200	15
Other	2006		425	1,200	15
Other	2006		157	1,400	15
Other	2006		157	1,400	15
Other	2006		157	1,400	15
Other	2006		54	360	15
Other	1999		49	360	15
Other	1999		50	175	15
Other	1999		82	162	15
Other	1999		300	771	15
Other	1999		300	771	15
Other	2004		277	771	15
Other	2000		56	771	15
Other	2001		75	771	15
Other	1999		160	771	15
Other	1999		230	771	15
Other	1999		160	771	15
Other	1999		85	771	15
Other	1999		85	771	15
Pump	1982		565	561	15
Pump	1982		565	561	15
Other	1982		565	771	15
Other	1982		565	771	15
Other	2007		1,476	771	15
Other	2007		1,476	771	15
Other	2007		1,476	771	15
Other	1999		1,175	771	15
Generator	1998		400	748	15
Other	1999		400	771	15
Other	1999		280	771	15
Other	1999		460	771	15
Other	1999		460	771	15
Other	1999		180	771	15
Other	1999		565	771	15
Other	1999		565	771	15
Other	1999		565	771	15
Other	1999		565	771	15
Other	1994		89	771	15
Other	2005		90	771	15
Other	1999		245	771	15
Other	1999		385	771	15
Other	1999		385	771	15
Other	1999		99	771	15
Hoist_swing_winch	1988		800	82	15
Generator	1998		147	748	15
Other	1999		380	771	15
Generator	1998		390	748	15

Table A-79. Sample Auxiliary Engine Data

Engine Use	Model Year	Engine_tier	HP	Annual Hours	Sulfur Content
Hoist_swing_winch	1988		240	82	15
Hoist_swing_winch	1988		240	82	15
Generator	1998		390	748	15
Other	1999		540	771	15
Other	1999		2,600	771	15
Other	1999		2,600	771	15
Other	1999		2,600	771	15
Other	1999		2,600	771	15
Generator	1998		550	748	15
Hoist_swing_winch	1988		379	82	15
Generator	1998		464	748	15
Hoist_swing_winch	1988		490	82	15
Generator	1998		464	748	15
Generator	1998		249	748	15
Other	1999		930	771	15
Other	1999		930	771	15
Generator	1998		240	748	15
Generator	1998		240	748	15
Other	1999		520	771	15
Other	1999		315	771	15

Source: CARB. California Barge and Dredge Emissions Inventory Database (Access Database). "View Sample Auxiliary Engine Data" input data table. Accessed on: October 18, 2018. Available at: https://www.arb.ca.gov/msei/ordiesel.htm

Table A-80. Average Engine Data

Type	Average Model Year	Average HP	Average Hours	Percentage
Compressor	2001	353	295	7%
Crane	1978	377	370	9%
Deck_door_engine	1970	86	1,400	34%
Dredger	2004	528	0	0%
Generator	1999	464	748	18%
Hoist_swing_winch	1988	379	82	2%
Other	1997	390	635	16%
Pump	2000	518	561	14%

Note: Represents average values from auxiliary engine data shown in Table 79.

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Table A-81. Vessel Profiles by Vessel Type

Vessel Type	Ves	ME Load	AE Load	ME Useful Life	AE Useful Life
Compressor	Compressor		0.54		19.5
Crane	Crane		0.42		9
Deck_door_engine	Deck_door_engine		0.89		16
Dredger	Dredger		0.51		16
Generator	Generator		0.75		22.5
Hoist_swing_winch	Hoist_swing_winch		0.31		27
Other	Other		0.80		16
Pump	Pump		0.71		21
propulsion	propulsion	0.45		17	

Source: CARB. 2010. Barge and Dredge Emission Inventory (Access Database).

Table A-82. Fuel Correction Factor

Calendar Years	Horsepower Range	Model Years	NOx	PM
1994-2006	<25	Pre-1995	0.930	0.750
	25-50	Pre-1999		
	51-100	Pre-1998		
	101-175	Pre-1997		
	176+	Pre-1996		
	<25	1995+	0.948	0.822
	25-50	1999-2010		
	51-100	1998-2010		
	101-175	1997-2010		
	176+	1996-2010		
2007+	<25	Pre-1995	0.930	0.720
	25-50	Pre-1999		
	51-100	Pre-1998		
	101-175	Pre-1997		
	176+	Pre-1996		
	<25	1995+	0.948	0.800
	25-50	1999-2010		
	51-100	1998-2010		
	101-175	1997-2010		
	176+	1996-2010		
	All	2011+	0.948	0.852

Table A-83. Deterioration Factors

HP_Range	ROG	CO	NOX	PM
0-15	0.51	0.41	0.06	0.31
15-25	0.51	0.41	0.06	0.31
25-50	0.51	0.41	0.06	0.31
51-120	0.28	0.16	0.14	0.44
121-175	0.28	0.16	0.14	0.44
176-250	0.28	0.16	0.14	0.44
251-500	0.44	0.25	0.21	0.67
501-750	0.44	0.25	0.21	0.67
>751	0.44	0.25	0.21	0.67

Table A-84. Zero-Hour Emissions Factors (g/hp-hr)

ID	HP Range	HPGroup	MYHPGroup	MaxHP	Model Year	AE ROG	AE CO	AE NOx	AE PM	Fuel	CO2zh	Offroad_original	THCzh
1	0<HP<=15	1	MY1994HP1	15	1994	1.815	5	10	1	244.9398798	568.3	Y	1.5
2	0<HP<=15	1	MY1995HP1	15	1995	1.815	5	10	1	244.9398798	568.3		1.5
3	0<HP<=15	1	MY1996HP1	15	1996	1.815	5	10	1	244.9398798	568.3		1.5
4	0<HP<=15	1	MY1997HP1	15	1997	1.815	5	10	1	244.9398798	568.3		1.5
5	0<HP<=15	1	MY1998HP1	15	1998	1.815	5	10	1	244.9398798	568.3		1.5
6	0<HP<=15	1	MY1999HP1	15	1999	1.2705	5	9.35	0.57	244.9398798	568.3	Y	1.05
7	0<HP<=15	1	MY2000HP1	15	2000	1.2705	5	9.35	0.57	244.9398798	568.3		1.05
8	0<HP<=15	1	MY2001HP1	15	2001	1.2705	5	9.35	0.57	244.9398798	568.3		1.05
9	0<HP<=15	1	MY2002HP1	15	2002	1.2705	5	9.35	0.57	244.9398798	568.3		1.05
10	0<HP<=15	1	MY2003HP1	15	2003	1.2705	5	9.35	0.57	244.9398798	568.3		1.05
11	0<HP<=15	1	MY2004HP1	15	2004	0.8228	3.47	6.08	0.47	244.9398798	568.3	Y	0.68
12	0<HP<=15	1	MY2005HP1	15	2005	0.8228	3.47	6.08	0.47	244.9398798	568.3		0.68
13	0<HP<=15	1	MY2006HP1	15	2006	0.8228	3.47	6.08	0.47	244.9398798	568.3		0.68
14	0<HP<=15	1	MY2007HP1	15	2007	0.5929	3.47	4.37	0.38	244.9398798	568.3	Y	0.49
15	0<HP<=15	1	MY2008HP1	15	2008	0.5929	3.47	4.37	0.38	244.9398798	568.3		0.49
16	0<HP<=15	1	MY2009HP1	15	2009	0.5929	3.47	4.37	0.38	244.9398798	568.3		0.49
17	0<HP<=15	1	MY2010HP1	15	2010	0.5929	3.47	4.37	0.38	244.9398798	568.3		0.49
18	0<HP<=15	1	MY2011HP1	15	2011	0.5929	3.47	4.37	0.38	244.9398798	568.3		0.49
19	0<HP<=15	1	MY2012HP1	15	2012	0.5929	3.47	4.37	0.38	244.9398798	568.3		0.49
20	0<HP<=15	1	MY2013HP1	15	2013	0.5929	3.47	4.37	0.38	244.9398798	568.3		0.49
21	0<HP<=15	1	MY2014HP1	15	2014	0.5929	3.47	4.37	0.38	244.9398798	568.3		0.49
22	0<HP<=15	1	MY2015HP1	15	2015	0.5929	3.47	4.37	0.38	244.9398798	568.3		0.49
23	0<HP<=15	1	MY2016HP1	15	2016	0.5929	3.47	4.37	0.38	244.9398798	568.3		0.49
24	0<HP<=15	1	MY2017HP1	15	2017	0.5929	3.47	4.37	0.38	244.9398798	568.3		0.49
25	0<HP<=15	1	MY2018HP1	15	2018	0.5929	3.47	4.37	0.38	244.9398798	568.3		0.49
26	0<HP<=15	1	MY2019HP1	15	2019	0.5929	3.47	4.37	0.38	244.9398798	568.3		0.49
27	0<HP<=15	1	MY2020HP1	15	2020	0.5929	3.47	4.37	0.38	244.9398798	568.3		0.49
28	0<HP<=15	1	MY2040HP1	15	2040	0.5929	3.47	4.37	0.19	244.9398798	568.3	Y	0.49
29	15<HP<=25	2	MY1994HP2	25	1994	2.2264	5	6.92	0.76	244.9398798	568.3	Y	1.84
30	15<HP<=25	2	MY1995HP2	25	1995	2.2264	5	6.92	0.76	244.9398798	568.3		1.84
31	15<HP<=25	2	MY1996HP2	25	1996	2.2264	5	6.92	0.76	244.9398798	568.3		1.84
32	15<HP<=25	2	MY1997HP2	25	1997	2.2264	5	6.92	0.76	244.9398798	568.3		1.84
33	15<HP<=25	2	MY1998HP2	25	1998	2.2264	5	6.92	0.76	244.9398798	568.3		1.84
34	15<HP<=25	2	MY1999HP2	25	1999	1.089	5	6.92	0.57	244.9398798	568.3	Y	0.9
35	15<HP<=25	2	MY2000HP2	25	2000	1.089	5	6.92	0.57	244.9398798	568.3		0.9
36	15<HP<=25	2	MY2001HP2	25	2001	1.089	5	6.92	0.57	244.9398798	568.3		0.9
37	15<HP<=25	2	MY2002HP2	25	2002	1.089	5	6.92	0.57	244.9398798	568.3		0.9
38	15<HP<=25	2	MY2003HP2	25	2003	1.089	5	6.92	0.57	244.9398798	568.3		0.9
39	15<HP<=25	2	MY2004HP2	25	2004	0.7744	2.34	5.79	0.38	244.9398798	568.3	Y	0.64
40	15<HP<=25	2	MY2005HP2	25	2005	0.7744	2.34	5.79	0.38	244.9398798	568.3		0.64
41	15<HP<=25	2	MY2006HP2	25	2006	0.7744	2.34	5.79	0.38	244.9398798	568.3		0.64
42	15<HP<=25	2	MY2007HP2	25	2007	0.6897	2.34	4.57	0.38	244.9398798	568.3	Y	0.57
43	15<HP<=25	2	MY2008HP2	25	2008	0.6897	2.34	4.57	0.38	244.9398798	568.3		0.57
44	15<HP<=25	2	MY2009HP2	25	2009	0.6897	2.34	4.57	0.38	244.9398798	568.3		0.57
45	15<HP<=25	2	MY2010HP2	25	2010	0.6897	2.34	4.57	0.38	244.9398798	568.3		0.57
46	15<HP<=25	2	MY2011HP2	25	2011	0.6897	2.34	4.57	0.38	244.9398798	568.3		0.57
47	15<HP<=25	2	MY2012HP2	25	2012	0.6897	2.34	4.57	0.38	244.9398798	568.3		0.57
48	15<HP<=25	2	MY2013HP2	25	2013	0.6897	2.34	4.57	0.38	244.9398798	568.3		0.57
49	15<HP<=25	2	MY2014HP2	25	2014	0.6897	2.34	4.57	0.38	244.9398798	568.3		0.57
50	15<HP<=25	2	MY2015HP2	25	2015	0.6897	2.34	4.57	0.38	244.9398798	568.3		0.57
51	15<HP<=25	2	MY2016HP2	25	2016	0.6897	2.34	4.57	0.38	244.9398798	568.3		0.57
52	15<HP<=25	2	MY2017HP2	25	2017	0.6897	2.34	4.57	0.38	244.9398798	568.3		0.57
53	15<HP<=25	2	MY2018HP2	25	2018	0.6897	2.34	4.57	0.38	244.9398798	568.3		0.57
54	15<HP<=25	2	MY2019HP2	25	2019	0.6897	2.34	4.57	0.38	244.9398798	568.3		0.57
55	15<HP<=25	2	MY2020HP2	25	2020	0.6897	2.34	4.57	0.38	244.9398798	568.3		0.57

Table A-84. Zero-Hour Emissions Factors (g/hp-hr)

ID	HP Range	HPGroup	MYHPGroup	MaxHP	Model Year	AE ROG	AE CO	AE NOx	AE PM	Fuel	CO2zh	Offroad_original	THCzh
56	15<HP<=25	2	MY2040HP2	25	2040	0.6897	2.34	4.57	0.19	244.9398798	568.3	Y	0.57
57	25<HP<=50	3	MY1987HP3	50	1987	2.2264	5	7	0.76	244.9398798	568.3	Y	1.84
58	25<HP<=50	3	MY1988HP3	50	1988	2.2264	5	7	0.76	244.9398798	568.3		1.84
59	25<HP<=50	3	MY1989HP3	50	1989	2.2264	5	7	0.76	244.9398798	568.3		1.84
60	25<HP<=50	3	MY1990HP3	50	1990	2.2264	5	7	0.76	244.9398798	568.3		1.84
61	25<HP<=50	3	MY1991HP3	50	1991	2.2264	5	7	0.76	244.9398798	568.3		1.84
62	25<HP<=50	3	MY1992HP3	50	1992	2.2264	5	7	0.76	244.9398798	568.3		1.84
63	25<HP<=50	3	MY1993HP3	50	1993	2.2264	5	7	0.76	244.9398798	568.3		1.84
64	25<HP<=50	3	MY1994HP3	50	1994	2.2264	5	7	0.76	244.9398798	568.3		1.84
65	25<HP<=50	3	MY1995HP3	50	1995	2.2264	5	7	0.76	244.9398798	568.3		1.84
66	25<HP<=50	3	MY1996HP3	50	1996	2.2264	5	7	0.76	244.9398798	568.3		1.84
67	25<HP<=50	3	MY1997HP3	50	1997	2.2264	5	7	0.76	244.9398798	568.3		1.84
68	25<HP<=50	3	MY1998HP3	50	1998	2.178	5	6.9	0.76	244.9398798	568.3	Y	1.8
69	25<HP<=50	3	MY1999HP3	50	1999	2.178	5	6.9	0.76	244.9398798	568.3		1.8
70	25<HP<=50	3	MY2000HP3	50	2000	2.178	5	6.9	0.76	244.9398798	568.3		1.8
71	25<HP<=50	3	MY2001HP3	50	2001	2.178	5	6.9	0.76	244.9398798	568.3		1.8
72	25<HP<=50	3	MY2002HP3	50	2002	2.178	5	6.9	0.76	244.9398798	568.3		1.8
73	25<HP<=50	3	MY2003HP3	50	2003	1.7545	4.1	5.55	0.6	244.9398798	568.3	Y	1.45
74	25<HP<=50	3	MY2004HP3	50	2004	0.7744	3.27	5.1	0.43	244.9398798	568.3	Y	0.64
75	25<HP<=50	3	MY2005HP3	50	2005	0.4477	3	4.95	0.38	244.9398798	568.3	Y	0.37
76	25<HP<=50	3	MY2006HP3	50	2006	0.4477	3	4.95	0.38	244.9398798	568.3		0.37
77	25<HP<=50	3	MY2007HP3	50	2007	0.2904	2.86	4.88	0.35	244.9398798	568.3	Y	0.24
78	25<HP<=50	3	MY2008HP3	50	2008	0.2904	2.86	4.88	0.35	244.9398798	568.3		0.24
79	25<HP<=50	3	MY2009HP3	50	2009	0.2904	2.86	4.88	0.35	244.9398798	568.3		0.24
80	25<HP<=50	3	MY2010HP3	50	2010	0.2904	2.86	4.88	0.35	244.9398798	568.3		0.24
81	25<HP<=50	3	MY2011HP3	50	2011	0.2904	2.86	4.88	0.35	244.9398798	568.3		0.24
82	25<HP<=50	3	MY2012HP3	50	2012	0.121	2.72	4.8	0.16	244.9398798	568.3	Y	0.1
83	25<HP<=50	3	MY2013HP3	50	2013	0.121	2.72	4.8	0.16	244.9398798	568.3		0.1
84	25<HP<=50	3	MY2014HP3	50	2014	0.121	2.72	4.8	0.16	244.9398798	568.3		0.1
85	25<HP<=50	3	MY2015HP3	50	2015	0.121	2.72	4.8	0.16	244.9398798	568.3		0.1
86	25<HP<=50	3	MY2016HP3	50	2016	0.121	2.72	4.8	0.16	244.9398798	568.3		0.1
87	25<HP<=50	3	MY2017HP3	50	2017	0.121	2.72	4.8	0.16	244.9398798	568.3		0.1
88	25<HP<=50	3	MY2018HP3	50	2018	0.121	2.72	4.8	0.16	244.9398798	568.3		0.1
89	25<HP<=50	3	MY2019HP3	50	2019	0.121	2.72	4.8	0.16	244.9398798	568.3		0.1
90	25<HP<=50	3	MY2020HP3	50	2020	0.121	2.72	4.8	0.16	244.9398798	568.3		0.1
91	25<HP<=50	3	MY2040HP3	50	2040	0.121	2.72	2.9	0.01	244.9398798	568.3	Y	0.1
92	50<HP<=120	4	MY1987HP4	120	1987	1.7424	4.8	13	0.84	222.2602613	568.3	Y	1.44
93	50<HP<=120	4	MY1988HP4	120	1988	1.7424	4.8	13	0.84	222.2602613	568.3		1.44
94	50<HP<=120	4	MY1989HP4	120	1989	1.7424	4.8	13	0.84	222.2602613	568.3		1.44
95	50<HP<=120	4	MY1990HP4	120	1990	1.7424	4.8	13	0.84	222.2602613	568.3		1.44
96	50<HP<=120	4	MY1991HP4	120	1991	1.7424	4.8	13	0.84	222.2602613	568.3		1.44
97	50<HP<=120	4	MY1992HP4	120	1992	1.7424	4.8	13	0.84	222.2602613	568.3		1.44
98	50<HP<=120	4	MY1993HP4	120	1993	1.7424	4.8	13	0.84	222.2602613	568.3		1.44
99	50<HP<=120	4	MY1994HP4	120	1994	1.7424	4.8	13	0.84	222.2602613	568.3		1.44
100	50<HP<=120	4	MY1995HP4	120	1995	1.7424	4.8	13	0.84	222.2602613	568.3		1.44
101	50<HP<=120	4	MY1996HP4	120	1996	1.7424	4.8	13	0.84	222.2602613	568.3		1.44
102	50<HP<=120	4	MY1997HP4	120	1997	1.1979	3.49	8.75	0.69	222.2602613	568.3	Y	0.99
103	50<HP<=120	4	MY1998HP4	120	1998	1.1979	3.49	8.75	0.69	222.2602613	568.3		0.99
104	50<HP<=120	4	MY1999HP4	120	1999	1.1979	3.49	8.75	0.69	222.2602613	568.3		0.99
105	50<HP<=120	4	MY2000HP4	120	2000	1.1979	3.49	8.75	0.69	222.2602613	568.3		0.99
106	50<HP<=120	4	MY2001HP4	120	2001	1.1979	3.49	8.75	0.69	222.2602613	568.3		0.99
107	50<HP<=120	4	MY2002HP4	120	2002	1.1979	3.49	8.75	0.69	222.2602613	568.3		0.99
108	50<HP<=120	4	MY2003HP4	120	2003	1.1979	3.49	6.9	0.69	222.2602613	568.3	Y	0.99
109	50<HP<=120	4	MY2004HP4	120	2004	0.5566	3.23	5.64	0.39	222.2602613	568.3	Y	0.46
110	50<HP<=120	4	MY2005HP4	120	2005	0.3388	3.14	5.22	0.29	222.2602613	568.3	Y	0.28

Table A-84. Zero-Hour Emissions Factors (g/hp-hr)

ID	HP Range	HPGroup	MYHPGroup	MaxHP	Model Year	AE ROG	AE CO	AE NOx	AE PM	Fuel	CO2zh	Offroad_original	THCzh
111	50<HP<=120	4	MY2006HP4	120	2006	0.3388	3.14	5.22	0.29	222.2602613	568.3		0.28
112	50<HP<=120	4	MY2007HP4	120	2007	0.2299	3.09	5.01	0.24	222.2602613	568.3	Y	0.19
113	50<HP<=120	4	MY2008HP4	120	2008	0.2299	3.09	5.01	0.24	222.2602613	568.3		0.19
114	50<HP<=120	4	MY2009HP4	120	2009	0.2299	3.09	5.01	0.24	222.2602613	568.3		0.19
115	50<HP<=120	4	MY2010HP4	120	2010	0.2299	3.09	5.01	0.24	222.2602613	568.3		0.19
116	50<HP<=120	4	MY2011HP4	120	2011	0.121	3.05	2.89	0.2	222.2602613	568.3	Y	0.1
117	50<HP<=120	4	MY2012HP4	120	2012	0.1089	3.05	2.53	0.07	222.2602613	568.3	Y	0.09
118	50<HP<=120	4	MY2013HP4	120	2013	0.1089	3.05	2.53	0.07	222.2602613	568.3		0.09
119	50<HP<=120	4	MY2014HP4	120	2014	0.1089	3.05	2.53	0.01	222.2602613	568.3	Y	0.09
120	50<HP<=120	4	MY2015HP4	120	2015	0.1089	3.05	2.53	0.01	222.2602613	568.3		0.09
121	50<HP<=120	4	MY2016HP4	120	2016	0.1089	3.05	2.53	0.01	222.2602613	568.3		0.09
122	50<HP<=120	4	MY2017HP4	120	2017	0.1089	3.05	2.53	0.01	222.2602613	568.3		0.09
123	50<HP<=120	4	MY2018HP4	120	2018	0.1089	3.05	2.53	0.01	222.2602613	568.3		0.09
124	50<HP<=120	4	MY2019HP4	120	2019	0.1089	3.05	2.53	0.01	222.2602613	568.3		0.09
125	50<HP<=120	4	MY2020HP4	120	2020	0.1089	3.05	2.53	0.01	222.2602613	568.3		0.09
126	50<HP<=120	4	MY2040HP4	120	2040	0.0847	3.05	1.4	0.01	222.2602613	568.3	Y	0.07
127	120<HP<=175	5	MY1969HP5	175	1969	1.5972	4.4	14	0.77	213.1884139	568.3	Y	1.32
128	120<HP<=175	5	MY1970HP5	175	1970	1.5972	4.4	14	0.77	213.1884139	568.3		1.32
129	120<HP<=175	5	MY1971HP5	175	1971	1.331	4.4	13	0.66	213.1884139	568.3	Y	1.1
130	120<HP<=175	5	MY1972HP5	175	1972	1.331	4.4	13	0.66	213.1884139	568.3		1.1
131	120<HP<=175	5	MY1973HP5	175	1973	1.331	4.4	13	0.66	213.1884139	568.3		1.1
132	120<HP<=175	5	MY1974HP5	175	1974	1.331	4.4	13	0.66	213.1884139	568.3		1.1
133	120<HP<=175	5	MY1975HP5	175	1975	1.331	4.4	13	0.66	213.1884139	568.3		1.1
134	120<HP<=175	5	MY1976HP5	175	1976	1.331	4.4	13	0.66	213.1884139	568.3		1.1
135	120<HP<=175	5	MY1977HP5	175	1977	1.331	4.4	13	0.66	213.1884139	568.3		1.1
136	120<HP<=175	5	MY1978HP5	175	1978	1.331	4.4	13	0.66	213.1884139	568.3		1.1
137	120<HP<=175	5	MY1979HP5	175	1979	1.21	4.4	12	0.55	213.1884139	568.3	Y	1
138	120<HP<=175	5	MY1980HP5	175	1980	1.21	4.4	12	0.55	213.1884139	568.3		1
139	120<HP<=175	5	MY1981HP5	175	1981	1.21	4.4	12	0.55	213.1884139	568.3		1
140	120<HP<=175	5	MY1982HP5	175	1982	1.21	4.4	12	0.55	213.1884139	568.3		1
141	120<HP<=175	5	MY1983HP5	175	1983	1.21	4.4	12	0.55	213.1884139	568.3		1
142	120<HP<=175	5	MY1984HP5	175	1984	1.1374	4.3	11	0.55	213.1884139	568.3	Y	0.94
143	120<HP<=175	5	MY1985HP5	175	1985	1.1374	4.3	11	0.55	213.1884139	568.3		0.94
144	120<HP<=175	5	MY1986HP5	175	1986	1.1374	4.3	11	0.55	213.1884139	568.3	Y	0.94
145	120<HP<=175	5	MY1987HP5	175	1987	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
146	120<HP<=175	5	MY1988HP5	175	1988	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
147	120<HP<=175	5	MY1989HP5	175	1989	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
148	120<HP<=175	5	MY1990HP5	175	1990	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
149	120<HP<=175	5	MY1991HP5	175	1991	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
150	120<HP<=175	5	MY1992HP5	175	1992	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
151	120<HP<=175	5	MY1993HP5	175	1993	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
152	120<HP<=175	5	MY1994HP5	175	1994	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
153	120<HP<=175	5	MY1995HP5	175	1995	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
154	120<HP<=175	5	MY1996HP5	175	1996	0.8228	2.7	8.17	0.38	213.1884139	568.3	Y	0.68
155	120<HP<=175	5	MY1997HP5	175	1997	0.8228	2.7	8.17	0.38	213.1884139	568.3		0.68
156	120<HP<=175	5	MY1998HP5	175	1998	0.8228	2.7	8.17	0.38	213.1884139	568.3		0.68
157	120<HP<=175	5	MY1999HP5	175	1999	0.8228	2.7	8.17	0.38	213.1884139	568.3		0.68
158	120<HP<=175	5	MY2000HP5	175	2000	0.8228	2.7	8.17	0.38	213.1884139	568.3		0.68
159	120<HP<=175	5	MY2001HP5	175	2001	0.8228	2.7	8.17	0.38	213.1884139	568.3		0.68
160	120<HP<=175	5	MY2002HP5	175	2002	0.8228	2.7	6.9	0.38	213.1884139	568.3	Y	0.68
161	120<HP<=175	5	MY2003HP5	175	2003	0.3993	2.7	5.26	0.24	213.1884139	568.3	Y	0.33
162	120<HP<=175	5	MY2004HP5	175	2004	0.2662	2.7	4.72	0.19	213.1884139	568.3	Y	0.22
163	120<HP<=175	5	MY2005HP5	175	2005	0.2662	2.7	4.72	0.19	213.1884139	568.3		0.22
164	120<HP<=175	5	MY2006HP5	175	2006	0.1936	2.7	4.44	0.16	213.1884139	568.3	Y	0.16
165	120<HP<=175	5	MY2007HP5	175	2007	0.1936	2.7	4.44	0.16	213.1884139	568.3		0.16

Table A-84. Zero-Hour Emissions Factors (g/hp-hr)

ID	HP Range	HPGroup	MYHPGroup	MaxHP	Model Year	AE ROG	AE CO	AE NOx	AE PM	Fuel	CO2zh	Offroad_original	THCzh
166	120<HP<=175	5	MY2008HP5	175	2008	0.1936	2.7	4.44	0.16	213.1884139	568.3		0.16
167	120<HP<=175	5	MY2009HP5	175	2009	0.1936	2.7	4.44	0.16	213.1884139	568.3		0.16
168	120<HP<=175	5	MY2010HP5	175	2010	0.1936	2.7	4.44	0.16	213.1884139	568.3		0.16
169	120<HP<=175	5	MY2011HP5	175	2011	0.121	2.7	2.45	0.14	213.1884139	568.3	Y	0.1
170	120<HP<=175	5	MY2012HP5	175	2012	0.121	2.7	2.45	0.14	213.1884139	568.3		0.1
171	120<HP<=175	5	MY2013HP5	175	2013	0.121	2.7	2.45	0.14	213.1884139	568.3		0.1
172	120<HP<=175	5	MY2014HP5	175	2014	0.1089	2.7	2.27	0.01	213.1884139	568.3	Y	0.09
173	120<HP<=175	5	MY2015HP5	175	2015	0.1089	2.7	2.27	0.01	213.1884139	568.3		0.09
174	120<HP<=175	5	MY2016HP5	175	2016	0.1089	2.7	2.27	0.01	213.1884139	568.3		0.09
175	120<HP<=175	5	MY2017HP5	175	2017	0.1089	2.7	2.27	0.01	213.1884139	568.3		0.09
176	120<HP<=175	5	MY2018HP5	175	2018	0.1089	2.7	2.27	0.01	213.1884139	568.3		0.09
177	120<HP<=175	5	MY2019HP5	175	2019	0.1089	2.7	2.27	0.01	213.1884139	568.3		0.09
178	120<HP<=175	5	MY2020HP5	175	2020	0.1089	2.7	2.27	0.01	213.1884139	568.3		0.09
179	120<HP<=175	5	MY2040HP5	175	2040	0.0605	2.7	0.27	0.01	213.1884139	568.3	Y	0.05
180	175<HP<=250	6	MY1969HP6	250	1969	1.5972	4.4	14	0.77	213.1884139	568.3	Y	1.32
181	175<HP<=250	6	MY1970HP6	250	1970	1.5972	4.4	14	0.77	213.1884139	568.3		1.32
182	175<HP<=250	6	MY1971HP6	250	1971	1.331	4.4	13	0.66	213.1884139	568.3	Y	1.1
183	175<HP<=250	6	MY1972HP6	250	1972	1.331	4.4	13	0.66	213.1884139	568.3		1.1
184	175<HP<=250	6	MY1973HP6	250	1973	1.331	4.4	13	0.66	213.1884139	568.3		1.1
185	175<HP<=250	6	MY1974HP6	250	1974	1.331	4.4	13	0.66	213.1884139	568.3		1.1
186	175<HP<=250	6	MY1975HP6	250	1975	1.331	4.4	13	0.66	213.1884139	568.3		1.1
187	175<HP<=250	6	MY1976HP6	250	1976	1.331	4.4	13	0.66	213.1884139	568.3		1.1
188	175<HP<=250	6	MY1977HP6	250	1977	1.331	4.4	13	0.66	213.1884139	568.3		1.1
189	175<HP<=250	6	MY1978HP6	250	1978	1.331	4.4	13	0.66	213.1884139	568.3		1.1
190	175<HP<=250	6	MY1979HP6	250	1979	1.21	4.4	12	0.55	213.1884139	568.3	Y	1
191	175<HP<=250	6	MY1980HP6	250	1980	1.21	4.4	12	0.55	213.1884139	568.3		1
192	175<HP<=250	6	MY1981HP6	250	1981	1.21	4.4	12	0.55	213.1884139	568.3		1
193	175<HP<=250	6	MY1982HP6	250	1982	1.21	4.4	12	0.55	213.1884139	568.3		1
194	175<HP<=250	6	MY1983HP6	250	1983	1.21	4.4	12	0.55	213.1884139	568.3		1
195	175<HP<=250	6	MY1984HP6	250	1984	1.1374	4.3	11	0.55	213.1884139	568.3	Y	0.94
196	175<HP<=250	6	MY1985HP6	250	1985	1.1374	4.3	11	0.55	213.1884139	568.3		0.94
197	175<HP<=250	6	MY1986HP6	250	1986	1.1374	4.3	11	0.55	213.1884139	568.3		0.94
198	175<HP<=250	6	MY1987HP6	250	1987	1.0648	4.2	11	0.55	213.1884139	568.3	Y	0.88
199	175<HP<=250	6	MY1988HP6	250	1988	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
200	175<HP<=250	6	MY1989HP6	250	1989	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
201	175<HP<=250	6	MY1990HP6	250	1990	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
202	175<HP<=250	6	MY1991HP6	250	1991	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
203	175<HP<=250	6	MY1992HP6	250	1992	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
204	175<HP<=250	6	MY1993HP6	250	1993	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
205	175<HP<=250	6	MY1994HP6	250	1994	1.0648	4.2	11	0.55	213.1884139	568.3		0.88
206	175<HP<=250	6	MY1995HP6	250	1995	0.8228	2.7	8.17	0.38	213.1884139	568.3	Y	0.68
207	175<HP<=250	6	MY1996HP6	250	1996	0.8228	2.7	8.17	0.38	213.1884139	568.3		0.68
208	175<HP<=250	6	MY1997HP6	250	1997	0.8228	2.7	8.17	0.38	213.1884139	568.3		0.68
209	175<HP<=250	6	MY1998HP6	250	1998	0.8228	2.7	8.17	0.38	213.1884139	568.3		0.68
210	175<HP<=250	6	MY1999HP6	250	1999	0.8228	2.7	8.17	0.38	213.1884139	568.3		0.68
211	175<HP<=250	6	MY2000HP6	250	2000	0.8228	2.7	8.17	0.38	213.1884139	568.3		0.68
212	175<HP<=250	6	MY2001HP6	250	2001	0.8228	2.7	8.17	0.38	213.1884139	568.3		0.68
213	175<HP<=250	6	MY2002HP6	250	2002	0.3872	0.92	6.25	0.15	213.1884139	568.3	Y	0.32
214	175<HP<=250	6	MY2003HP6	250	2003	0.2299	0.92	5	0.12	213.1884139	568.3	Y	0.19
215	175<HP<=250	6	MY2004HP6	250	2004	0.1694	0.92	4.58	0.11	213.1884139	568.3	Y	0.14
216	175<HP<=250	6	MY2005HP6	250	2005	0.1694	0.92	4.58	0.11	213.1884139	568.3		0.14
217	175<HP<=250	6	MY2006HP6	250	2006	0.1452	0.92	4.38	0.11	213.1884139	568.3	Y	0.12
218	175<HP<=250	6	MY2007HP6	250	2007	0.1452	0.92	4.38	0.11	213.1884139	568.3		0.12
219	175<HP<=250	6	MY2008HP6	250	2008	0.1452	0.92	4.38	0.11	213.1884139	568.3		0.12
220	175<HP<=250	6	MY2009HP6	250	2009	0.1452	0.92	4.38	0.11	213.1884139	568.3		0.12

Table A-84. Zero-Hour Emissions Factors (g/hp-hr)

ID	HP Range	HPGroup	MYHPGroup	MaxHP	Model Year	AE ROG	AE CO	AE NOx	AE PM	Fuel	CO2zh	Offroad_original	THCzh
221	175<HP<=250	6	MY2010HP6	250	2010	0.121	0.92	2.45	0.11	213.1884139	568.3	Y	0.1
222	175<HP<=250	6	MY2011HP6	250	2011	0.121	0.92	2.45	0.11	213.1884139	568.3		0.1
223	175<HP<=250	6	MY2012HP6	250	2012	0.121	0.92	2.45	0.11	213.1884139	568.3		0.1
224	175<HP<=250	6	MY2013HP6	250	2013	0.0847	0.92	1.36	0.01	213.1884139	568.3	Y	0.07
225	175<HP<=250	6	MY2014HP6	250	2014	0.0847	0.92	1.36	0.01	213.1884139	568.3		0.07
226	175<HP<=250	6	MY2015HP6	250	2015	0.0847	0.92	1.36	0.01	213.1884139	568.3		0.07
227	175<HP<=250	6	MY2016HP6	250	2016	0.0847	0.92	1.36	0.01	213.1884139	568.3		0.07
228	175<HP<=250	6	MY2017HP6	250	2017	0.0847	0.92	1.36	0.01	213.1884139	568.3		0.07
229	175<HP<=250	6	MY2018HP6	250	2018	0.0847	0.92	1.36	0.01	213.1884139	568.3		0.07
230	175<HP<=250	6	MY2019HP6	250	2019	0.0847	0.92	1.36	0.01	213.1884139	568.3		0.07
231	175<HP<=250	6	MY2020HP6	250	2020	0.0847	0.92	1.36	0.01	213.1884139	568.3		0.07
232	175<HP<=250	6	MY2040HP6	250	2040	0.0605	0.92	0.27	0.01	213.1884139	568.3	Y	0.05
233	250<HP<=500	7	MY1969HP7	500	1969	1.5246	4.2	14	0.74	185.9728717	568.3	Y	1.26
234	250<HP<=500	7	MY1970HP7	500	1970	1.5246	4.2	14	0.74	185.9728717	568.3		1.26
235	250<HP<=500	7	MY1971HP7	500	1971	1.2705	4.2	13	0.63	185.9728717	568.3	Y	1.05
236	250<HP<=500	7	MY1972HP7	500	1972	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
237	250<HP<=500	7	MY1973HP7	500	1973	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
238	250<HP<=500	7	MY1974HP7	500	1974	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
239	250<HP<=500	7	MY1975HP7	500	1975	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
240	250<HP<=500	7	MY1976HP7	500	1976	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
241	250<HP<=500	7	MY1977HP7	500	1977	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
242	250<HP<=500	7	MY1978HP7	500	1978	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
243	250<HP<=500	7	MY1979HP7	500	1979	1.1495	4.2	12	0.53	185.9728717	568.3	Y	0.95
244	250<HP<=500	7	MY1980HP7	500	1980	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
245	250<HP<=500	7	MY1981HP7	500	1981	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
246	250<HP<=500	7	MY1982HP7	500	1982	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
247	250<HP<=500	7	MY1983HP7	500	1983	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
248	250<HP<=500	7	MY1984HP7	500	1984	1.089	4.2	11	0.53	185.9728717	568.3	Y	0.9
249	250<HP<=500	7	MY1985HP7	500	1985	1.089	4.2	11	0.53	185.9728717	568.3		0.9
250	250<HP<=500	7	MY1986HP7	500	1986	1.089	4.2	11	0.53	185.9728717	568.3		0.9
251	250<HP<=500	7	MY1987HP7	500	1987	1.0164	4.1	11	0.53	185.9728717	568.3	Y	0.84
252	250<HP<=500	7	MY1988HP7	500	1988	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
253	250<HP<=500	7	MY1989HP7	500	1989	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
254	250<HP<=500	7	MY1990HP7	500	1990	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
255	250<HP<=500	7	MY1991HP7	500	1991	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
256	250<HP<=500	7	MY1992HP7	500	1992	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
257	250<HP<=500	7	MY1993HP7	500	1993	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
258	250<HP<=500	7	MY1994HP7	500	1994	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
259	250<HP<=500	7	MY1995HP7	500	1995	0.8228	2.7	8.17	0.38	185.9728717	568.3	Y	0.68
260	250<HP<=500	7	MY1996HP7	500	1996	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
261	250<HP<=500	7	MY1997HP7	500	1997	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
262	250<HP<=500	7	MY1998HP7	500	1998	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
263	250<HP<=500	7	MY1999HP7	500	1999	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
264	250<HP<=500	7	MY2000HP7	500	2000	0.3872	0.92	6.25	0.15	185.9728717	568.3	Y	0.32
265	250<HP<=500	7	MY2001HP7	500	2001	0.2299	0.92	4.95	0.12	185.9728717	568.3	Y	0.19
266	250<HP<=500	7	MY2002HP7	500	2002	0.1694	0.92	4.51	0.11	185.9728717	568.3	Y	0.14
267	250<HP<=500	7	MY2003HP7	500	2003	0.1694	0.92	4.51	0.11	185.9728717	568.3		0.14
268	250<HP<=500	7	MY2004HP7	500	2004	0.1452	0.92	4.29	0.11	185.9728717	568.3	Y	0.12
269	250<HP<=500	7	MY2005HP7	500	2005	0.121	0.92	4	0.11	185.9728717	568.3	Y	0.1
270	250<HP<=500	7	MY2006HP7	500	2006	0.121	0.92	4	0.11	185.9728717	568.3		0.1
271	250<HP<=500	7	MY2007HP7	500	2007	0.121	0.92	4	0.11	185.9728717	568.3		0.1
272	250<HP<=500	7	MY2008HP7	500	2008	0.121	0.92	4	0.11	185.9728717	568.3		0.1
273	250<HP<=500	7	MY2009HP7	500	2009	0.121	0.92	4	0.11	185.9728717	568.3		0.1
274	250<HP<=500	7	MY2010HP7	500	2010	0.121	0.92	2.45	0.11	185.9728717	568.3	Y	0.1
275	250<HP<=500	7	MY2011HP7	500	2011	0.121	0.92	2.45	0.11	185.9728717	568.3		0.1

Table A-84. Zero-Hour Emissions Factors (g/hp-hr)

ID	HP Range	HPGroup	MYHPGroup	MaxHP	Model Year	AE ROG	AE CO	AE NOx	AE PM	Fuel	CO2zh	Offroad_original	THCzh
276	250<HP<=500	7	MY2012HP7	500	2012	0.121	0.92	2.45	0.11	185.9728717	568.3		0.1
277	250<HP<=500	7	MY2013HP7	500	2013	0.0847	0.92	1.36	0.01	185.9728717	568.3	Y	0.07
278	250<HP<=500	7	MY2014HP7	500	2014	0.0847	0.92	1.36	0.01	185.9728717	568.3		0.07
279	250<HP<=500	7	MY2015HP7	500	2015	0.0847	0.92	1.36	0.01	185.9728717	568.3		0.07
280	250<HP<=500	7	MY2016HP7	500	2016	0.0847	0.92	1.36	0.01	185.9728717	568.3		0.07
281	250<HP<=500	7	MY2017HP7	500	2017	0.0847	0.92	1.36	0.01	185.9728717	568.3		0.07
282	250<HP<=500	7	MY2018HP7	500	2018	0.0847	0.92	1.36	0.01	185.9728717	568.3		0.07
283	250<HP<=500	7	MY2019HP7	500	2019	0.0847	0.92	1.36	0.01	185.9728717	568.3		0.07
284	250<HP<=500	7	MY2020HP7	500	2020	0.0847	0.92	1.36	0.01	185.9728717	568.3		0.07
285	250<HP<=500	7	MY2040HP7	500	2040	0.0605	0.92	0.27	0.01	185.9728717	568.3	Y	0.05
286	500<HP<=750	8	MY1969HP8	750	1969	1.5246	4.2	14	0.74	185.9728717	568.3	Y	1.26
287	500<HP<=750	8	MY1970HP8	750	1970	1.5246	4.2	14	0.74	185.9728717	568.3		1.26
288	500<HP<=750	8	MY1971HP8	750	1971	1.2705	4.2	13	0.63	185.9728717	568.3	Y	1.05
289	500<HP<=750	8	MY1972HP8	750	1972	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
290	500<HP<=750	8	MY1973HP8	750	1973	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
291	500<HP<=750	8	MY1974HP8	750	1974	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
292	500<HP<=750	8	MY1975HP8	750	1975	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
293	500<HP<=750	8	MY1976HP8	750	1976	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
294	500<HP<=750	8	MY1977HP8	750	1977	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
295	500<HP<=750	8	MY1978HP8	750	1978	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
296	500<HP<=750	8	MY1979HP8	750	1979	1.1495	4.2	12	0.53	185.9728717	568.3	Y	0.95
297	500<HP<=750	8	MY1980HP8	750	1980	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
298	500<HP<=750	8	MY1981HP8	750	1981	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
299	500<HP<=750	8	MY1982HP8	750	1982	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
300	500<HP<=750	8	MY1983HP8	750	1983	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
301	500<HP<=750	8	MY1984HP8	750	1984	1.089	4.2	11	0.53	185.9728717	568.3	Y	0.9
302	500<HP<=750	8	MY1985HP8	750	1985	1.089	4.2	11	0.53	185.9728717	568.3		0.9
303	500<HP<=750	8	MY1986HP8	750	1986	1.089	4.2	11	0.53	185.9728717	568.3		0.9
304	500<HP<=750	8	MY1987HP8	750	1987	1.0164	4.1	11	0.53	185.9728717	568.3	Y	0.84
305	500<HP<=750	8	MY1988HP8	750	1988	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
306	500<HP<=750	8	MY1989HP8	750	1989	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
307	500<HP<=750	8	MY1990HP8	750	1990	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
308	500<HP<=750	8	MY1991HP8	750	1991	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
309	500<HP<=750	8	MY1992HP8	750	1992	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
310	500<HP<=750	8	MY1993HP8	750	1993	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
311	500<HP<=750	8	MY1994HP8	750	1994	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
312	500<HP<=750	8	MY1995HP8	750	1995	0.8228	2.7	8.17	0.38	185.9728717	568.3	Y	0.68
313	500<HP<=750	8	MY1996HP8	750	1996	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
314	500<HP<=750	8	MY1997HP8	750	1997	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
315	500<HP<=750	8	MY1998HP8	750	1998	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
316	500<HP<=750	8	MY1999HP8	750	1999	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
317	500<HP<=750	8	MY2000HP8	750	2000	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
318	500<HP<=750	8	MY2001HP8	750	2001	0.3872	0.92	6.25	0.15	185.9728717	568.3	Y	0.32
319	500<HP<=750	8	MY2002HP8	750	2002	0.2299	0.92	4.95	0.12	185.9728717	568.3	Y	0.19
320	500<HP<=750	8	MY2003HP8	750	2003	0.1694	0.92	4.51	0.11	185.9728717	568.3	Y	0.14
321	500<HP<=750	8	MY2004HP8	750	2004	0.1694	0.92	4.51	0.11	185.9728717	568.3		0.14
322	500<HP<=750	8	MY2005HP8	750	2005	0.1452	0.92	4.29	0.11	185.9728717	568.3	Y	0.12
323	500<HP<=750	8	MY2006HP8	750	2006	0.1452	0.92	4.29	0.11	185.9728717	568.3		0.12
324	500<HP<=750	8	MY2007HP8	750	2007	0.1452	0.92	4.29	0.11	185.9728717	568.3		0.12
325	500<HP<=750	8	MY2008HP8	750	2008	0.1452	0.92	4.29	0.11	185.9728717	568.3		0.12
326	500<HP<=750	8	MY2009HP8	750	2009	0.1452	0.92	4.29	0.11	185.9728717	568.3		0.12
327	500<HP<=750	8	MY2010HP8	750	2010	0.121	0.92	2.45	0.11	185.9728717	568.3	Y	0.1
328	500<HP<=750	8	MY2011HP8	750	2011	0.121	0.92	2.45	0.11	185.9728717	568.3		0.1
329	500<HP<=750	8	MY2012HP8	750	2012	0.121	0.92	2.45	0.11	185.9728717	568.3		0.1
330	500<HP<=750	8	MY2013HP8	750	2013	0.0847	0.92	1.36	0.01	185.9728717	568.3	Y	0.07

Table A-84. Zero-Hour Emissions Factors (g/hp-hr)

ID	HP Range	HPGroup	MYHPGroup	MaxHP	Model Year	AE ROG	AE CO	AE NOx	AE PM	Fuel	CO2zh	Offroad_original	THCzh
331	500<HP<=750	8	MY2014HP8	750	2014	0.0847	0.92	1.36	0.01	185.9728717	568.3		0.07
332	500<HP<=750	8	MY2015HP8	750	2015	0.0847	0.92	1.36	0.01	185.9728717	568.3		0.07
333	500<HP<=750	8	MY2016HP8	750	2016	0.0847	0.92	1.36	0.01	185.9728717	568.3		0.07
334	500<HP<=750	8	MY2017HP8	750	2017	0.0847	0.92	1.36	0.01	185.9728717	568.3		0.07
335	500<HP<=750	8	MY2018HP8	750	2018	0.0847	0.92	1.36	0.01	185.9728717	568.3		0.07
336	500<HP<=750	8	MY2019HP8	750	2019	0.0847	0.92	1.36	0.01	185.9728717	568.3		0.07
337	500<HP<=750	8	MY2020HP8	750	2020	0.0847	0.92	1.36	0.01	185.9728717	568.3		0.07
338	500<HP<=750	8	MY2040HP8	750	2040	0.0605	0.92	0.27	0.01	185.9728717	568.3	Y	0.05
339	750<HP<=1000	9	MY1969HP9	1000	1969	1.5246	4.2	14	0.74	185.9728717	568.3	Y	1.26
340	750<HP<=1000	9	MY1970HP9	1000	1970	1.5246	4.2	14	0.74	185.9728717	568.3		1.26
341	750<HP<=1000	9	MY1971HP9	1000	1971	1.2705	4.2	13	0.63	185.9728717	568.3	Y	1.05
342	750<HP<=1000	9	MY1972HP9	1000	1972	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
343	750<HP<=1000	9	MY1973HP9	1000	1973	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
344	750<HP<=1000	9	MY1974HP9	1000	1974	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
345	750<HP<=1000	9	MY1975HP9	1000	1975	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
346	750<HP<=1000	9	MY1976HP9	1000	1976	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
347	750<HP<=1000	9	MY1977HP9	1000	1977	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
348	750<HP<=1000	9	MY1978HP9	1000	1978	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
349	750<HP<=1000	9	MY1979HP9	1000	1979	1.1495	4.2	12	0.53	185.9728717	568.3	Y	0.95
350	750<HP<=1000	9	MY1980HP9	1000	1980	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
351	750<HP<=1000	9	MY1981HP9	1000	1981	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
352	750<HP<=1000	9	MY1982HP9	1000	1982	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
353	750<HP<=1000	9	MY1983HP9	1000	1983	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
354	750<HP<=1000	9	MY1984HP9	1000	1984	1.089	4.2	11	0.53	185.9728717	568.3	Y	0.9
355	750<HP<=1000	9	MY1985HP9	1000	1985	1.089	4.2	11	0.53	185.9728717	568.3		0.9
356	750<HP<=1000	9	MY1986HP9	1000	1986	1.089	4.2	11	0.53	185.9728717	568.3		0.9
357	750<HP<=1000	9	MY1987HP9	1000	1987	1.0164	4.1	11	0.53	185.9728717	568.3	Y	0.84
358	750<HP<=1000	9	MY1988HP9	1000	1988	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
359	750<HP<=1000	9	MY1989HP9	1000	1989	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
360	750<HP<=1000	9	MY1990HP9	1000	1990	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
361	750<HP<=1000	9	MY1991HP9	1000	1991	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
362	750<HP<=1000	9	MY1992HP9	1000	1992	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
363	750<HP<=1000	9	MY1993HP9	1000	1993	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
364	750<HP<=1000	9	MY1994HP9	1000	1994	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
365	750<HP<=1000	9	MY1995HP9	1000	1995	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
366	750<HP<=1000	9	MY1996HP9	1000	1996	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
367	750<HP<=1000	9	MY1997HP9	1000	1997	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
368	750<HP<=1000	9	MY1998HP9	1000	1998	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
369	750<HP<=1000	9	MY1999HP9	1000	1999	0.8228	2.7	8.17	0.38	185.9728717	568.3	Y	0.68
370	750<HP<=1000	9	MY2000HP9	1000	2000	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
371	750<HP<=1000	9	MY2001HP9	1000	2001	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
372	750<HP<=1000	9	MY2002HP9	1000	2002	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
373	750<HP<=1000	9	MY2003HP9	1000	2003	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
374	750<HP<=1000	9	MY2004HP9	1000	2004	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
375	750<HP<=1000	9	MY2005HP9	1000	2005	0.3872	0.92	6.25	0.15	185.9728717	568.3	Y	0.32
376	750<HP<=1000	9	MY2006HP9	1000	2006	0.2299	0.92	4.95	0.12	185.9728717	568.3	Y	0.19
377	750<HP<=1000	9	MY2007HP9	1000	2007	0.1694	0.92	4.51	0.11	185.9728717	568.3	Y	0.14
378	750<HP<=1000	9	MY2008HP9	1000	2008	0.1694	0.92	4.51	0.11	185.9728717	568.3		0.14
379	750<HP<=1000	9	MY2009HP9	1000	2009	0.1452	0.92	4.29	0.11	185.9728717	568.3	Y	0.12
380	750<HP<=1000	9	MY2010HP9	1000	2010	0.121	0.92	4.08	0.11	185.9728717	568.3	Y	0.1
381	750<HP<=1000	9	MY2011HP9	1000	2011	0.121	0.92	4.08	0.11	185.9728717	568.3		0.1
382	750<HP<=1000	9	MY2012HP9	1000	2012	0.121	0.92	4.08	0.11	185.9728717	568.3		0.1
383	750<HP<=1000	9	MY2013HP9	1000	2013	0.121	0.92	4.08	0.11	185.9728717	568.3		0.1
384	750<HP<=1000	9	MY2014HP9	1000	2014	0.0847	0.92	2.36	0.06	185.9728717	568.3	Y	0.07
385	750<HP<=1000	9	MY2015HP9	1000	2015	0.0847	0.92	2.36	0.06	185.9728717	568.3		0.07

Table A-84. Zero-Hour Emissions Factors (g/hp-hr)

ID	HP Range	HPGroup	MYHPGroup	MaxHP	Model Year	AE ROG	AE CO	AE NOx	AE PM	Fuel	CO2zh	Offroad_original	THCzh
386	750<HP<=1000	9	MY2016HP9	1000	2016	0.0847	0.92	2.36	0.06	185.9728717	568.3		0.07
387	750<HP<=1000	9	MY2017HP9	1000	2017	0.0847	0.92	2.36	0.06	185.9728717	568.3		0.07
388	750<HP<=1000	9	MY2018HP9	1000	2018	0.0847	0.92	2.36	0.06	185.9728717	568.3		0.07
389	750<HP<=1000	9	MY2019HP9	1000	2019	0.0847	0.92	2.36	0.06	185.9728717	568.3		0.07
390	750<HP<=1000	9	MY2020HP9	1000	2020	0.0847	0.92	2.36	0.06	185.9728717	568.3		0.07
391	750<HP<=1000	9	MY2040HP9	1000	2040	0.0605	0.92	2.36	0.02	185.9728717	568.3	Y	0.05
392	1000<HP<=9999	10	MY1969HP10	9999	1969	1.5246	4.2	14	0.74	185.9728717	568.3	Y	1.26
393	1000<HP<=9999	10	MY1970HP10	9999	1970	1.5246	4.2	14	0.74	185.9728717	568.3		1.26
394	1000<HP<=9999	10	MY1971HP10	9999	1971	1.2705	4.2	13	0.63	185.9728717	568.3	Y	1.05
395	1000<HP<=9999	10	MY1972HP10	9999	1972	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
396	1000<HP<=9999	10	MY1973HP10	9999	1973	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
397	1000<HP<=9999	10	MY1974HP10	9999	1974	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
398	1000<HP<=9999	10	MY1975HP10	9999	1975	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
399	1000<HP<=9999	10	MY1976HP10	9999	1976	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
400	1000<HP<=9999	10	MY1977HP10	9999	1977	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
401	1000<HP<=9999	10	MY1978HP10	9999	1978	1.2705	4.2	13	0.63	185.9728717	568.3		1.05
402	1000<HP<=9999	10	MY1979HP10	9999	1979	1.1495	4.2	12	0.53	185.9728717	568.3	Y	0.95
403	1000<HP<=9999	10	MY1980HP10	9999	1980	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
404	1000<HP<=9999	10	MY1981HP10	9999	1981	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
405	1000<HP<=9999	10	MY1982HP10	9999	1982	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
406	1000<HP<=9999	10	MY1983HP10	9999	1983	1.1495	4.2	12	0.53	185.9728717	568.3		0.95
407	1000<HP<=9999	10	MY1984HP10	9999	1984	1.089	4.2	11	0.53	185.9728717	568.3	Y	0.9
408	1000<HP<=9999	10	MY1985HP10	9999	1985	1.089	4.2	11	0.53	185.9728717	568.3		0.9
409	1000<HP<=9999	10	MY1986HP10	9999	1986	1.089	4.2	11	0.53	185.9728717	568.3		0.9
410	1000<HP<=9999	10	MY1987HP10	9999	1987	1.0164	4.1	11	0.53	185.9728717	568.3	Y	0.84
411	1000<HP<=9999	10	MY1988HP10	9999	1988	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
412	1000<HP<=9999	10	MY1989HP10	9999	1989	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
413	1000<HP<=9999	10	MY1990HP10	9999	1990	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
414	1000<HP<=9999	10	MY1991HP10	9999	1991	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
415	1000<HP<=9999	10	MY1992HP10	9999	1992	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
416	1000<HP<=9999	10	MY1993HP10	9999	1993	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
417	1000<HP<=9999	10	MY1994HP10	9999	1994	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
418	1000<HP<=9999	10	MY1995HP10	9999	1995	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
419	1000<HP<=9999	10	MY1996HP10	9999	1996	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
420	1000<HP<=9999	10	MY1997HP10	9999	1997	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
421	1000<HP<=9999	10	MY1998HP10	9999	1998	1.0164	4.1	11	0.53	185.9728717	568.3		0.84
422	1000<HP<=9999	10	MY1999HP10	9999	1999	0.8228	2.7	8.17	0.38	185.9728717	568.3	Y	0.68
423	1000<HP<=9999	10	MY2000HP10	9999	2000	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
424	1000<HP<=9999	10	MY2001HP10	9999	2001	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
425	1000<HP<=9999	10	MY2002HP10	9999	2002	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
426	1000<HP<=9999	10	MY2003HP10	9999	2003	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
427	1000<HP<=9999	10	MY2004HP10	9999	2004	0.8228	2.7	8.17	0.38	185.9728717	568.3		0.68
428	1000<HP<=9999	10	MY2005HP10	9999	2005	0.3872	0.92	6.25	0.15	185.9728717	568.3	Y	0.32
429	1000<HP<=9999	10	MY2006HP10	9999	2006	0.2299	0.92	4.95	0.12	185.9728717	568.3	Y	0.19
430	1000<HP<=9999	10	MY2007HP10	9999	2007	0.1694	0.92	4.51	0.11	185.9728717	568.3	Y	0.14
431	1000<HP<=9999	10	MY2008HP10	9999	2008	0.1694	0.92	4.51	0.11	185.9728717	568.3		0.14
432	1000<HP<=9999	10	MY2009HP10	9999	2009	0.1452	0.92	4.29	0.11	185.9728717	568.3	Y	0.12
433	1000<HP<=9999	10	MY2010HP10	9999	2010	0.121	0.92	4.08	0.11	185.9728717	568.3	Y	0.1
434	1000<HP<=9999	10	MY2011HP10	9999	2011	0.121	0.92	4.08	0.11	185.9728717	568.3		0.1
435	1000<HP<=9999	10	MY2012HP10	9999	2012	0.121	0.92	4.08	0.11	185.9728717	568.3		0.1
436	1000<HP<=9999	10	MY2013HP10	9999	2013	0.121	0.92	4.08	0.11	185.9728717	568.3		0.1
437	1000<HP<=9999	10	MY2014HP10	9999	2014	0.121	0.92	2.36	0.06	185.9728717	568.3	Y	0.1
438	1000<HP<=9999	10	MY2015HP10	9999	2015	0.121	0.92	2.36	0.06	185.9728717	568.3		0.1
439	1000<HP<=9999	10	MY2016HP10	9999	2016	0.121	0.92	2.36	0.06	185.9728717	568.3		0.1
440	1000<HP<=9999	10	MY2017HP10	9999	2017	0.121	0.92	2.36	0.06	185.9728717	568.3		0.1

Table A-84. Zero-Hour Emissions Factors (g/hp-hr)

ID	HP Range	HPGroup	MYHPGroup	MaxHP	Model Year	AE ROG	AE CO	AE NOx	AE PM	Fuel	CO2zh	Offroad_original	THCzh
441	1000<HP<=9999	10	MY2018HP10	9999	2018	0.121	0.92	2.36	0.06	185.9728717	568.3		0.1
442	1000<HP<=9999	10	MY2019HP10	9999	2019	0.121	0.92	2.36	0.06	185.9728717	568.3		0.1
443	1000<HP<=9999	10	MY2020HP10	9999	2020	0.121	0.92	2.36	0.06	185.9728717	568.3		0.1
444	1000<HP<=9999	10	MY2040HP10	9999	2040	0.0605	0.92	2.36	0.02	185.9728717	568.3	Y	0.05

CVP Enlarged Reservoir Expansion Alternative

Table A-85. Unmitigated Onsite Construction Equipment Emissions

Equipment Type	Quantity	OFFROAD Description	HP	Hours per Day	Emission Factors (g/hp-hr or g/mi)						Daily Emissions (lb/day)						Annual Emissions (tons/year)					
					ROG	CO	NOX	SO2	PM10	PM2.5	ROG	CO	NOX	SO2	PM10	PM2.5	ROG	CO	NOX	SO2	PM10	PM2.5
Excavators	3	ConstMin - Excavators	158	20	0.089	1.180	0.875	0.002	0.043	0.039	1.86	24.65	18.28	0.04	0.89	0.82	0.34	4.50	3.34	0.01	0.16	0.15
Bulldozers	4	ConstMin - Rubber Tired Dozers	249	20	0.266	1.399	2.836	0.002	0.138	0.127	11.69	61.46	124.56	0.08	6.07	5.58	2.13	11.22	22.73	0.02	1.11	1.02
Cranes/Lifts	5	ConstMin - Cranes	231	20	0.108	0.507	1.297	0.001	0.053	0.049	5.50	25.84	66.06	0.07	2.70	2.48	1.00	4.72	12.06	0.01	0.49	0.45
Compactors	5	ConstMin - Rollers	80	20	0.142	1.314	1.427	0.002	0.091	0.083	2.50	23.18	25.17	0.03	1.60	1.47	0.46	4.23	4.59	0.01	0.29	0.27
Graders	2	ConstMin - Graders	188	20	0.140	0.565	1.756	0.002	0.058	0.054	2.33	9.37	29.11	0.03	0.97	0.89	0.42	1.71	5.31	0.01	0.18	0.16
Scrapers	2	ConstMin - Scrapers	367	20	0.143	1.024	1.682	0.002	0.064	0.059	4.62	33.13	54.43	0.08	2.08	1.91	0.84	6.05	9.93	0.01	0.38	0.35
Loaders (small)	2	ConstMin - Rubber Tired Loaders	188	20	0.100	0.459	1.164	0.002	0.039	0.036	1.66	7.62	19.30	0.03	0.64	0.59	0.30	1.39	3.52	0.01	0.12	0.11
Loaders (large)	3	ConstMin - Rubber Tired Loaders	541	20	0.109	0.584	1.138	0.002	0.043	0.039	7.81	41.80	81.46	0.13	3.06	2.82	1.42	7.63	14.87	0.02	0.56	0.51
Dump trucks	13	ConstMin - Off-Highway Trucks	403	20	0.094	0.545	0.903	0.002	0.033	0.030	21.75	125.98	208.63	0.43	7.62	7.01	3.97	22.99	38.07	0.08	1.39	1.28
Water Trucks	5		N/A	20	0.085	1.368	0.106	0.004	0.061	0.034	0.28	4.52	0.35	0.01	0.20	0.11	0.05	0.83	0.06	0.00	0.04	0.02
Offroad equipment have units of g/hp-hr; onroad equipment have units of g/mi.										**Total**	**60.00**	**357.54**	**627.35**	**0.93**	**25.82**	**23.68**	10.95	65.25	114.49	0.17	4.71	4.32

Note:
Offroad equipment emission factors from OFFROAD2017 model.
Onroad truck emission factors from EMFAC2014.

Sources:
OFFROAD2017: https://www.arb.ca.gov/orion/
EMFAC2014: http://www.arb.ca.gov/emfac/2014/

Operating Schedule

2 shifts per day
10 hours per shift
365 days per year

Construction Start: 2020

Speed Limit for Onroad Vehicles (Onsite)

15 miles per hour
(speed limit is 35 mph on site, but it is assumed that a water truck will be operating at a lower rate of speed)

Conversions

453.6 grams per pound
2,000 pounds per ton

CVP Enlarged Reservoir Expansion Alternative
Offsite Construction Emissions

Table A-86. Unmitigated Emission Factors (g/mi)

Source	ROG	CO	NOx	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust	PM2.5 Total
Construction workers	0.015	0.753	0.078	0.003	0.002	0.008	0.037	0.100	0.147	0.002	0.002	0.016	0.025	0.045
Haul trucks	0.104	0.430	4.124	0.016	0.019	0.036	0.062	0.100	0.217	0.018	0.009	0.026	0.025	0.079

Table A-87. Unmitigated Daily Emissions (pounds per day)

Source	ROG	CO	NOx	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust	PM2.5 Total
Construction workers	0.59	28.83	2.97	0.12	0.07	0.31	1.41	3.84	5.63	0.06	0.08	0.60	0.96	1.71
Haul trucks	4.40	18.21	174.57	0.66	0.80	1.52	2.61	4.25	9.19	0.77	0.38	1.12	1.06	3.33
Total	**4.98**	**47.05**	**177.54**	**0.78**	**0.87**	**1.83**	**4.02**	**8.10**	**14.82**	**0.83**	**0.46**	**1.72**	**2.02**	**5.04**

Table A-88. Unmitigated Annual Emissions (tons per year)

Source	ROG	CO	NOx	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust	PM2.5 Total
Construction workers	0.11	5.26	0.54	0.02	0.01	0.06	0.26	0.70	1.03	0.01	0.01	0.11	0.18	0.31
Haul trucks	0.80	3.32	31.86	0.12	0.15	0.28	0.48	0.78	1.68	0.14	0.07	0.20	0.19	0.61
Total	**0.91**	**8.59**	**32.40**	**0.14**	**0.16**	**0.33**	**0.73**	**1.48**	**2.70**	**0.15**	**0.08**	**0.31**	**0.37**	**0.92**

One-way trip distance

Workers	40	miles per trip
Trucks	40	miles per trip

Maximum Daily Workers and Trucks

217	workers per day	(130 day time workers and 87 night time workers)
240	trucks per day	

Conversions

453.6	grams per pound
2,000	pounds per ton

Operating Schedule

365	days per year

Construction Start Year

2020

CVP Enlarged Reservoir Expansion Alternative
Fugitive Dust Emissions - Material Handling

Excavated Volume
11,200 cubic yards per shift
8,176,000 cubic yards per year

Equation (AP-42, Chapter 13.2.4):

$$E = k(0.0032)\frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

where:
E = emission factor, pound per ton
k = particle size multiplier
U = mean wind speed, miles per hour
M = material moisture content, %

Average Wind Speed 9.64 mph
Source: MesoWest, Station CF031 (Rt. 152 San Luis), 2015 data. Accessed on: July 27, 2016. Available at: mesowest.utah.edu.

Material Moisture Content: 7.9 %
Source: EPA. 1998. AP-42, Chapter 11-9, Overburden moisture content, bulldozing.

Table A-89. Material Handling Emissions

Size	k	EF	Emissions	
		lb/ton	lbs/day	tpy
PM10	0.35	3.8E-04	8.4	1.5
PM2.5	0.053	5.8E-05	1.3	0.2

Operating Schedule
2 shift per day
7 days per week
365 days per year

Density
1.25 tons per cubic yard
Note: CalEEMod assumes haul trucks can handle 20 tons or 16 cy.

Number of Drops
2 drops per truck *(one drop at borrow site and one drop at dam site)*

Dust Control
61% reduction from watering at least 3 times per day
Source: CalEEMod

CVP Enlarged Reservoir Expansion Alternative
Fugitive Dust Emissions - Grading

Operating Schedule

2	graders
7.1	miles per hour (AP-42, Table 11.9-3)
20	hours per day (total)
142	miles per day
51,830	miles per year *assumes 365 days per year*

Equations (AP-42, Chapter 11.9):

$TSP = 0.040(S)^{2.5}$ and $PM15 = 0.051(S)^{2.0}$

where:
S = mean vehicle speed, miles per hour

Scaling Factors

PM10	0.60	(multiply the 15-micron equation by this fraction to determine emissions)
PM2.5	0.031	(multiply the TSP equation by this fraction to determine emissions)

Table A-90. Grading Emissions

	EF	Emissions	
Size	lb/VMT	lbs/day	tpy
PM10	1.54	85.4	15.6
PM2.5	0.17	9.2	1.7

Dust Control

61% reduction from watering at least 3 times per day

Source: CalEEMod

CVP Enlarged Reservoir Expansion Alternative
Fugitive Dust Emissions - Bulldozing

Operating Schedule

4	bulldozers	
20	hours per day (total)	
7,300	hours per year (total)	*assumes 365 days per year*

Equations (AP-42, Chapter 11.9):

$$TSP = \frac{5.7(s)^{1.2}}{M^{1.3}} \quad \text{and} \quad PM15 = \frac{1.0(s)^{1.5}}{M^{1.4}}$$

where:

s = silt content	6.9 %	(AP-42, Table 11.9-3, Overburden)
M = material moisture content	7.9 %	(AP-42, Table 11.9-3, Overburden)

Scaling Factors

PM10	0.75	(multiply the 15-micron equation by this fraction to determine emissions)
PM2.5	0.105	(multiply the TSP equation by this fraction to determine emissions)

Table A-91. Bulldozing Emissions

	EF	Emissions	
Size	lb/hr	lbs/day	tpy
PM10	0.75	5.9	1.1
PM2.5	0.41	3.2	0.6

Dust Control

61% reduction from watering at least 3 times per day

Source: CalEEMod

CVP Enlarged Reservoir Expansion Alternative
Fugitive Dust Emissions - Paved Road Dust (Haul Roads)

Number of Trucks	13		
Excavated quantity	11,200	cubic yards per shift	
Number of shifts	2	shift per day	
	1,723	cubic yards per truck per day	
	46.75	cubic yards per truck (body capacity)	
	74	trips per day per truck (loaded and unloaded trips)	
Haul Road Length	0.8	miles one-way (paved road; total route is 3.2 miles)	
	770	miles per day	
	280,904	miles per year	*assumes 365 days per year*

Table A-92. Paved Road Dust Emissions

	EF, g/VMT		Emissions	
Size	Uncontrolled	Controlled	lbs/day	tpy
PM10	22.2	21.5	7.5	1.3
PM2.5	5.6	5.4	1.9	0.3

Note: Uncontrolled EF used for daily emissions and controlled EF used for annual emissions.

Dust Control

80% assumes pipe-grid trackout-control device installed

Source: SCAQMD, Mitigation Measures, Fugitive Dust from Paved Roads
http://www.aqmd.gov/home/regulations/ceqa/air-quality-analysis-handbook/mitigation-measures-and-control-efficiencies/fugitive-dust

Conversions

453.6 grams per pound
2,000 pounds per ton

Percentage of haul route paved (estimated from Google Earth) 25%

CVP Enlarged Reservoir Expansion Alternative
Fugitive Dust Emissions - Unpaved Road Dust (Haul Roads)

Number of Trucks	13		
Excavated quantity	11,200	cubic yards per shift	
Number of shifts	2	shift per day	
	1,723	cubic yards per truck per day	
	46.75	cubic yards per truck (body capacity)	
	74	trips per day per truck (loaded and unloaded trips)	
Haul Road Length	2.4	miles one-way (unpaved road; total route is 3.2 miles)	
	2,309	miles per day	
	842,712	miles per year	*assumes 365 days per year*

Equations (AP-42, Chapter 13.2.2):

$$E = k(s/12)^a(W/3)^b$$

$$E_{ext} = E[(365 - P)/365]$$

where:
k, a, and b are empirical constants
E = size-specific emission factor (lb/VMT)
s = surface material silt content (%)
W = mean vehicle weight (tons)
Eext = annual size-specific emission factor extrapolated for natural mitigation
P = number of days in a year with at least 0.254 mm (0.01 in) of precipitation

silt content (construction)	8.5	%	(AP-42, Table 13.2.2-1)
days of precipitation	49		(CalEEMod default)
Unloaded truck weight	50	tons	
Loaded truck weight	126	tons	
Average vehicle weight	88	tons	(estimated from eqiupment specifications)

Table A-93. Unmitigated Unpaved Road Dust Emissions

Size	k	a	b	EF, lb/VMT		Emissions	
				Uncontrolled	Controlled	lbs/day	tpy
PM10	1.5	0.9	0.45	5.0	4.4	4,529.0	715.6
PM2.5	0.15	0.9	0.45	0.5	0.4	452.9	71.6

Source: AP-42, Table 13.2.2-2

Dust Control

61% reduction from watering at least 3 times per day

Source: CalEEMod

Percentage of haul route unpaved 75%
(estimated from Google Earth)

Conversions

2,000 pounds per ton

EMFAC2014 Emission Factors
On-Road Motor Vehicles

Table A-94. Unmitigated Emission Factors for Construction Worker Commutes

		grams per mile												
Air Basin	Year	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
San Joaquin Valley	2020	0.0153	0.0223	0.0776	0.7533	0.0031	0.0018	0.0080	0.0368	0.0466	0.0017	0.0020	0.0158	0.0194
	2021	0.0137	0.0199	0.0692	0.6917	0.0030	0.0018	0.0080	0.0368	0.0465	0.0017	0.0020	0.0158	0.0194
	2022	0.0123	0.0179	0.0621	0.6401	0.0029	0.0018	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0194
	2023	0.0111	0.0161	0.0560	0.5941	0.0028	0.0017	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0193
	2024	0.0100	0.0146	0.0507	0.5567	0.0026	0.0017	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0193

Note:
Vehicle fleet mix includes gasoline, diesel, and electric automobiles (LDA) and light-duty trucks (LDT1 and LDT2).

Table A-95. Unmitigated Emission Factors for Haul and Delivery Trucks

		grams per mile												
Air Basin	Year	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
San Joaquin Valley	2020	0.104	0.118	4.124	0.430	0.016	0.019	0.036	0.062	0.117	0.018	0.009	0.026	0.054
	2021	0.100	0.114	3.639	0.427	0.015	0.017	0.036	0.062	0.115	0.016	0.009	0.026	0.052
	2022	0.096	0.110	3.225	0.423	0.015	0.015	0.036	0.062	0.112	0.014	0.009	0.026	0.049
	2023	0.063	0.071	1.295	0.367	0.015	0.005	0.036	0.062	0.102	0.004	0.009	0.026	0.040
	2024	0.063	0.072	1.277	0.369	0.015	0.005	0.036	0.062	0.102	0.004	0.009	0.026	0.040

Table A-96. Unmitigated Emission Factors for On-Site Water Trucks (San Joaquin Valley Air Basin)

		grams per mile												
Year	Speed	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
2020	5	0.223	0.254	0.169	3.701	0.004	0.029	0.008	0.037	0.074	0.028	0.002	0.016	0.045
2020	10	0.166	0.189	0.146	2.763	0.004	0.022	0.008	0.037	0.067	0.021	0.002	0.016	0.039
2020	15	0.085	0.096	0.106	1.368	0.004	0.017	0.008	0.037	0.061	0.016	0.002	0.016	0.034
2020	20	0.039	0.044	0.084	0.556	0.004	0.015	0.008	0.037	0.059	0.014	0.002	0.016	0.032
2020	25	0.025	0.029	0.072	0.343	0.004	0.012	0.008	0.037	0.056	0.011	0.002	0.016	0.029
2020	30	0.019	0.021	0.063	0.260	0.004	0.009	0.008	0.037	0.054	0.009	0.002	0.016	0.027
2020	35	0.016	0.018	0.063	0.213	0.004	0.009	0.008	0.037	0.054	0.008	0.002	0.016	0.026
2020	40	0.014	0.016	0.065	0.182	0.004	0.009	0.008	0.037	0.053	0.008	0.002	0.016	0.026
2020	45	0.013	0.014	0.063	0.159	0.004	0.008	0.008	0.037	0.053	0.008	0.002	0.016	0.025
2020	50	0.012	0.013	0.062	0.143	0.004	0.008	0.008	0.037	0.053	0.007	0.002	0.016	0.025
2020	55	0.012	0.014	0.066	0.137	0.004	0.008	0.008	0.037	0.053	0.008	0.002	0.016	0.026
2020	60	0.012	0.013	0.065	0.137	0.004	0.008	0.008	0.037	0.053	0.008	0.002	0.016	0.026
2020	65	0.012	0.013	0.060	0.140	0.004	0.008	0.008	0.037	0.053	0.008	0.002	0.016	0.025
2021	5	0.211	0.240	0.155	3.656	0.004	0.026	0.008	0.037	0.071	0.025	0.002	0.016	0.043
2021	10	0.157	0.179	0.135	2.728	0.004	0.021	0.008	0.037	0.066	0.020	0.002	0.016	0.038
2021	15	0.079	0.090	0.096	1.348	0.004	0.015	0.008	0.037	0.060	0.014	0.002	0.016	0.032
2021	20	0.036	0.041	0.075	0.546	0.004	0.013	0.008	0.037	0.058	0.013	0.002	0.016	0.030
2021	25	0.023	0.027	0.065	0.335	0.004	0.010	0.008	0.037	0.055	0.010	0.002	0.016	0.028
2021	30	0.017	0.020	0.056	0.254	0.004	0.008	0.008	0.037	0.053	0.008	0.002	0.016	0.026
2021	35	0.015	0.017	0.056	0.207	0.004	0.008	0.008	0.037	0.053	0.008	0.002	0.016	0.025
2021	40	0.013	0.015	0.058	0.177	0.004	0.008	0.008	0.037	0.053	0.007	0.002	0.016	0.025
2021	45	0.012	0.013	0.055	0.153	0.004	0.007	0.008	0.037	0.052	0.007	0.002	0.016	0.025

Table A-96. Unmitigated Emission Factors for On-Site Water Trucks (San Joaquin Valley Air Basin)

		grams per mile												
Year	Speed	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
2021	50	0.011	0.012	0.055	0.138	0.004	0.007	0.008	0.037	0.052	0.007	0.002	0.016	0.024
2021	55	0.011	0.012	0.057	0.130	0.004	0.007	0.008	0.037	0.052	0.007	0.002	0.016	0.025
2021	60	0.011	0.012	0.058	0.131	0.004	0.008	0.008	0.037	0.052	0.007	0.002	0.016	0.025
2021	65	0.010	0.012	0.052	0.132	0.004	0.007	0.008	0.037	0.052	0.007	0.002	0.016	0.025
2022	5	0.199	0.226	0.142	3.608	0.004	0.024	0.008	0.037	0.068	0.023	0.002	0.016	0.040
2022	10	0.148	0.169	0.123	2.692	0.004	0.019	0.008	0.037	0.064	0.018	0.002	0.016	0.036
2022	15	0.075	0.085	0.087	1.328	0.004	0.014	0.008	0.037	0.058	0.013	0.002	0.016	0.031
2022	20	0.034	0.038	0.068	0.535	0.004	0.012	0.008	0.037	0.057	0.011	0.002	0.016	0.029
2022	25	0.022	0.025	0.058	0.328	0.004	0.010	0.008	0.037	0.054	0.009	0.002	0.016	0.027
2022	30	0.016	0.018	0.050	0.249	0.004	0.008	0.008	0.037	0.052	0.007	0.002	0.016	0.025
2022	35	0.014	0.016	0.050	0.202	0.004	0.007	0.008	0.037	0.052	0.007	0.002	0.016	0.025
2022	40	0.012	0.014	0.052	0.172	0.004	0.007	0.008	0.037	0.052	0.007	0.002	0.016	0.025
2022	45	0.011	0.012	0.049	0.149	0.004	0.007	0.008	0.037	0.051	0.006	0.002	0.016	0.024
2022	50	0.010	0.011	0.049	0.133	0.004	0.006	0.008	0.037	0.051	0.006	0.002	0.016	0.024
2022	55	0.010	0.011	0.050	0.125	0.004	0.007	0.008	0.037	0.051	0.006	0.002	0.016	0.024
2022	60	0.010	0.011	0.052	0.125	0.004	0.007	0.008	0.037	0.052	0.007	0.002	0.016	0.024
2022	65	0.009	0.011	0.046	0.126	0.004	0.007	0.008	0.037	0.051	0.006	0.002	0.016	0.024
2023	5	0.187	0.213	0.131	3.568	0.004	0.021	0.008	0.037	0.065	0.020	0.002	0.016	0.038
2023	10	0.139	0.159	0.113	2.661	0.004	0.016	0.008	0.037	0.061	0.016	0.002	0.016	0.033
2023	15	0.070	0.080	0.080	1.310	0.004	0.012	0.008	0.037	0.057	0.011	0.002	0.016	0.029
2023	20	0.031	0.035	0.061	0.526	0.004	0.010	0.008	0.037	0.055	0.010	0.002	0.016	0.028
2023	25	0.020	0.022	0.052	0.321	0.004	0.008	0.008	0.037	0.053	0.008	0.002	0.016	0.026
2023	30	0.015	0.017	0.045	0.243	0.004	0.007	0.008	0.037	0.051	0.006	0.002	0.016	0.024
2023	35	0.012	0.014	0.044	0.197	0.004	0.006	0.008	0.037	0.051	0.006	0.002	0.016	0.024
2023	40	0.011	0.013	0.045	0.167	0.004	0.006	0.008	0.037	0.051	0.006	0.002	0.016	0.024
2023	45	0.010	0.011	0.043	0.144	0.004	0.006	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2023	50	0.009	0.010	0.042	0.128	0.004	0.006	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2023	55	0.008	0.010	0.044	0.119	0.004	0.006	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2023	60	0.009	0.010	0.045	0.119	0.004	0.006	0.008	0.037	0.051	0.006	0.002	0.016	0.023
2023	65	0.008	0.009	0.040	0.119	0.004	0.006	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2024	5	0.177	0.201	0.121	3.527	0.004	0.017	0.008	0.037	0.062	0.017	0.002	0.016	0.034
2024	10	0.131	0.150	0.104	2.630	0.004	0.014	0.008	0.037	0.059	0.013	0.002	0.016	0.031
2024	15	0.065	0.074	0.073	1.292	0.004	0.010	0.008	0.037	0.055	0.010	0.002	0.016	0.027
2024	20	0.028	0.032	0.055	0.517	0.004	0.009	0.008	0.037	0.054	0.009	0.002	0.016	0.026
2024	25	0.018	0.020	0.046	0.314	0.004	0.007	0.008	0.037	0.052	0.007	0.002	0.016	0.025
2024	30	0.013	0.015	0.040	0.238	0.004	0.006	0.008	0.037	0.051	0.006	0.002	0.016	0.023
2024	35	0.011	0.013	0.039	0.193	0.004	0.006	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2024	40	0.010	0.011	0.040	0.163	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2024	45	0.009	0.010	0.038	0.140	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.022
2024	50	0.008	0.009	0.037	0.124	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.022
2024	55	0.007	0.008	0.037	0.114	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.022
2024	60	0.007	0.008	0.038	0.113	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2024	65	0.007	0.008	0.034	0.113	0.004	0.005	0.008	0.037	0.049	0.005	0.002	0.016	0.022

Emission Factors
Paved Road Dust Emissions

Equation 1:

$$E = k(sL)^{0.91} \times (W)^{1.02}$$

where: E = particulate emission factor (having units matching the units of k),
k = particle size multiplier for particle size range and units of interest (see below),
sL = road surface silt loading (grams per square meter) (g/m2), and
W = average weight (tons) of the vehicles traveling the road.

Equation 2:

$$E_{ext} = [k(sL)^{0.91} \times (W)^{1.02}](1 - P/4N)$$

where: k, sL, and W are as defined in Equation 1 and
E_{ext} = annual or other long-term average emission factor in the same units as k,
P = number of "wet" days with at least 0.254 mm (0.01 in) of precipitation during the averaging period, and
N = number of days in the averaging period (e.g., 365 for annual, 91 for seasonal, 30 for monthly).

Table A-97. Particle Size Multipliers for Paved Road Equation

Size Range [a]	Ref.	Particle Size Multiplier, k [b]		
		g/VKT	g/VMT	lb/VMT
$PM_{2.5}$	[c]	0.15	0.25	0.00054
PM_{10}		0.62	1.00	0.0022
PM_{15}		0.77	1.23	0.0027
PM_{30}	[d]	3.23	5.24	0.011

Source: USEPA. 2011. Compilation of Air Pollutant Emission Factors (AP-42). Fifth Edition, Volume I. Chapter 13.2.1 Paved Roads. January. Available online at: http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf [Accessed July 17, 2012].

Notes:

[a] Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.

[b] Units shown are grams per vehicle kilometer traveled (g/VKT), grams per vehicle mile traveled (g/VMT), and pounds per vehicle mile traveled (lb/VMT). The multiplier k includes unit conversions to produce emission factors in the units shown for the indicated size range from the mixed units required in Equation 1.

[c] The k-factors for $PM_{2.5}$ were based on the average $PM_{2.5}$:PM_{10} ratio of test runs in Reference 30.

[d] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

Offsite Construction Vehicles

Number precipitation days >0.1 inches
Merced County 49

Road silt loading 0.03 g/m^2 (AP-42, Table 13.2.1-2, ADT > 10,000, ubiquitous baseline)
Average vehicle weight 2.4 tons

Source: CAPCOA. 2013. California Emissions Estimator Model User's Guide, Version 2013.2, Appendix D: Default Data Tables. Prepared by ENVIRON International Corporation and California Air Districts. July. Available online at: http://www.caleemod.com/ [Accessed on July 28, 2016].

Table A-98. Paved Road Dust Emission Factors - Offsite Construction Vehicles

	Emission Factor (g/VMT)			
	Uncontrolled		Controlled	
County	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Merced	0.100	0.025	0.097	0.024

Note:
Controlled emission factor only valid for long-term (annual) emissions; uncontrolled emission factor used for daily emissions.

Haul Road Vehicles

Number precipitation days >0.1 inches			
Merced County	49		
Road silt loading	0.2	g/m^2	(AP-42, Table 13.2.1-2, ADT 500-5,000, ubiquitous baseline)
Unloaded truck weight	50	tons	
	126	tons	
Average vehicle weight	88	tons	(estimated from eqiupment specifications)

Table A-99. Paved Road Dust Emission Factors - Onsite Haul Trucks

	Emission Factor (g/VMT)			
	Uncontrolled		Controlled	
County	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Merced	22.2	5.6	21.5	5.4

Note:
Controlled emission factor only valid for long-term (annual) emissions; uncontrolled emission factor used for daily emissions.

Unmitigated Emissions Summary

Table A-100. New Pacheco Alternative - Maximum Daily Unmitigated Emissions

Source	Daily Emissions (pounds per day)					
	ROG	NOx	CO	SOx	PM10	PM2.5
			2024			
Off-Road Construction Equipment	2,099.53	2,639.92	2,847.58	2,025.58	2,051.43	2,048.45
On-Road Haul Trucks and Delivery Vehicles	1.41	28.31	8.26	0.32	4.38	1.41
Construction Worker Commuting	0.49	2.51	27.71	0.13	7.77	2.35
Total	**2101.43**	**2670.74**	**2883.55**	**2026.03**	**2063.58**	**2052.21**
			2025			
Off-Road Construction Equipment	2,096.57	2,576.55	2,837.15	2,026.57	2,049.68	2,046.93
On-Road Haul Trucks and Delivery Vehicles	2.49	49.25	14.60	0.55	7.69	2.47
Construction Worker Commuting	0.45	2.30	25.93	0.13	7.77	2.35
Total	**2099.51**	**2628.10**	**2877.68**	**2027.26**	**2065.15**	**2051.75**
			2026			
Off-Road Construction Equipment	2,095.81	2,548.05	2,833.15	2,027.57	2,049.13	2,046.50
On-Road Haul Trucks and Delivery Vehicles	2.51	48.85	14.70	0.55	7.69	2.46
Construction Worker Commuting	0.62	3.19	36.64	0.19	11.65	3.52
Total	**2098.94**	**2600.09**	**2884.49**	**2028.31**	**2068.48**	**2052.49**
			2027			
Off-Road Construction Equipment	2,095.01	2,515.94	2,826.33	2,028.57	2,048.63	2,046.12
On-Road Haul Trucks and Delivery Vehicles	2.52	48.37	14.77	0.55	7.69	2.46
Construction Worker Commuting	0.60	3.12	36.58	0.19	12.29	3.71
Total	**2098.13**	**2567.43**	**2877.69**	**2029.31**	**2068.61**	**2052.29**
			2028			
Off-Road Construction Equipment	2,094.76	2,492.61	2,827.05	2,029.57	2,048.55	2,046.13
On-Road Haul Trucks and Delivery Vehicles	0.18	3.35	1.04	0.04	0.54	0.17
Construction Worker Commuting	0.56	2.90	34.72	0.18	12.28	3.70
Total	**2095.49**	**2498.86**	**2862.80**	**2029.80**	**2061.38**	**2050.00**
			2029			
Off-Road Construction Equipment	2,094.26	2,468.34	2,817.82	2,030.57	2,048.39	2,046.06
On-Road Haul Trucks and Delivery Vehicles	0.18	3.32	1.04	0.04	0.54	0.17
Construction Worker Commuting	0.30	1.57	19.10	0.10	7.11	2.14
Total	**2094.73**	**2473.23**	**2837.96**	**2030.71**	**2056.03**	**2048.37**
Maximum Daily Emissions	**2101.43**	**2670.74**	**2884.49**	**2030.71**	**2068.61**	**2052.49**
BAAQMD Significance Threshold	54	54	n/a	n/a	82	54
Significant?	Yes	Yes	n/a	n/a	Yes	Yes

Source: BAAQMD 2017

Table A-101. New Pacheco Alternative - Annual Unmitigated Emissions

Source	Annual Emissions (tons per year)					
	ROG	NOx	CO	SOx	PM10	PM2.5
			2024			
Off-Road Construction Equipment	2,037.78	2,136.41	2,174.30	2,024.29	2,029.01	2,028.46
On-Road Haul Trucks and Delivery Vehicles	0.14	2.79	0.81	0.03	0.43	0.14
Construction Worker Commuting	0.07	0.33	3.68	0.02	1.03	0.31
Total	**2037.99**	**2139.53**	**2178.79**	**2024.34**	**2030.47**	**2028.91**
			2025			
Off-Road Construction Equipment	2,038.06	2,125.66	2,173.22	2,025.29	2,029.50	2,029.00
On-Road Haul Trucks and Delivery Vehicles	0.38	7.57	2.25	0.09	1.18	0.38
Construction Worker Commuting	0.07	0.37	4.15	0.02	1.24	0.38
Total	**2038.52**	**2133.60**	**2179.61**	**2025.39**	**2031.93**	**2029.76**
			2026			
Off-Road Construction Equipment	2,038.74	2,121.27	2,173.30	2,026.29	2,030.22	2,029.74
On-Road Haul Trucks and Delivery Vehicles	0.46	8.89	2.68	0.10	1.40	0.45
Construction Worker Commuting	0.10	0.52	5.93	0.03	1.89	0.57
Total	**2039.30**	**2130.68**	**2181.91**	**2026.42**	**2033.51**	**2030.76**
			2027			
Off-Road Construction Equipment	2,039.41	2,116.23	2,172.88	2,027.29	2,030.95	2,030.49
On-Road Haul Trucks and Delivery Vehicles	0.42	8.12	2.48	0.09	1.29	0.41
Construction Worker Commuting	0.10	0.51	5.96	0.03	2.00	0.60
Total	**2039.93**	**2124.86**	**2181.32**	**2027.41**	**2034.24**	**2031.51**
			2028			
Off-Road Construction Equipment	2,040.18	2,112.79	2,173.83	2,028.29	2,031.75	2,031.31
On-Road Haul Trucks and Delivery Vehicles	0.03	0.61	0.19	0.01	0.10	0.03
Construction Worker Commuting	0.09	0.47	5.65	0.03	2.00	0.60
Total	**2040.31**	**2113.87**	**2179.67**	**2028.32**	**2033.85**	**2031.94**
			2029			
Off-Road Construction Equipment	2,040.91	2,109.18	2,172.96	2,029.29	2,032.54	2,032.11
On-Road Haul Trucks and Delivery Vehicles	0.01	0.25	0.08	0.00	0.04	0.01
Construction Worker Commuting	0.04	0.20	2.48	0.01	0.92	0.28
Total	**2040.96**	**2109.64**	**2175.51**	**2029.30**	**2033.50**	**2032.40**
Maximum Annual Emissions	**2040.96**	**2139.53**	**2181.91**	**2029.30**	**2034.24**	**2032.40**
De Minimis Threshold	100	100	100	100	n/a	100
Significant?	Yes	Yes	Yes	Yes	n/a	Yes

Source: 40 CFR 93.153

Table A-102. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Emission Factors - 2024 (g/hp-hr or g/hr)					
							ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment												
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	53	110	1	g/hp-hr	0.2314	1.4875	2.0419	0.0019	0.1316	0.1211
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	71,036	170	2	g/hp-hr	0.2314	1.4875	2.0419	0.0019	0.1316	0.1211
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	110,098	305	3	g/hp-hr	0.1615	1.2857	1.5853	0.0019	0.0706	0.0649
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	1,867	202	1	g/hp-hr	0.0698	0.4227	0.6454	0.0018	0.0214	0.0197
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	59,824	373	2	g/hp-hr	0.0793	0.4875	0.6496	0.0018	0.0246	0.0226
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	9,507	699	1	g/hp-hr	0.0713	0.5566	0.4721	0.0018	0.0171	0.0157
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	914	193	1	g/hp-hr	0.1319	0.7805	1.4539	0.0021	0.0602	0.0554
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	138	36	1	g/hp-hr	0.1285	1.3495	1.2299	0.0020	0.0326	0.0300
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	70,318	200	2	g/hp-hr	0.1089	0.5160	1.1890	0.0020	0.0397	0.0365
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	914	27	1	g/hp-hr	0.2196	1.7167	1.4035	0.0020	0.0618	0.0568
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	11,600	235	1	g/hp-hr	0.0647	0.4518	0.6070	0.0018	0.0221	0.0203
2.0 CY Excavator	ConstMin - Excavators	Diesel	75	235	1	g/hp-hr	0.0540	0.4238	0.4346	0.0019	0.0142	0.0131
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,063	286	1	g/hp-hr	0.0647	0.4518	0.6070	0.0018	0.0221	0.0203
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	5,755	290	1	g/hp-hr	0.0647	0.4518	0.6070	0.0018	0.0221	0.0203
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	24,968	80	1	g/hp-hr	0.0792	1.2879	0.8076	0.0018	0.0358	0.0329
5 Ton Flatbed Truck	n/a - onroad	Diesel	5,457	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	83	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	5,080	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	256,985	340	6	g/hp-hr	0.0701	0.4563	0.4719	0.0019	0.0169	0.0156
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	43,944	680	2	g/hp-hr	0.0988	0.6322	0.7900	0.0019	0.0302	0.0278
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	12,112	783	1	g/hp-hr	0.2006	1.9531	2.8770	0.0023	0.0988	0.0909
22" Smooth Drum Manual (Bomag 55)	OFF - ConstMin - Rollers	Diesel	2,021	4	1	g/hp-hr	0.3113	1.6462	2.3694	0.0045	0.0906	0.0834
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	50	120	1	g/hp-hr	0.0530	1.0924	0.4964	0.0018	0.0227	0.0209
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	597	145	1	g/hp-hr	0.0530	1.0924	0.4964	0.0018	0.0227	0.0209
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	157	145	1	g/hp-hr	0.0530	1.0924	0.4964	0.0018	0.0227	0.0209
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	5,391	165	1	g/hp-hr	0.0530	1.0924	0.4964	0.0018	0.0227	0.0209
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	55	190	1	g/hp-hr	0.0805	0.5711	0.8843	0.0018	0.0340	0.0313
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	23,482	315	1	g/hp-hr	0.0531	0.5317	0.5429	0.0018	0.0185	0.0170
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	2,210	180	1	g/hp-hr	0.1157	0.8239	0.3373	0.0047	0.0124	0.0114
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	2,210	210	1	g/hp-hr	0.1157	0.8239	0.3373	0.0047	0.0124	0.0114
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	1,105	150	1	g/hp-hr	0.1217	2.4188	0.4191	0.0047	0.0172	0.0159
Concrete Equipment												
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	5,334	10	1	g/hp-hr	0.3093	1.8191	2.3471	0.0048	0.0917	0.0843
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	15,182	220	1	g/hp-hr	0.0289	0.3075	0.2191	0.0015	0.0083	0.0076
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	917	330	1	g/hp-hr	0.0304	0.2998	0.2877	0.0015	0.0115	0.0106
Grout Pump	OFF - Light Commercial - Pumps	Diesel	8,685	18	1	g/hp-hr	0.4273	2.2253	3.2169	0.0060	0.1349	0.1241
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	9,808	100	1	g/hp-hr	0.0364	1.0249	0.5723	0.0015	0.0360	0.0332
Utility Equipment												
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	34,088	13	1	g/hp-hr	3.0202	183.1939	2.3371	0.0080	0.1926	0.1455
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	200	134	1	g/hp-hr	0.0541	1.0313	0.3302	0.0015	0.0163	0.0150
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	20,262	268	1	g/hp-hr	0.0652	0.3751	0.4345	0.0015	0.0193	0.0177
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	2,843	429	1	g/hp-hr	0.0613	0.3656	0.3609	0.0015	0.0159	0.0146
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	483,274	12	12	g/hp-hr	0.4483	2.8454	3.3971	0.0073	0.1327	0.1221
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	200	18	1	g/hp-hr	4.5023	167.7216	3.3283	0.0090	1.8410	1.3910
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	1,060	35	1	g/hp-hr	0.2645	2.3156	1.8352	0.0035	0.0606	0.0558
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	19,943	61	1	g/hp-hr	0.0697	1.0678	0.9053	0.0015	0.0240	0.0221
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	7,171	130	1	g/hp-hr	0.0340	0.9244	0.3201	0.0015	0.0119	0.0110
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	30,483	266	1	g/hp-hr	0.0420	0.3408	0.3288	0.0015	0.0137	0.0126
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	19,230	19	1	g/hp-hr	0.2617	1.2652	1.9657	0.0035	0.0815	0.0750
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	38,711	22	1	g/hp-hr	0.2617	1.2652	1.9657	0.0035	0.0815	0.0750
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	237	24	1	g/hp-hr	0.2617	1.2652	1.9657	0.0035	0.0815	0.0750
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	111	33	1	g/hp-hr	0.2268	2.0240	1.6832	0.0033	0.0546	0.0502
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	19,299	21	1	g/hp-hr	0.1573	0.9680	1.3007	0.0025	0.0538	0.0495
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	12,675	21	1	g/hp-hr	0.1573	0.9680	1.3007	0.0025	0.0538	0.0495

Table A-102. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Emission Factors - 2025 (g/hp-hr or g/hr)						Emission Factors - 2026 (g/hp-hr or g/hr)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment														
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.2065	1.4576	1.7679	0.0019	0.1146	0.1054	0.1714	1.4131	1.4651	0.0019	0.0870	0.0800
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	0.2065	1.4576	1.7679	0.0019	0.1146	0.1054	0.1714	1.4131	1.4651	0.0019	0.0870	0.0800
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	0.1466	1.1472	1.3861	0.0019	0.0609	0.0560	0.1395	1.0777	1.2739	0.0019	0.0562	0.0517
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.0648	0.4195	0.5400	0.0018	0.0180	0.0165	0.0633	0.4218	0.4838	0.0018	0.0162	0.0149
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	0.0711	0.4564	0.5279	0.0018	0.0198	0.0182	0.0676	0.4468	0.4716	0.0018	0.0176	0.0162
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	0.0731	0.5695	0.4535	0.0018	0.0167	0.0153	0.0710	0.5342	0.4102	0.0018	0.0144	0.0132
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.1188	0.7499	1.2582	0.0021	0.0525	0.0483	0.1138	0.7320	1.1683	0.0021	0.0491	0.0452
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.1255	1.3459	1.2169	0.0020	0.0309	0.0284	0.1221	1.3318	1.2035	0.0020	0.0294	0.0271
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	0.0970	0.4957	0.9993	0.0020	0.0333	0.0306	0.0895	0.4891	0.8660	0.0020	0.0291	0.0268
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.2047	1.6972	1.3630	0.0020	0.0540	0.0497	0.2004	1.6970	1.3383	0.0020	0.0501	0.0461
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0602	0.4498	0.5156	0.0018	0.0195	0.0180	0.0584	0.4494	0.4702	0.0018	0.0184	0.0169
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.0507	0.4198	0.3768	0.0019	0.0125	0.0115	0.0496	0.4198	0.3506	0.0019	0.0119	0.0109
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0602	0.4498	0.5156	0.0018	0.0195	0.0180	0.0584	0.4494	0.4702	0.0018	0.0184	0.0169
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0602	0.4498	0.5156	0.0018	0.0195	0.0180	0.0584	0.4494	0.4702	0.0018	0.0184	0.0169
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0722	1.2830	0.7405	0.0018	0.0285	0.0262	0.0678	1.2828	0.6945	0.0018	0.0234	0.0215
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	0.0678	0.4484	0.4147	0.0019	0.0147	0.0135	0.0672	0.4500	0.3862	0.0019	0.0136	0.0125
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	0.0884	0.6011	0.6377	0.0019	0.0244	0.0225	0.0900	0.6068	0.6338	0.0019	0.0243	0.0224
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	0.2025	1.9562	2.8802	0.0023	0.0990	0.0911	0.2043	1.9592	2.8827	0.0023	0.0992	0.0913
22" Smooth Drum Manual (Bomag 55)	OFF - ConstMin - Rollers	Diesel	0.3114	1.6464	2.3696	0.0045	0.0906	0.0834	0.3114	1.6464	2.3696	0.0045	0.0906	0.0834
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.0475	1.0903	0.4127	0.0018	0.0185	0.0170	0.0453	1.0922	0.3753	0.0018	0.0167	0.0154
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.0475	1.0903	0.4127	0.0018	0.0185	0.0170	0.0453	1.0922	0.3753	0.0018	0.0167	0.0154
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.0475	1.0903	0.4127	0.0018	0.0185	0.0170	0.0453	1.0922	0.3753	0.0018	0.0167	0.0154
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.0475	1.0903	0.4127	0.0018	0.0185	0.0170	0.0453	1.0922	0.3753	0.0018	0.0167	0.0154
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.0782	0.5712	0.8162	0.0018	0.0326	0.0300	0.0766	0.5698	0.7719	0.0018	0.0313	0.0288
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.0536	0.5337	0.5359	0.0018	0.0186	0.0171	0.0552	0.5390	0.5447	0.0018	0.0190	0.0174
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.1128	0.8240	0.2987	0.0047	0.0109	0.0101	0.1100	0.8238	0.2697	0.0047	0.0098	0.0090
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.1128	0.8240	0.2987	0.0047	0.0109	0.0101	0.1100	0.8238	0.2697	0.0047	0.0098	0.0090
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.1174	2.4187	0.3626	0.0047	0.0148	0.0136	0.1136	2.4157	0.3215	0.0047	0.0126	0.0116
Concrete Equipment														
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.3089	1.8178	2.3450	0.0048	0.0914	0.0841	0.3088	1.8183	2.3451	0.0048	0.0912	0.0839
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.0277	0.3108	0.1485	0.0015	0.0062	0.0057	0.0280	0.3142	0.1497	0.0015	0.0062	0.0057
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.0284	0.3030	0.1960	0.0015	0.0086	0.0079	0.0287	0.3063	0.1998	0.0015	0.0088	0.0081
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.4231	2.2180	3.1966	0.0060	0.1319	0.1213	0.4196	2.2123	3.1799	0.0060	0.1293	0.1190
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.0335	1.0360	0.4718	0.0015	0.0307	0.0283	0.0337	1.0473	0.4716	0.0015	0.0307	0.0283
Utility Equipment														
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	2.9963	183.0409	2.3311	0.0080	0.1924	0.1454	2.9767	182.9059	2.3252	0.0080	0.1923	0.1453
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0508	1.0425	0.2634	0.0015	0.0119	0.0109	0.0512	1.0539	0.2586	0.0015	0.0117	0.0107
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0617	0.3792	0.3575	0.0015	0.0164	0.0151	0.0612	0.3833	0.3354	0.0015	0.0157	0.0144
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0569	0.3696	0.2657	0.0015	0.0123	0.0113	0.0569	0.3736	0.2448	0.0015	0.0117	0.0108
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	0.4483	2.8454	3.3971	0.0073	0.1327	0.1221	0.4483	2.8454	3.3971	0.0073	0.1327	0.1221
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	4.5006	167.6948	3.3280	0.0090	1.8408	1.3908	4.4996	167.6712	3.3278	0.0090	1.8406	1.3906
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.2487	2.3028	1.7845	0.0035	0.0521	0.0479	0.2346	2.2887	1.7335	0.0035	0.0439	0.0404
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0702	1.0793	0.9105	0.0015	0.0238	0.0219	0.0710	1.0911	0.9191	0.0015	0.0236	0.0217
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0328	0.9344	0.2764	0.0015	0.0095	0.0087	0.0332	0.9446	0.2747	0.0015	0.0096	0.0088
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0389	0.3445	0.2185	0.0015	0.0103	0.0095	0.0394	0.3483	0.2159	0.0015	0.0103	0.0095
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2590	1.2606	1.9550	0.0035	0.0798	0.0734	0.2568	1.2567	1.9460	0.0035	0.0784	0.0721
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2590	1.2606	1.9550	0.0035	0.0798	0.0734	0.2568	1.2567	1.9460	0.0035	0.0784	0.0721
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2590	1.2606	1.9550	0.0035	0.0798	0.0734	0.2568	1.2567	1.9460	0.0035	0.0784	0.0721
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.2118	2.0106	1.6371	0.0033	0.0470	0.0432	0.1986	1.9975	1.5913	0.0033	0.0397	0.0366
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.1564	0.9663	1.2934	0.0025	0.0530	0.0487	0.1552	0.9624	1.2839	0.0025	0.0521	0.0479
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.1564	0.9663	1.2934	0.0025	0.0530	0.0487	0.1552	0.9624	1.2839	0.0025	0.0521	0.0479

Table A-102. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Emission Factors - 2027 (g/hp-hr or g/hr)						Emission Factors - 2028 (g/hp-hr or g/hr)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment														
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.1601	1.4136	1.3420	0.0019	0.0785	0.0722	0.1320	1.3972	1.0179	0.0019	0.0595	0.0547
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	0.1601	1.4136	1.3420	0.0019	0.0785	0.0722	0.1320	1.3972	1.0179	0.0019	0.0595	0.0547
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	0.1355	1.0501	1.2219	0.0019	0.0536	0.0493	0.1352	1.0529	1.2021	0.0019	0.0529	0.0486
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.0578	0.4155	0.3891	0.0018	0.0133	0.0123	0.0569	0.4165	0.3489	0.0018	0.0120	0.0111
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	0.0679	0.4510	0.4354	0.0018	0.0166	0.0153	0.0675	0.4472	0.4112	0.0018	0.0156	0.0144
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	0.0639	0.4365	0.3410	0.0018	0.0107	0.0098	0.0653	0.4461	0.3041	0.0018	0.0098	0.0090
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.0960	0.5992	0.9385	0.0021	0.0381	0.0350	0.0940	0.6022	0.8791	0.0021	0.0366	0.0336
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.1189	1.3249	1.1908	0.0020	0.0278	0.0255	0.1133	1.3183	1.1786	0.0020	0.0254	0.0234
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	0.0832	0.4823	0.7499	0.0020	0.0256	0.0235	0.0803	0.4800	0.6862	0.0020	0.0235	0.0217
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.1933	1.6910	1.3111	0.0020	0.0451	0.0415	0.1890	1.6971	1.2975	0.0020	0.0419	0.0385
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0574	0.4403	0.4353	0.0018	0.0172	0.0159	0.0545	0.4366	0.3802	0.0018	0.0154	0.0142
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.0482	0.4192	0.3166	0.0019	0.0109	0.0100	0.0474	0.4198	0.2899	0.0019	0.0102	0.0094
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0574	0.4403	0.4353	0.0018	0.0172	0.0159	0.0545	0.4366	0.3802	0.0018	0.0154	0.0142
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0574	0.4403	0.4353	0.0018	0.0172	0.0159	0.0545	0.4366	0.3802	0.0018	0.0154	0.0142
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0653	1.2850	0.6660	0.0018	0.0200	0.0184	0.0637	1.2881	0.6447	0.0018	0.0176	0.0162
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	0.0674	0.4501	0.3685	0.0019	0.0130	0.0120	0.0666	0.4470	0.3397	0.0019	0.0121	0.0111
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	0.0879	0.5723	0.5878	0.0019	0.0221	0.0203	0.0892	0.5759	0.5954	0.0019	0.0224	0.0206
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	0.2060	1.9626	2.8854	0.0023	0.0994	0.0915	0.2075	1.9643	2.8850	0.0023	0.0995	0.0916
22" Smooth Drum Manual (Bomag 55)	OFF - ConstMin - Rollers	Diesel	0.3114	1.6464	2.3696	0.0045	0.0906	0.0834	0.3114	1.6464	2.3696	0.0045	0.0906	0.0834
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.0422	1.0947	0.3285	0.0018	0.0143	0.0131	0.0407	1.0974	0.2978	0.0018	0.0130	0.0119
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.0422	1.0947	0.3285	0.0018	0.0143	0.0131	0.0407	1.0974	0.2978	0.0018	0.0130	0.0119
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.0422	1.0947	0.3285	0.0018	0.0143	0.0131	0.0407	1.0974	0.2978	0.0018	0.0130	0.0119
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.0422	1.0947	0.3285	0.0018	0.0143	0.0131	0.0407	1.0974	0.2978	0.0018	0.0130	0.0119
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.0705	0.5549	0.6593	0.0018	0.0276	0.0254	0.0687	0.5534	0.6279	0.0018	0.0265	0.0244
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.0567	0.5479	0.5641	0.0018	0.0197	0.0181	0.0539	0.5534	0.4854	0.0018	0.0178	0.0164
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.1075	0.8213	0.2486	0.0047	0.0090	0.0083	0.1056	0.8200	0.2329	0.0047	0.0085	0.0078
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.1075	0.8213	0.2486	0.0047	0.0090	0.0083	0.1056	0.8200	0.2329	0.0047	0.0085	0.0078
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.1104	2.4117	0.2897	0.0047	0.0110	0.0101	0.1081	2.4101	0.2655	0.0047	0.0099	0.0091
Concrete Equipment														
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.3089	1.8191	2.3456	0.0048	0.0911	0.0839	0.3088	1.8189	2.3449	0.0048	0.0910	0.0837
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.0265	0.3177	0.0893	0.0015	0.0042	0.0039	0.0268	0.3211	0.0884	0.0016	0.0042	0.0039
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.0260	0.3097	0.1043	0.0015	0.0051	0.0047	0.0262	0.3131	0.0983	0.0016	0.0049	0.0045
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.4168	2.2079	3.1660	0.0060	0.1271	0.1170	0.4146	2.2043	3.1543	0.0060	0.1253	0.1152
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.0321	1.0588	0.3866	0.0015	0.0263	0.0242	0.0317	1.0703	0.3647	0.0016	0.0258	0.0237
Utility Equipment														
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	2.9623	182.8091	2.3214	0.0080	0.1922	0.1452	2.9529	182.7410	2.3192	0.0080	0.1922	0.1452
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0480	1.0654	0.1859	0.0015	0.0077	0.0071	0.0482	1.0770	0.1766	0.0016	0.0071	0.0065
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0567	0.3875	0.2522	0.0015	0.0123	0.0114	0.0572	0.3917	0.2514	0.0016	0.0124	0.0114
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0551	0.3777	0.2081	0.0015	0.0099	0.0091	0.0551	0.3818	0.1998	0.0016	0.0095	0.0088
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	0.4483	2.8454	3.3971	0.0073	0.1327	0.1221	0.4483	2.8455	3.3972	0.0073	0.1327	0.1221
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	4.4997	167.6690	3.3280	0.0090	1.8406	1.3907	4.4995	167.6658	3.3277	0.0090	1.8405	1.3906
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.2214	2.2706	1.6809	0.0035	0.0358	0.0329	0.2103	2.2552	1.6347	0.0035	0.0287	0.0264
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0717	1.1030	0.9279	0.0015	0.0234	0.0215	0.0725	1.1150	0.9312	0.0016	0.0218	0.0200
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0317	0.9549	0.2137	0.0015	0.0070	0.0064	0.0317	0.9653	0.2035	0.0016	0.0065	0.0060
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0388	0.3521	0.1824	0.0015	0.0092	0.0085	0.0393	0.3559	0.1796	0.0016	0.0092	0.0084
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2551	1.2537	1.9383	0.0035	0.0771	0.0709	0.2537	1.2514	1.9320	0.0035	0.0760	0.0699
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2551	1.2537	1.9383	0.0035	0.0771	0.0709	0.2537	1.2514	1.9320	0.0035	0.0760	0.0699
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2551	1.2537	1.9383	0.0035	0.0771	0.0709	0.2537	1.2514	1.9320	0.0035	0.0760	0.0699
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.1864	1.9814	1.5438	0.0033	0.0326	0.0300	0.1760	1.9678	1.5017	0.0033	0.0262	0.0241
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.1546	0.9611	1.2784	0.0025	0.0514	0.0473	0.1539	0.9594	1.2728	0.0025	0.0508	0.0467
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.1546	0.9611	1.2784	0.0025	0.0514	0.0473	0.1539	0.9594	1.2728	0.0025	0.0508	0.0467

Table A-102. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Emission Factors - 2029 (g/hp-hr or g/hr)					
			ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment								
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.1229	1.4048	0.9310	0.0019	0.0508	0.0468
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	0.1229	1.4048	0.9310	0.0019	0.0508	0.0468
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	0.1321	1.0383	1.1293	0.0019	0.0505	0.0465
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.0573	0.4259	0.3278	0.0018	0.0115	0.0106
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	0.0665	0.4385	0.3847	0.0018	0.0146	0.0134
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	0.0648	0.4353	0.2574	0.0018	0.0083	0.0076
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.0899	0.5970	0.7968	0.0021	0.0337	0.0310
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.1118	1.3113	1.1717	0.0020	0.0247	0.0227
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	0.0785	0.4804	0.6380	0.0020	0.0221	0.0203
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.1865	1.7009	1.2855	0.0020	0.0394	0.0362
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0563	0.4467	0.3776	0.0018	0.0157	0.0144
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.0473	0.4208	0.2783	0.0019	0.0100	0.0092
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0563	0.4467	0.3776	0.0018	0.0157	0.0144
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0563	0.4467	0.3776	0.0018	0.0157	0.0144
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0629	1.2903	0.6292	0.0018	0.0160	0.0147
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	0.0656	0.4411	0.3142	0.0019	0.0112	0.0103
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	0.0856	0.5465	0.5498	0.0019	0.0203	0.0187
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	0.1909	1.7487	2.7037	0.0024	0.0896	0.0825
22" Smooth Drum Manual (Bomag 55)	OFF - ConstMin - Rollers	Diesel	0.3114	1.6466	2.3698	0.0045	0.0907	0.0834
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.0402	1.0995	0.2810	0.0018	0.0124	0.0114
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.0402	1.0995	0.2810	0.0018	0.0124	0.0114
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.0402	1.0995	0.2810	0.0018	0.0124	0.0114
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.0402	1.0995	0.2810	0.0018	0.0124	0.0114
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.0687	0.5540	0.6214	0.0018	0.0266	0.0245
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.0546	0.5562	0.4865	0.0018	0.0179	0.0165
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.1046	0.8212	0.2224	0.0047	0.0082	0.0076
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.1046	0.8212	0.2224	0.0047	0.0082	0.0076
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.1062	2.4080	0.2454	0.0047	0.0092	0.0085
Concrete Equipment								
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.3085	1.8173	2.3425	0.0048	0.0909	0.0836
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.0259	0.3246	0.0651	0.0016	0.0036	0.0033
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.0259	0.3165	0.0840	0.0016	0.0045	0.0041
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.4130	2.2020	3.1453	0.0060	0.1238	0.1139
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.0316	1.0820	0.3419	0.0016	0.0250	0.0230
Utility Equipment								
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	2.9467	182.6911	2.3179	0.0080	0.1922	0.1453
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0478	1.0887	0.1571	0.0016	0.0061	0.0056
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0567	0.3960	0.2370	0.0016	0.0118	0.0108
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0554	0.3860	0.1988	0.0016	0.0095	0.0087
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	0.4483	2.8455	3.3971	0.0073	0.1327	0.1221
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	4.4997	167.6648	3.3279	0.0090	1.8405	1.3906
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.2014	2.2430	1.6076	0.0035	0.0240	0.0221
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0733	1.1271	0.9348	0.0016	0.0193	0.0178
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0316	0.9759	0.1983	0.0016	0.0062	0.0057
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0393	0.3598	0.1598	0.0016	0.0087	0.0080
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2527	1.2497	1.9269	0.0035	0.0752	0.0692
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2527	1.2497	1.9269	0.0035	0.0752	0.0692
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2527	1.2497	1.9269	0.0035	0.0752	0.0692
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.1678	1.9573	1.4769	0.0033	0.0219	0.0202
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.1540	0.9616	1.2730	0.0025	0.0505	0.0464
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.1540	0.9616	1.2730	0.0025	0.0505	0.0464

Table A-102. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Emission Factors - 2024 (g/hp-hr or g/hr)					
							ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment												
20 Ton Truck Crane	ConstMin - Cranes	Diesel	50	123	1	g/hp-hr	0.1134	0.9792	1.0919	0.0014	0.0590	0.0543
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	148	170	1	g/hp-hr	0.1134	0.9792	1.0919	0.0014	0.0590	0.0543
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	26,245	178	1	g/hp-hr	0.0847	0.4853	0.9076	0.0014	0.0379	0.0348
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	14,545	308	1	g/hp-hr	0.0606	0.4841	0.6138	0.0014	0.0247	0.0227
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	6,457	123	1	g/hp-hr	0.1134	0.9792	1.0919	0.0014	0.0590	0.0543
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	300	130	1	g/hp-hr	0.1134	0.9792	1.0919	0.0014	0.0590	0.0543
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	1,050	355	1	g/hp-hr	0.0606	0.4841	0.6138	0.0014	0.0247	0.0227
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	375	63	1	g/hp-hr	0.0339	0.9759	0.5060	0.0015	0.0113	0.0104
Drilling & Tunneling Equipment												
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	54,435	221	2	g/hp-hr	0.0582	0.5316	0.5618	0.0024	0.0182	0.0168
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	4,319	221	1	g/hp-hr	0.0582	0.5316	0.5618	0.0024	0.0182	0.0168
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	338	44	1	g/hp-hr	0.3090	2.1982	2.1110	0.0028	0.1112	0.1023
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	19	63	1	g/hp-hr	0.0339	0.9759	0.5060	0.0015	0.0113	0.0104
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,585	98	1	g/hp-hr	0.0792	1.2879	0.8076	0.0018	0.0358	0.0329
Service & Maintenance Equipment												
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	1,287	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	404,389	n/a	10	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	117,268	n/a	3	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
5 Ton Flat Bed Truck	n/a - onroad	Diesel	22,262	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
10 Ton Flat Bed Truck	n/a - onroad	Diesel	3,158	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
1- Ton Mechanic Truck	n/a - onroad	Diesel	3,250	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
2-Ton Mechanic Truck	n/a - onroad	Diesel	116,578	n/a	3	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
Lube Truck	n/a - onroad	Diesel	76,667	n/a	2	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	38,333	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
1000 Gallon Watertruck	n/a - onroad	Diesel	2,091	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
3000 Gallon Watertruck	n/a - onroad	Diesel	26,605	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
5000 Gallon Watertanker	n/a - onroad	Diesel	597	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	74,735	500	2	g/hp-hr	0.0573	0.4621	0.3801	0.0021	0.0130	0.0119
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	3,803	500	1	g/hp-hr	0.0573	0.4621	0.3801	0.0021	0.0130	0.0119
5 Ton Boomtruck	n/a - onroad	Diesel	212	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
10 Ton Boomtruck	n/a - onroad	Diesel	249	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777
20 Ton Boomtruck	n/a - onroad	Diesel	375	n/a	1	g/hr	0.9261	19.0185	0.9953	0.0577	0.7878	0.3777

Notes:
No logging equipment is available in the OFFROAD2017 database for the San Francisco Bay Area Air Basin. Therefore, equipment from the San Joaquin Valley Air Basin was used to estimate emission factors for skidders.
Emission factors are in units of grams per horsepower-hour (g/hp-hr) for offroad construction equipment and grams per hour (g/hr) for on-road motor vehicles (e.g., flatbed trucks).

Table A-102. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Emission Factors - 2025 (g/hp-hr or g/hr)						Emission Factors - 2026 (g/hp-hr or g/hr)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment														
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.1026	0.9687	0.9569	0.0014	0.0520	0.0479	0.0931	0.9591	0.8462	0.0014	0.0456	0.0420
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.1026	0.9687	0.9569	0.0014	0.0520	0.0479	0.0931	0.9591	0.8462	0.0014	0.0456	0.0420
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.0778	0.4427	0.7987	0.0014	0.0339	0.0312	0.0720	0.4274	0.7233	0.0014	0.0301	0.0277
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.0579	0.4791	0.5617	0.0014	0.0228	0.0210	0.0569	0.4717	0.5291	0.0014	0.0217	0.0199
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.1026	0.9687	0.9569	0.0014	0.0520	0.0479	0.0931	0.9591	0.8462	0.0014	0.0456	0.0420
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.1026	0.9687	0.9569	0.0014	0.0520	0.0479	0.0931	0.9591	0.8462	0.0014	0.0456	0.0420
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.0579	0.4791	0.5617	0.0014	0.0228	0.0210	0.0569	0.4717	0.5291	0.0014	0.0217	0.0199
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.0301	0.9692	0.4723	0.0015	0.0086	0.0079	0.0317	0.9746	0.4787	0.0015	0.0094	0.0087
Drilling & Tunneling Equipment														
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	0.0569	0.5303	0.5302	0.0024	0.0174	0.0160	0.0585	0.5332	0.5391	0.0024	0.0177	0.0163
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.0569	0.5303	0.5302	0.0024	0.0174	0.0160	0.0585	0.5332	0.5391	0.0024	0.0177	0.0163
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.2988	2.1614	2.0122	0.0028	0.0977	0.0899	0.3013	2.1946	2.0138	0.0028	0.0957	0.0881
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.0301	0.9692	0.4723	0.0015	0.0086	0.0079	0.0317	0.9746	0.4787	0.0015	0.0094	0.0087
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0722	1.2830	0.7405	0.0018	0.0285	0.0262	0.0678	1.2828	0.6945	0.0018	0.0234	0.0215
Service & Maintenance Equipment														
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
Lube Truck	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
1000 Gallon Watertruck	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
3000 Gallon Watertruck	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
5000 Gallon Watertanker	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	0.0548	0.4576	0.3265	0.0021	0.0112	0.0103	0.0562	0.4603	0.3215	0.0021	0.0111	0.0102
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	0.0548	0.4576	0.3265	0.0021	0.0112	0.0103	0.0562	0.4603	0.3215	0.0021	0.0111	0.0102
5 Ton Boomtruck	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
10 Ton Boomtruck	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579
20 Ton Boomtruck	n/a - onroad	Diesel	0.8777	18.7445	0.9174	0.0558	0.7766	0.3670	0.8346	18.4902	0.8504	0.0542	0.7671	0.3579

Notes:
No logging equipment is available in the OFFROAD2017 database for the San Francisco Bay Area Air Basin. Therefore, equipment from th
Emission factors are in units of grams per horsepower-hour (g/hp-hr) for offroad construction equipment and grams per hour (g/hr) for on-ro

Table A-102. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Emission Factors - 2027 (g/hp-hr or g/hr)						Emission Factors - 2028 (g/hp-hr or g/hr)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment														
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.0867	0.9539	0.7722	0.0014	0.0411	0.0378	0.0843	0.9552	0.7357	0.0014	0.0389	0.0358
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.0867	0.9539	0.7722	0.0014	0.0411	0.0378	0.0843	0.9552	0.7357	0.0014	0.0389	0.0358
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.0673	0.4166	0.6485	0.0014	0.0271	0.0249	0.0651	0.4080	0.6060	0.0014	0.0254	0.0234
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.0561	0.4692	0.5035	0.0014	0.0207	0.0190	0.0540	0.4690	0.4613	0.0014	0.0191	0.0175
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.0867	0.9539	0.7722	0.0014	0.0411	0.0378	0.0843	0.9552	0.7357	0.0014	0.0389	0.0358
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.0867	0.9539	0.7722	0.0014	0.0411	0.0378	0.0843	0.9552	0.7357	0.0014	0.0389	0.0358
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.0561	0.4692	0.5035	0.0014	0.0207	0.0190	0.0540	0.4690	0.4613	0.0014	0.0191	0.0175
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.0328	0.9805	0.4771	0.0015	0.0093	0.0086	0.0337	0.9856	0.4763	0.0015	0.0096	0.0089
Drilling & Tunneling Equipment														
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	0.0576	0.5325	0.5166	0.0024	0.0172	0.0158	0.0564	0.5282	0.5066	0.0024	0.0166	0.0153
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.0576	0.5325	0.5166	0.0024	0.0172	0.0158	0.0564	0.5282	0.5066	0.0024	0.0166	0.0153
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.2963	2.1646	1.9358	0.0028	0.0881	0.0811	0.2719	2.1352	1.8846	0.0028	0.0782	0.0720
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.0328	0.9805	0.4771	0.0015	0.0093	0.0086	0.0337	0.9856	0.4763	0.0015	0.0096	0.0089
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0653	1.2850	0.6660	0.0018	0.0200	0.0184	0.0637	1.2881	0.6447	0.0018	0.0176	0.0162
Service & Maintenance Equipment														
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
Lube Truck	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
1000 Gallon Watertruck	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
3000 Gallon Watertruck	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
5000 Gallon Watertanker	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	0.0554	0.4620	0.2848	0.0021	0.0100	0.0092	0.0536	0.4619	0.2485	0.0021	0.0087	0.0080
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	0.0554	0.4620	0.2848	0.0021	0.0100	0.0092	0.0536	0.4619	0.2485	0.0021	0.0087	0.0080
5 Ton Boomtruck	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
10 Ton Boomtruck	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329
20 Ton Boomtruck	n/a - onroad	Diesel	0.7890	18.2339	0.7784	0.0527	0.7528	0.3443	0.7507	17.9817	0.7171	0.0515	0.7409	0.3329

Notes:
No logging equipment is available in the OFFROAD2017 database for the San Francisco Bay Area Air Basin. Therefore, equipment from th
Emission factors are in units of grams per horsepower-hour (g/hp-hr) for offroad construction equipment and grams per hour (g/hr) for on-ro

Table A-102. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Emission Factors - 2029 (g/hp-hr or g/hr)					
			ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment								
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.0830	0.9601	0.7128	0.0014	0.0371	0.0341
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.0830	0.9601	0.7128	0.0014	0.0371	0.0341
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.0648	0.4066	0.5875	0.0014	0.0247	0.0227
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.0523	0.4626	0.4275	0.0014	0.0179	0.0165
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.0830	0.9601	0.7128	0.0014	0.0371	0.0341
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.0830	0.9601	0.7128	0.0014	0.0371	0.0341
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.0523	0.4626	0.4275	0.0014	0.0179	0.0165
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.0369	0.9883	0.4988	0.0015	0.0123	0.0113
Drilling & Tunneling Equipment								
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	0.0558	0.5296	0.4896	0.0024	0.0161	0.0148
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.0558	0.5296	0.4896	0.0024	0.0161	0.0148
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.2904	2.1703	1.8962	0.0028	0.0817	0.0752
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.0369	0.9883	0.4988	0.0015	0.0123	0.0113
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0629	1.2903	0.6292	0.0018	0.0160	0.0147
Service & Maintenance Equipment								
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
Lube Truck	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
1000 Gallon Watertruck	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
3000 Gallon Watertruck	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
5000 Gallon Watertanker	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	0.0525	0.4609	0.2358	0.0021	0.0082	0.0075
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	0.0525	0.4609	0.2358	0.0021	0.0082	0.0075
5 Ton Boomtruck	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
10 Ton Boomtruck	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254
20 Ton Boomtruck	n/a - onroad	Diesel	0.7153	17.7375	0.6688	0.0503	0.7331	0.3254

Notes:
No logging equipment is available in the OFFROAD2017 database for the San Francisco Bay Area Air Basin. Therefore, equipment from th
Emission factors are in units of grams per horsepower-hour (g/hp-hr) for offroad construction equipment and grams per hour (g/hr) for on-ro

Table A-103. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Maximum Daily Emissions - 2024 (pounds per day)					
							ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment												
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	53	110	1	g/hp-hr	1.12	7.21	9.90	0.01	0.64	0.59
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	71,036	170	2	g/hp-hr	3.47	22.30	30.61	0.03	1.97	1.82
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	110,098	305	3	g/hp-hr	6.52	51.87	63.96	0.08	2.85	2.62
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	1,867	202	1	g/hp-hr	0.62	3.77	5.75	0.02	0.19	0.18
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	59,824	373	2	g/hp-hr	2.61	16.04	21.37	0.06	0.81	0.74
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	9,507	699	1	g/hp-hr	2.20	17.16	14.55	0.05	0.53	0.48
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	914	193	1	g/hp-hr	1.12	6.64	12.37	0.02	0.51	0.47
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	138	36	1	g/hp-hr	0.20	2.14	1.95	0.00	0.05	0.05
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	70,318	200	2	g/hp-hr	1.92	9.10	20.97	0.04	0.70	0.64
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	914	27	1	g/hp-hr	0.26	2.04	1.67	0.00	0.07	0.07
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	11,600	235	1	g/hp-hr	0.67	4.68	6.29	0.02	0.23	0.21
2.0 CY Excavator	ConstMin - Excavators	Diesel	75	235	1	g/hp-hr	0.56	4.39	4.50	0.02	0.15	0.14
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,063	286	1	g/hp-hr	0.82	5.70	7.65	0.02	0.28	0.26
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	5,755	290	1	g/hp-hr	0.83	5.78	7.76	0.02	0.28	0.26
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	24,968	80	1	g/hp-hr	0.28	4.54	2.85	0.01	0.13	0.12
5 Ton Flatbed Truck	n/a - onroad	Diesel	5,457	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	83	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	5,080	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	256,985	340	6	g/hp-hr	6.30	41.04	42.45	0.17	1.52	1.40
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	43,944	680	2	g/hp-hr	5.93	37.91	47.37	0.11	1.81	1.67
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	12,112	783	1	g/hp-hr	6.92	67.43	99.32	0.08	3.41	3.14
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	2,021	4	1	g/hp-hr	0.05	0.25	0.37	0.00	0.01	0.01
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	50	120	1	g/hp-hr	0.28	5.78	2.63	0.01	0.12	0.11
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	597	145	1	g/hp-hr	0.34	6.98	3.17	0.01	0.14	0.13
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	157	145	1	g/hp-hr	0.34	6.98	3.17	0.01	0.14	0.13
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	5,391	165	1	g/hp-hr	0.39	7.95	3.61	0.01	0.16	0.15
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	55	190	1	g/hp-hr	0.67	4.78	7.41	0.02	0.28	0.26
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	23,482	315	1	g/hp-hr	0.74	7.39	7.54	0.03	0.26	0.24
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	2,210	180	1	g/hp-hr	0.92	6.54	2.68	0.04	0.10	0.09
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	2,210	210	1	g/hp-hr	1.07	7.63	3.12	0.04	0.11	0.11
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	1,105	150	1	g/hp-hr	0.80	16.00	2.77	0.03	0.11	0.10
Concrete Equipment												
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	5,334	10	1	g/hp-hr	0.14	0.80	1.03	0.00	0.04	0.04
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	15,182	220	1	g/hp-hr	0.28	2.98	2.13	0.01	0.08	0.07
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	917	330	1	g/hp-hr	0.44	4.36	4.19	0.02	0.17	0.15
Grout Pump	OFF - Light Commercial - Pumps	Diesel	8,685	18	1	g/hp-hr	0.34	1.77	2.55	0.00	0.11	0.10
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	9,808	100	1	g/hp-hr	0.16	4.52	2.52	0.01	0.16	0.15
Utility Equipment												
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	34,088	13	1	g/hp-hr	1.73	105.01	1.34	0.00	0.11	0.08
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	200	134	1	g/hp-hr	0.32	6.09	1.95	0.01	0.10	0.09
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	20,262	268	1	g/hp-hr	0.77	4.43	5.13	0.02	0.23	0.21
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	2,843	429	1	g/hp-hr	1.16	6.92	6.83	0.03	0.30	0.28
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	483,274	12	12	g/hp-hr	2.85	18.07	21.57	0.05	0.84	0.78
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	200	18	1	g/hp-hr	3.57	133.11	2.64	0.01	1.46	1.10
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	1,060	35	1	g/hp-hr	0.41	3.57	2.83	0.01	0.09	0.09
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	19,943	61	1	g/hp-hr	0.19	2.87	2.43	0.00	0.06	0.06
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	7,171	130	1	g/hp-hr	0.19	5.30	1.83	0.01	0.07	0.06
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	30,483	266	1	g/hp-hr	0.49	4.00	3.86	0.02	0.16	0.15
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	19,230	19	1	g/hp-hr	0.22	1.06	1.65	0.00	0.07	0.06
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	38,711	22	1	g/hp-hr	0.25	1.23	1.91	0.00	0.08	0.07
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	237	24	1	g/hp-hr	0.28	1.34	2.08	0.00	0.09	0.08
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	111	33	1	g/hp-hr	0.33	2.94	2.45	0.00	0.08	0.07
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	19,299	21	1	g/hp-hr	0.15	0.90	1.20	0.00	0.05	0.05
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	12,675	21	1	g/hp-hr	0.15	0.90	1.20	0.00	0.05	0.05

Table A-103. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Maximum Daily Emissions - 2025 (pounds per day)						Maximum Daily Emissions - 2026 (pounds per day)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment														
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	1.00	7.07	8.57	0.01	0.56	0.51	0.83	6.85	7.11	0.01	0.42	0.39
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	3.10	21.85	26.50	0.03	1.72	1.58	2.57	21.18	21.96	0.03	1.30	1.20
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	5.91	46.28	55.92	0.08	2.46	2.26	5.63	43.48	51.39	0.08	2.27	2.08
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.58	3.74	4.81	0.02	0.16	0.15	0.56	3.76	4.31	0.02	0.14	0.13
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	2.34	15.01	17.36	0.06	0.65	0.60	2.22	14.70	15.51	0.06	0.58	0.53
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	2.25	17.55	13.98	0.05	0.51	0.47	2.19	16.46	12.64	0.05	0.44	0.41
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	1.01	6.38	10.71	0.02	0.45	0.41	0.97	6.23	9.94	0.02	0.42	0.38
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.20	2.14	1.93	0.00	0.05	0.05	0.19	2.11	1.91	0.00	0.05	0.04
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	1.71	8.74	17.62	0.04	0.59	0.54	1.58	8.63	15.27	0.04	0.51	0.47
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.24	2.02	1.62	0.00	0.06	0.06	0.24	2.02	1.59	0.00	0.06	0.05
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.62	4.66	5.34	0.02	0.20	0.19	0.61	4.66	4.87	0.02	0.19	0.18
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.52	4.35	3.90	0.02	0.13	0.12	0.51	4.35	3.63	0.02	0.12	0.11
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.76	5.67	6.50	0.02	0.25	0.23	0.74	5.67	5.93	0.02	0.23	0.21
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.77	5.75	6.59	0.02	0.25	0.23	0.75	5.75	6.01	0.02	0.23	0.22
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.25	4.53	2.61	0.01	0.10	0.09	0.24	4.52	2.45	0.01	0.08	0.08
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	6.10	40.33	37.30	0.17	1.32	1.22	6.04	40.47	34.74	0.17	1.22	1.13
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	5.30	36.05	38.24	0.11	1.46	1.35	5.40	36.39	38.01	0.11	1.46	1.34
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	6.99	67.53	99.43	0.08	3.42	3.14	7.05	67.64	99.52	0.08	3.43	3.15
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	0.05	0.25	0.37	0.00	0.01	0.01	0.05	0.25	0.37	0.00	0.01	0.01
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.25	5.77	2.18	0.01	0.10	0.09	0.24	5.78	1.99	0.01	0.09	0.08
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.30	6.97	2.64	0.01	0.12	0.11	0.29	6.98	2.40	0.01	0.11	0.10
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.30	6.97	2.64	0.01	0.12	0.11	0.29	6.98	2.40	0.01	0.11	0.10
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.35	7.93	3.00	0.01	0.13	0.12	0.33	7.95	2.73	0.01	0.12	0.11
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.66	4.79	6.84	0.02	0.27	0.25	0.64	4.77	6.47	0.02	0.26	0.24
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.75	7.41	7.44	0.03	0.26	0.24	0.77	7.49	7.57	0.03	0.26	0.24
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.89	6.54	2.37	0.04	0.09	0.08	0.87	6.54	2.14	0.04	0.08	0.07
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	1.04	7.63	2.77	0.04	0.10	0.09	1.02	7.63	2.50	0.04	0.09	0.08
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.78	16.00	2.40	0.03	0.10	0.09	0.75	15.98	2.13	0.03	0.08	0.08
Concrete Equipment														
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.14	0.80	1.03	0.00	0.04	0.04	0.14	0.80	1.03	0.00	0.04	0.04
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.27	3.02	1.44	0.01	0.06	0.06	0.27	3.05	1.45	0.01	0.06	0.06
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.41	4.41	2.85	0.02	0.13	0.12	0.42	4.46	2.91	0.02	0.13	0.12
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.34	1.76	2.54	0.00	0.10	0.10	0.33	1.76	2.52	0.00	0.10	0.09
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.15	4.57	2.08	0.01	0.14	0.12	0.15	4.62	2.08	0.01	0.14	0.12
Utility Equipment														
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	1.72	104.92	1.34	0.00	0.11	0.08	1.71	104.84	1.33	0.00	0.11	0.08
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.30	6.16	1.56	0.01	0.07	0.06	0.30	6.23	1.53	0.01	0.07	0.06
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.73	4.48	4.22	0.02	0.19	0.18	0.72	4.53	3.96	0.02	0.19	0.17
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	1.08	6.99	5.03	0.03	0.23	0.21	1.08	7.07	4.63	0.03	0.22	0.20
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	2.85	18.07	21.57	0.05	0.84	0.78	2.85	18.07	21.57	0.05	0.84	0.78
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	3.57	133.09	2.64	0.01	1.46	1.10	3.57	133.07	2.64	0.01	1.46	1.10
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.38	3.55	2.75	0.01	0.08	0.07	0.36	3.53	2.68	0.01	0.07	0.06
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.19	2.90	2.45	0.00	0.06	0.06	0.19	2.93	2.47	0.00	0.06	0.06
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.19	5.36	1.58	0.01	0.05	0.05	0.19	5.41	1.57	0.01	0.05	0.05
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.46	4.04	2.56	0.02	0.12	0.11	0.46	4.08	2.53	0.02	0.12	0.11
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.22	1.06	1.64	0.00	0.07	0.06	0.22	1.05	1.63	0.00	0.07	0.06
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.25	1.22	1.90	0.00	0.08	0.07	0.25	1.22	1.89	0.00	0.08	0.07
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.27	1.33	2.07	0.00	0.08	0.08	0.27	1.33	2.06	0.00	0.08	0.08
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.31	2.93	2.38	0.00	0.07	0.06	0.29	2.91	2.32	0.00	0.06	0.05
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.14	0.89	1.20	0.00	0.05	0.05	0.14	0.89	1.19	0.00	0.05	0.04
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.14	0.89	1.20	0.00	0.05	0.05	0.14	0.89	1.19	0.00	0.05	0.04

Table A-103. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Maximum Daily Emissions - 2027 (pounds per day)						Maximum Daily Emissions - 2028 (pounds per day)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment														
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.78	6.86	6.51	0.01	0.38	0.35	0.64	6.78	4.94	0.01	0.29	0.27
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	2.40	21.19	20.12	0.03	1.18	1.08	1.98	20.95	15.26	0.03	0.89	0.82
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	5.47	42.37	49.30	0.08	2.16	1.99	5.46	42.48	48.50	0.08	2.13	1.96
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.51	3.70	3.47	0.02	0.12	0.11	0.51	3.71	3.11	0.02	0.11	0.10
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	2.23	14.83	14.32	0.06	0.55	0.50	2.22	14.71	13.53	0.06	0.51	0.47
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	1.97	13.45	10.51	0.05	0.33	0.30	2.01	13.75	9.37	0.05	0.30	0.28
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.82	5.10	7.99	0.02	0.32	0.30	0.80	5.12	7.48	0.02	0.31	0.29
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.19	2.10	1.89	0.00	0.04	0.04	0.18	2.09	1.87	0.00	0.04	0.04
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	1.47	8.51	13.23	0.04	0.45	0.41	1.42	8.47	12.10	0.04	0.42	0.38
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.23	2.01	1.56	0.00	0.05	0.05	0.23	2.02	1.54	0.00	0.05	0.05
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.59	4.56	4.51	0.02	0.18	0.16	0.56	4.52	3.94	0.02	0.16	0.15
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.50	4.34	3.28	0.02	0.11	0.10	0.49	4.35	3.00	0.02	0.11	0.10
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.72	5.55	5.49	0.02	0.22	0.20	0.69	5.51	4.79	0.02	0.19	0.18
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.73	5.63	5.57	0.02	0.22	0.20	0.70	5.58	4.86	0.02	0.20	0.18
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.23	4.53	2.35	0.01	0.07	0.07	0.22	4.54	2.27	0.01	0.06	0.06
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	6.06	40.49	33.15	0.17	1.17	1.08	5.99	40.20	30.55	0.17	1.08	1.00
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	5.27	34.32	35.25	0.11	1.32	1.22	5.35	34.53	35.70	0.11	1.34	1.24
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	7.11	67.76	99.62	0.08	3.43	3.16	7.16	67.81	99.60	0.08	3.44	3.16
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	0.05	0.25	0.37	0.00	0.01	0.01	0.05	0.25	0.37	0.00	0.01	0.01
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.22	5.79	1.74	0.01	0.08	0.07	0.22	5.81	1.58	0.01	0.07	0.06
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.27	7.00	2.10	0.01	0.09	0.08	0.26	7.02	1.90	0.01	0.08	0.08
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.27	7.00	2.10	0.01	0.09	0.08	0.26	7.02	1.90	0.01	0.08	0.08
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.31	7.96	2.39	0.01	0.10	0.10	0.30	7.98	2.17	0.01	0.09	0.09
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.59	4.65	5.52	0.02	0.23	0.21	0.58	4.64	5.26	0.02	0.22	0.20
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.79	7.61	7.83	0.03	0.27	0.25	0.75	7.69	6.74	0.03	0.25	0.23
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.85	6.52	1.97	0.04	0.07	0.07	0.84	6.51	1.85	0.04	0.07	0.06
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	1.00	7.60	2.30	0.04	0.08	0.08	0.98	7.59	2.16	0.04	0.08	0.07
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.73	15.95	1.92	0.03	0.07	0.07	0.71	15.94	1.76	0.03	0.07	0.06
Concrete Equipment														
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.14	0.80	1.03	0.00	0.04	0.04	0.14	0.80	1.03	0.00	0.04	0.04
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.26	3.08	0.87	0.01	0.04	0.04	0.26	3.11	0.86	0.02	0.04	0.04
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.38	4.51	1.52	0.02	0.07	0.07	0.38	4.56	1.43	0.02	0.07	0.07
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.33	1.75	2.51	0.00	0.10	0.09	0.33	1.75	2.50	0.00	0.10	0.09
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.14	4.67	1.70	0.01	0.12	0.11	0.14	4.72	1.61	0.01	0.11	0.10
Utility Equipment														
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	1.70	104.78	1.33	0.00	0.11	0.08	1.69	104.75	1.33	0.00	0.11	0.08
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.28	6.29	1.10	0.01	0.05	0.04	0.28	6.36	1.04	0.01	0.04	0.04
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.67	4.58	2.98	0.02	0.15	0.13	0.68	4.63	2.97	0.02	0.15	0.13
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	1.04	7.14	3.94	0.03	0.19	0.17	1.04	7.22	3.78	0.03	0.18	0.17
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	2.85	18.07	21.57	0.05	0.84	0.78	2.85	18.07	21.57	0.05	0.84	0.78
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	3.57	133.07	2.64	0.01	1.46	1.10	3.57	133.07	2.64	0.01	1.46	1.10
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.34	3.50	2.59	0.01	0.06	0.05	0.32	3.48	2.52	0.01	0.04	0.04
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.19	2.97	2.50	0.00	0.06	0.06	0.20	3.00	2.50	0.00	0.06	0.05
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.18	5.47	1.23	0.01	0.04	0.04	0.18	5.53	1.17	0.01	0.04	0.03
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.46	4.13	2.14	0.02	0.11	0.10	0.46	4.17	2.11	0.02	0.11	0.10
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.21	1.05	1.62	0.00	0.06	0.06	0.21	1.05	1.62	0.00	0.06	0.06
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.25	1.22	1.88	0.00	0.07	0.07	0.25	1.21	1.87	0.00	0.07	0.07
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.27	1.33	2.05	0.00	0.08	0.08	0.27	1.32	2.04	0.00	0.08	0.07
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.27	2.88	2.25	0.00	0.05	0.04	0.26	2.86	2.18	0.00	0.04	0.04
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.14	0.89	1.18	0.00	0.05	0.04	0.14	0.89	1.18	0.00	0.05	0.04
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.14	0.89	1.18	0.00	0.05	0.04	0.14	0.89	1.18	0.00	0.05	0.04

Table A-103. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Maximum Daily Emissions - 2029 (pounds per day)					
			ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment								
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.60	6.81	4.52	0.01	0.25	0.23
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	1.84	21.06	13.96	0.03	0.76	0.70
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	5.33	41.89	45.56	0.08	2.04	1.87
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.51	3.79	2.92	0.02	0.10	0.09
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	2.19	14.42	12.65	0.06	0.48	0.44
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	2.00	13.42	7.93	0.05	0.25	0.23
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.76	5.08	6.78	0.02	0.29	0.26
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.18	2.08	1.86	0.00	0.04	0.04
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	1.38	8.47	11.25	0.04	0.39	0.36
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.22	2.02	1.53	0.00	0.05	0.04
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.58	4.63	3.91	0.02	0.16	0.15
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.49	4.36	2.88	0.02	0.10	0.10
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.71	5.63	4.76	0.02	0.20	0.18
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.72	5.71	4.83	0.02	0.20	0.18
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.22	4.55	2.22	0.01	0.06	0.05
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	5.90	39.68	28.26	0.17	1.01	0.93
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	5.13	32.77	32.97	0.11	1.22	1.12
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	6.59	60.37	93.34	0.08	3.09	2.85
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	0.05	0.25	0.37	0.00	0.01	0.01
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.21	5.82	1.49	0.01	0.07	0.06
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.26	7.03	1.80	0.01	0.08	0.07
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.26	7.03	1.80	0.01	0.08	0.07
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.29	8.00	2.04	0.01	0.09	0.08
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.58	4.64	5.21	0.02	0.22	0.21
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.76	7.72	6.76	0.03	0.25	0.23
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.83	6.52	1.77	0.04	0.07	0.06
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.97	7.60	2.06	0.04	0.08	0.07
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.70	15.93	1.62	0.03	0.06	0.06
Concrete Equipment								
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.14	0.80	1.03	0.00	0.04	0.04
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.25	3.15	0.63	0.02	0.03	0.03
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.38	4.60	1.22	0.02	0.07	0.06
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.33	1.75	2.50	0.00	0.10	0.09
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.14	4.77	1.51	0.01	0.11	0.10
Utility Equipment								
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	1.69	104.72	1.33	0.00	0.11	0.08
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.28	6.43	0.93	0.01	0.04	0.03
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.67	4.68	2.80	0.02	0.14	0.13
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	1.05	7.30	3.76	0.03	0.18	0.16
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	2.85	18.07	21.57	0.05	0.84	0.78
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	3.57	133.07	2.64	0.01	1.46	1.10
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.31	3.46	2.48	0.01	0.04	0.03
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.20	3.03	2.51	0.00	0.05	0.05
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.18	5.59	1.14	0.01	0.04	0.03
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.46	4.22	1.87	0.02	0.10	0.09
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.21	1.05	1.61	0.00	0.06	0.06
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.25	1.21	1.87	0.00	0.07	0.07
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.27	1.32	2.04	0.00	0.08	0.07
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.24	2.85	2.15	0.00	0.03	0.03
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.14	0.89	1.18	0.00	0.05	0.04
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.14	0.89	1.18	0.00	0.05	0.04

Table A-103. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Maximum Daily Emissions - 2024 (pounds per day)					
							ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment												
20 Ton Truck Crane	ConstMin - Cranes	Diesel	50	123	1	g/hp-hr	0.62	5.31	5.92	0.01	0.32	0.29
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	148	170	1	g/hp-hr	0.85	7.34	8.18	0.01	0.44	0.41
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	26,245	178	1	g/hp-hr	0.66	3.81	7.12	0.01	0.30	0.27
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	14,545	308	1	g/hp-hr	0.82	6.57	8.34	0.02	0.34	0.31
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	6,457	123	1	g/hp-hr	0.62	5.31	5.92	0.01	0.32	0.29
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	300	130	1	g/hp-hr	0.65	5.61	6.26	0.01	0.34	0.31
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	1,050	355	1	g/hp-hr	0.95	7.58	9.61	0.02	0.39	0.36
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	375	63	1	g/hp-hr	0.09	2.71	1.41	0.00	0.03	0.03
Drilling & Tunneling Equipment												
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	54,435	221	2	g/hp-hr	1.13	10.36	10.95	0.05	0.36	0.33
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	4,319	221	1	g/hp-hr	0.57	5.18	5.47	0.02	0.18	0.16
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	338	44	1	g/hp-hr	0.60	4.26	4.10	0.01	0.22	0.20
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	19	63	1	g/hp-hr	0.09	2.71	1.41	0.00	0.03	0.03
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,585	98	1	g/hp-hr	0.34	5.56	3.49	0.01	0.15	0.14
Service & Maintenance Equipment												
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	1,287	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	404,389	n/a	10	g/hr	0.41	8.39	0.44	0.03	0.35	0.17
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	117,268	n/a	3	g/hr	0.12	2.52	0.13	0.01	0.10	0.05
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
5 Ton Flat Bed Truck	n/a - onroad	Diesel	22,262	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
10 Ton Flat Bed Truck	n/a - onroad	Diesel	3,158	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
1- Ton Mechanic Truck	n/a - onroad	Diesel	3,250	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
2-Ton Mechanic Truck	n/a - onroad	Diesel	116,578	n/a	3	g/hr	0.12	2.52	0.13	0.01	0.10	0.05
Lube Truck	n/a - onroad	Diesel	76,667	n/a	2	g/hr	0.08	1.68	0.09	0.01	0.07	0.03
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	38,333	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
1000 Gallon Watertruck	n/a - onroad	Diesel	2,091	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
3000 Gallon Watertruck	n/a - onroad	Diesel	26,605	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
5000 Gallon Watertanker	n/a - onroad	Diesel	597	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	74,735	500	2	g/hp-hr	2.52	20.38	16.76	0.09	0.57	0.53
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	3,803	500	1	g/hp-hr	1.26	10.19	8.38	0.05	0.29	0.26
5 Ton Boomtruck	n/a - onroad	Diesel	212	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
10 Ton Boomtruck	n/a - onroad	Diesel	249	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
20 Ton Boomtruck	n/a - onroad	Diesel	375	n/a	1	g/hr	0.04	0.84	0.04	0.00	0.03	0.02
		Total	**2,461,102**	**n/a**	**n/a**	**n/a**	**2,099.53**	**2,847.58**	**2,639.92**	**2,025.58**	**2,051.43**	**2,048.45**

Table A-103. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Maximum Daily Emissions - 2025 (pounds per day)						Maximum Daily Emissions - 2026 (pounds per day)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment														
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.56	5.25	5.19	0.01	0.28	0.26	0.50	5.20	4.59	0.01	0.25	0.23
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.77	7.26	7.17	0.01	0.39	0.36	0.70	7.19	6.34	0.01	0.34	0.31
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.61	3.47	6.27	0.01	0.27	0.24	0.57	3.35	5.68	0.01	0.24	0.22
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.79	6.51	7.63	0.02	0.31	0.28	0.77	6.41	7.19	0.02	0.29	0.27
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.56	5.25	5.19	0.01	0.28	0.26	0.50	5.20	4.59	0.01	0.25	0.23
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.59	5.55	5.48	0.01	0.30	0.27	0.53	5.50	4.85	0.01	0.26	0.24
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.91	7.50	8.79	0.02	0.36	0.33	0.89	7.38	8.28	0.02	0.34	0.31
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.08	2.69	1.31	0.00	0.02	0.02	0.09	2.71	1.33	0.00	0.03	0.02
Drilling & Tunneling Equipment														
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	1.11	10.34	10.33	0.05	0.34	0.31	1.14	10.39	10.51	0.05	0.34	0.32
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.55	5.17	5.17	0.02	0.17	0.16	0.57	5.20	5.25	0.02	0.17	0.16
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.58	4.19	3.90	0.01	0.19	0.17	0.58	4.26	3.91	0.01	0.19	0.17
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.08	2.69	1.31	0.00	0.02	0.02	0.09	2.71	1.33	0.00	0.03	0.02
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.31	5.54	3.20	0.01	0.12	0.11	0.29	5.54	3.00	0.01	0.10	0.09
Service & Maintenance Equipment														
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.39	8.26	0.40	0.02	0.34	0.16	0.37	8.15	0.37	0.02	0.34	0.16
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.12	2.48	0.12	0.01	0.10	0.05	0.11	2.45	0.11	0.01	0.10	0.05
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.12	2.48	0.12	0.01	0.10	0.05	0.11	2.45	0.11	0.01	0.10	0.05
Lube Truck	n/a - onroad	Diesel	0.08	1.65	0.08	0.00	0.07	0.03	0.07	1.63	0.07	0.00	0.07	0.03
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
1000 Gallon Watertruck	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
3000 Gallon Watertruck	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
5000 Gallon Watertanker	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	2.42	20.17	14.39	0.09	0.49	0.45	2.48	20.30	14.17	0.09	0.49	0.45
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	1.21	10.09	7.20	0.05	0.25	0.23	1.24	10.15	7.09	0.05	0.25	0.23
5 Ton Boomtruck	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
10 Ton Boomtruck	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
20 Ton Boomtruck	n/a - onroad	Diesel	0.04	0.83	0.04	0.00	0.03	0.02	0.04	0.82	0.04	0.00	0.03	0.02
		Total	**2,096.57**	**2,837.15**	**2,576.55**	**2,026.57**	**2,049.68**	**2,046.93**	**2,095.81**	**2,833.15**	**2,548.05**	**2,027.57**	**2,049.13**	**2,046.50**

Table A-103. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Maximum Daily Emissions - 2027 (pounds per day)						Maximum Daily Emissions - 2028 (pounds per day)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment														
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.47	5.17	4.19	0.01	0.22	0.21	0.46	5.18	3.99	0.01	0.21	0.19
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.65	7.15	5.79	0.01	0.31	0.28	0.63	7.16	5.51	0.01	0.29	0.27
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.53	3.27	5.09	0.01	0.21	0.20	0.51	3.20	4.76	0.01	0.20	0.18
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.76	6.37	6.84	0.02	0.28	0.26	0.73	6.37	6.27	0.02	0.26	0.24
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.47	5.17	4.19	0.01	0.22	0.21	0.46	5.18	3.99	0.01	0.21	0.19
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.50	5.47	4.43	0.01	0.24	0.22	0.48	5.47	4.22	0.01	0.22	0.21
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.88	7.34	7.88	0.02	0.32	0.30	0.85	7.34	7.22	0.02	0.30	0.27
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.09	2.72	1.33	0.00	0.03	0.02	0.09	2.74	1.32	0.00	0.03	0.02
Drilling & Tunneling Equipment														
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	1.12	10.38	10.07	0.05	0.34	0.31	1.10	10.29	9.87	0.05	0.32	0.30
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.56	5.19	5.03	0.02	0.17	0.15	0.55	5.15	4.94	0.02	0.16	0.15
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.57	4.20	3.76	0.01	0.17	0.16	0.53	4.14	3.66	0.01	0.15	0.14
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.09	2.72	1.33	0.00	0.03	0.02	0.09	2.74	1.32	0.00	0.03	0.02
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.28	5.55	2.88	0.01	0.09	0.08	0.28	5.57	2.79	0.01	0.08	0.07
Service & Maintenance Equipment														
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.35	8.04	0.34	0.02	0.33	0.15	0.33	7.93	0.32	0.02	0.33	0.15
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.10	2.41	0.10	0.01	0.10	0.05	0.10	2.38	0.09	0.01	0.10	0.04
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.10	2.41	0.10	0.01	0.10	0.05	0.10	2.38	0.09	0.01	0.10	0.04
Lube Truck	n/a - onroad	Diesel	0.07	1.61	0.07	0.00	0.07	0.03	0.07	1.59	0.06	0.00	0.07	0.03
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
1000 Gallon Watertruck	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
3000 Gallon Watertruck	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
5000 Gallon Watertanker	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	2.44	20.37	12.56	0.09	0.44	0.41	2.36	20.37	10.96	0.09	0.38	0.35
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	1.22	10.18	6.28	0.05	0.22	0.20	1.18	10.18	5.48	0.05	0.19	0.18
5 Ton Boomtruck	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
10 Ton Boomtruck	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
20 Ton Boomtruck	n/a - onroad	Diesel	0.03	0.80	0.03	0.00	0.03	0.02	0.03	0.79	0.03	0.00	0.03	0.01
		Total	**2,095.01**	**2,826.33**	**2,515.94**	**2,028.57**	**2,048.63**	**2,046.12**	**2,094.76**	**2,827.05**	**2,492.61**	**2,029.57**	**2,048.55**	**2,046.13**

Table A-103. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Maximum Daily Emissions - 2029 (pounds per day)					
			ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment								
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.45	5.21	3.87	0.01	0.20	0.19
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.62	7.20	5.34	0.01	0.28	0.26
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.51	3.19	4.61	0.01	0.19	0.18
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.71	6.28	5.81	0.02	0.24	0.22
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.45	5.21	3.87	0.01	0.20	0.19
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.48	5.50	4.09	0.01	0.21	0.20
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.82	7.24	6.69	0.02	0.28	0.26
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.10	2.75	1.39	0.00	0.03	0.03
Drilling & Tunneling Equipment								
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	1.09	10.32	9.54	0.05	0.31	0.29
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.54	5.16	4.77	0.02	0.16	0.14
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.56	4.21	3.68	0.01	0.16	0.15
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.10	2.75	1.39	0.00	0.03	0.03
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.27	5.58	2.72	0.01	0.07	0.06
Service & Maintenance Equipment								
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.32	7.82	0.29	0.02	0.32	0.14
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.09	2.35	0.09	0.01	0.10	0.04
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.09	2.35	0.09	0.01	0.10	0.04
Lube Truck	n/a - onroad	Diesel	0.06	1.56	0.06	0.00	0.06	0.03
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
1000 Gallon Watertruck	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
3000 Gallon Watertruck	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
5000 Gallon Watertanker	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	2.32	20.32	10.40	0.09	0.36	0.33
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	1.16	10.16	5.20	0.05	0.18	0.17
5 Ton Boomtruck	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
10 Ton Boomtruck	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
20 Ton Boomtruck	n/a - onroad	Diesel	0.03	0.78	0.03	0.00	0.03	0.01
		Total	**2,094.26**	**2,817.82**	**2,468.34**	**2,030.57**	**2,048.39**	**2,046.06**

Table A-104. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Annual Emissions - 2024 (tons per year)					
							ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment												
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	53	110	1	g/hp-hr	0.20	1.32	1.81	0.00	0.12	0.11
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	71,036	170	2	g/hp-hr	0.63	4.07	5.59	0.01	0.36	0.33
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	110,098	305	3	g/hp-hr	1.19	9.47	11.67	0.01	0.52	0.48
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	1,867	202	1	g/hp-hr	0.11	0.69	1.05	0.00	0.03	0.03
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	59,824	373	2	g/hp-hr	0.48	2.93	3.90	0.01	0.15	0.14
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	9,507	699	1	g/hp-hr	0.40	3.13	2.66	0.01	0.10	0.09
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	914	193	1	g/hp-hr	0.20	1.21	2.26	0.00	0.09	0.09
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	138	36	1	g/hp-hr	0.04	0.39	0.36	0.00	0.01	0.01
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	70,318	200	2	g/hp-hr	0.35	1.66	3.83	0.01	0.13	0.12
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	914	27	1	g/hp-hr	0.05	0.37	0.30	0.00	0.01	0.01
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	11,600	235	1	g/hp-hr	0.12	0.85	1.15	0.00	0.04	0.04
2.0 CY Excavator	ConstMin - Excavators	Diesel	75	235	1	g/hp-hr	0.10	0.80	0.82	0.00	0.03	0.02
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,063	286	1	g/hp-hr	0.15	1.04	1.40	0.00	0.05	0.05
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	5,755	290	1	g/hp-hr	0.15	1.05	1.42	0.00	0.05	0.05
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	24,968	80	1	g/hp-hr	0.05	0.83	0.52	0.00	0.02	0.02
5 Ton Flatbed Truck	n/a - onroad	Diesel	5,457	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	83	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	5,080	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	256,985	340	6	g/hp-hr	1.15	7.49	7.75	0.03	0.28	0.26
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	43,944	680	2	g/hp-hr	1.08	6.92	8.65	0.02	0.33	0.30
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	12,112	783	1	g/hp-hr	1.26	12.31	18.13	0.01	0.62	0.57
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	2,021	4	1	g/hp-hr	0.01	0.05	0.07	0.00	0.00	0.00
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	50	120	1	g/hp-hr	0.05	1.05	0.48	0.00	0.02	0.02
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	597	145	1	g/hp-hr	0.06	1.27	0.58	0.00	0.03	0.02
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	157	145	1	g/hp-hr	0.06	1.27	0.58	0.00	0.03	0.02
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	5,391	165	1	g/hp-hr	0.07	1.45	0.66	0.00	0.03	0.03
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	55	190	1	g/hp-hr	0.12	0.87	1.35	0.00	0.05	0.05
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	23,482	315	1	g/hp-hr	0.13	1.35	1.38	0.00	0.05	0.04
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	2,210	180	1	g/hp-hr	0.17	1.19	0.49	0.01	0.02	0.02
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	2,210	210	1	g/hp-hr	0.20	1.39	0.57	0.01	0.02	0.02
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	1,105	150	1	g/hp-hr	0.15	2.92	0.51	0.01	0.02	0.02
Concrete Equipment												
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	5,334	10	1	g/hp-hr	0.02	0.15	0.19	0.00	0.01	0.01
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	15,182	220	1	g/hp-hr	0.05	0.54	0.39	0.00	0.01	0.01
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	917	330	1	g/hp-hr	0.08	0.80	0.76	0.00	0.03	0.03
Grout Pump	OFF - Light Commercial - Pumps	Diesel	8,685	18	1	g/hp-hr	0.06	0.32	0.47	0.00	0.02	0.02
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	9,808	100	1	g/hp-hr	0.03	0.82	0.46	0.00	0.03	0.03
Utility Equipment												
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	34,088	13	1	g/hp-hr	0.32	19.16	0.24	0.00	0.02	0.02
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	200	134	1	g/hp-hr	0.06	1.11	0.36	0.00	0.02	0.02
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	20,262	268	1	g/hp-hr	0.14	0.81	0.94	0.00	0.04	0.04
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	2,843	429	1	g/hp-hr	0.21	1.26	1.25	0.01	0.05	0.05
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	483,274	12	12	g/hp-hr	0.52	3.30	3.94	0.01	0.15	0.14
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	200	18	1	g/hp-hr	0.65	24.29	0.48	0.00	0.27	0.20
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	1,060	35	1	g/hp-hr	0.07	0.65	0.52	0.00	0.02	0.02
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	19,943	61	1	g/hp-hr	0.03	0.52	0.44	0.00	0.01	0.01
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	7,171	130	1	g/hp-hr	0.04	0.97	0.33	0.00	0.01	0.01
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	30,483	266	1	g/hp-hr	0.09	0.73	0.70	0.00	0.03	0.03
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	19,230	19	1	g/hp-hr	0.04	0.19	0.30	0.00	0.01	0.01
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	38,711	22	1	g/hp-hr	0.05	0.22	0.35	0.00	0.01	0.01
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	237	24	1	g/hp-hr	0.05	0.24	0.38	0.00	0.02	0.01
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	111	33	1	g/hp-hr	0.06	0.54	0.45	0.00	0.01	0.01
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	19,299	21	1	g/hp-hr	0.03	0.16	0.22	0.00	0.01	0.01
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	12,675	21	1	g/hp-hr	0.03	0.16	0.22	0.00	0.01	0.01

Table A-104. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Annual Emissions - 2025 (tons per year)						Annual Emissions - 2026 (tons per year)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment														
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.18	1.29	1.56	0.00	0.10	0.09	0.15	1.25	1.30	0.00	0.08	0.07
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	0.56	3.99	4.84	0.01	0.31	0.29	0.47	3.87	4.01	0.01	0.24	0.22
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	1.08	8.45	10.21	0.01	0.45	0.41	1.03	7.93	9.38	0.01	0.41	0.38
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.11	0.68	0.88	0.00	0.03	0.03	0.10	0.69	0.79	0.00	0.03	0.02
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	0.43	2.74	3.17	0.01	0.12	0.11	0.41	2.68	2.83	0.01	0.11	0.10
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	0.41	3.20	2.55	0.01	0.09	0.09	0.40	3.00	2.31	0.01	0.08	0.07
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.18	1.16	1.95	0.00	0.08	0.07	0.18	1.14	1.81	0.00	0.08	0.07
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.04	0.39	0.35	0.00	0.01	0.01	0.04	0.39	0.35	0.00	0.01	0.01
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	0.31	1.60	3.22	0.01	0.11	0.10	0.29	1.57	2.79	0.01	0.09	0.09
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.04	0.37	0.30	0.00	0.01	0.01	0.04	0.37	0.29	0.00	0.01	0.01
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.11	0.85	0.97	0.00	0.04	0.03	0.11	0.85	0.89	0.00	0.03	0.03
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.10	0.79	0.71	0.00	0.02	0.02	0.09	0.79	0.66	0.00	0.02	0.02
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.14	1.04	1.19	0.00	0.04	0.04	0.13	1.03	1.08	0.00	0.04	0.04
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.14	1.05	1.20	0.00	0.05	0.04	0.14	1.05	1.10	0.00	0.04	0.04
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.05	0.83	0.48	0.00	0.02	0.02	0.04	0.83	0.45	0.00	0.02	0.01
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	1.11	7.36	6.81	0.03	0.24	0.22	1.10	7.39	6.34	0.03	0.22	0.21
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	0.97	6.58	6.98	0.02	0.27	0.25	0.99	6.64	6.94	0.02	0.27	0.24
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	1.28	12.33	18.15	0.01	0.62	0.57	1.29	12.34	18.16	0.01	0.63	0.58
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	0.01	0.05	0.07	0.00	0.00	0.00	0.01	0.05	0.07	0.00	0.00	0.00
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.05	1.05	0.40	0.00	0.02	0.02	0.04	1.05	0.36	0.00	0.02	0.01
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.06	1.27	0.48	0.00	0.02	0.02	0.05	1.27	0.44	0.00	0.02	0.02
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.06	1.27	0.48	0.00	0.02	0.02	0.05	1.27	0.44	0.00	0.02	0.02
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.06	1.45	0.55	0.00	0.02	0.02	0.06	1.45	0.50	0.00	0.02	0.02
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.12	0.87	1.25	0.00	0.05	0.05	0.12	0.87	1.18	0.00	0.05	0.04
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.14	1.35	1.36	0.00	0.05	0.04	0.14	1.37	1.38	0.00	0.05	0.04
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.16	1.19	0.43	0.01	0.02	0.01	0.16	1.19	0.39	0.01	0.01	0.01
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.19	1.39	0.50	0.01	0.02	0.02	0.19	1.39	0.46	0.01	0.02	0.02
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.14	2.92	0.44	0.01	0.02	0.02	0.14	2.92	0.39	0.01	0.02	0.01
Concrete Equipment														
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.02	0.15	0.19	0.00	0.01	0.01	0.02	0.15	0.19	0.00	0.01	0.01
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.05	0.55	0.26	0.00	0.01	0.01	0.05	0.56	0.27	0.00	0.01	0.01
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.08	0.80	0.52	0.00	0.02	0.02	0.08	0.81	0.53	0.00	0.02	0.02
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.06	0.32	0.46	0.00	0.02	0.02	0.06	0.32	0.46	0.00	0.02	0.02
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.03	0.83	0.38	0.00	0.02	0.02	0.03	0.84	0.38	0.00	0.02	0.02
Utility Equipment														
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	0.31	19.15	0.24	0.00	0.02	0.02	0.31	19.13	0.24	0.00	0.02	0.02
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.05	1.12	0.28	0.00	0.01	0.01	0.06	1.14	0.28	0.00	0.01	0.01
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.13	0.82	0.77	0.00	0.04	0.03	0.13	0.83	0.72	0.00	0.03	0.03
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.20	1.28	0.92	0.01	0.04	0.04	0.20	1.29	0.85	0.01	0.04	0.04
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	0.52	3.30	3.94	0.01	0.15	0.14	0.52	3.30	3.94	0.01	0.15	0.14
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	0.65	24.29	0.48	0.00	0.27	0.20	0.65	24.29	0.48	0.00	0.27	0.20
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.07	0.65	0.50	0.00	0.01	0.01	0.07	0.64	0.49	0.00	0.01	0.01
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.03	0.53	0.45	0.00	0.01	0.01	0.03	0.54	0.45	0.00	0.01	0.01
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.03	0.98	0.29	0.00	0.01	0.01	0.03	0.99	0.29	0.00	0.01	0.01
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.08	0.74	0.47	0.00	0.02	0.02	0.08	0.75	0.46	0.00	0.02	0.02
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.04	0.19	0.30	0.00	0.01	0.01	0.04	0.19	0.30	0.00	0.01	0.01
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.05	0.22	0.35	0.00	0.01	0.01	0.05	0.22	0.34	0.00	0.01	0.01
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.05	0.24	0.38	0.00	0.02	0.01	0.05	0.24	0.38	0.00	0.02	0.01
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.06	0.53	0.43	0.00	0.01	0.01	0.05	0.53	0.42	0.00	0.01	0.01
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.03	0.16	0.22	0.00	0.01	0.01	0.03	0.16	0.22	0.00	0.01	0.01
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.03	0.16	0.22	0.00	0.01	0.01	0.03	0.16	0.22	0.00	0.01	0.01

Table A-104. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Annual Emissions - 2027 (tons per year)						Annual Emissions - 2028 (tons per year)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment														
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.14	1.25	1.19	0.00	0.07	0.06	0.12	1.24	0.90	0.00	0.05	0.05
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	0.44	3.87	3.67	0.01	0.21	0.20	0.36	3.82	2.78	0.01	0.16	0.15
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	1.00	7.73	9.00	0.01	0.39	0.36	1.00	7.75	8.85	0.01	0.39	0.36
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.09	0.68	0.63	0.00	0.02	0.02	0.09	0.68	0.57	0.00	0.02	0.02
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	0.41	2.71	2.61	0.01	0.10	0.09	0.41	2.68	2.47	0.01	0.09	0.09
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	0.36	2.46	1.92	0.01	0.06	0.06	0.37	2.51	1.71	0.01	0.06	0.05
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.15	0.93	1.46	0.00	0.06	0.05	0.15	0.94	1.37	0.00	0.06	0.05
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.03	0.38	0.34	0.00	0.01	0.01	0.03	0.38	0.34	0.00	0.01	0.01
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	0.27	1.55	2.41	0.01	0.08	0.08	0.26	1.55	2.21	0.01	0.08	0.07
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.04	0.37	0.28	0.00	0.01	0.01	0.04	0.37	0.28	0.00	0.01	0.01
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.11	0.83	0.82	0.00	0.03	0.03	0.10	0.83	0.72	0.00	0.03	0.03
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.09	0.79	0.60	0.00	0.02	0.02	0.09	0.79	0.55	0.00	0.02	0.02
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.13	1.01	1.00	0.00	0.04	0.04	0.13	1.00	0.87	0.00	0.04	0.03
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.13	1.03	1.02	0.00	0.04	0.04	0.13	1.02	0.89	0.00	0.04	0.03
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.04	0.83	0.43	0.00	0.01	0.01	0.04	0.83	0.42	0.00	0.01	0.01
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	1.11	7.39	6.05	0.03	0.21	0.20	1.09	7.34	5.58	0.03	0.20	0.18
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	0.96	6.26	6.43	0.02	0.24	0.22	0.98	6.30	6.52	0.02	0.25	0.23
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	1.30	12.37	18.18	0.01	0.63	0.58	1.31	12.38	18.18	0.01	0.63	0.58
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	0.01	0.05	0.07	0.00	0.00	0.00	0.01	0.05	0.07	0.00	0.00	0.00
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.04	1.06	0.32	0.00	0.01	0.01	0.04	1.06	0.29	0.00	0.01	0.01
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.05	1.28	0.38	0.00	0.02	0.02	0.05	1.28	0.35	0.00	0.02	0.01
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.05	1.28	0.38	0.00	0.02	0.02	0.05	1.28	0.35	0.00	0.02	0.01
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.06	1.45	0.44	0.00	0.02	0.02	0.05	1.46	0.40	0.00	0.02	0.02
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.11	0.85	1.01	0.00	0.04	0.04	0.11	0.85	0.96	0.00	0.04	0.04
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.14	1.39	1.43	0.00	0.05	0.05	0.14	1.40	1.23	0.00	0.05	0.04
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.16	1.19	0.36	0.01	0.01	0.01	0.15	1.19	0.34	0.01	0.01	0.01
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.18	1.39	0.42	0.01	0.02	0.01	0.18	1.39	0.39	0.01	0.01	0.01
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.13	2.91	0.35	0.01	0.01	0.01	0.13	2.91	0.32	0.01	0.01	0.01
Concrete Equipment														
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.02	0.15	0.19	0.00	0.01	0.01	0.02	0.15	0.19	0.00	0.01	0.01
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.05	0.56	0.16	0.00	0.01	0.01	0.05	0.57	0.16	0.00	0.01	0.01
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.07	0.82	0.28	0.00	0.01	0.01	0.07	0.83	0.26	0.00	0.01	0.01
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.06	0.32	0.46	0.00	0.02	0.02	0.06	0.32	0.46	0.00	0.02	0.02
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.03	0.85	0.31	0.00	0.02	0.02	0.03	0.86	0.29	0.00	0.02	0.02
Utility Equipment														
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	0.31	19.12	0.24	0.00	0.02	0.02	0.31	19.12	0.24	0.00	0.02	0.02
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.05	1.15	0.20	0.00	0.01	0.01	0.05	1.16	0.19	0.00	0.01	0.01
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.12	0.84	0.54	0.00	0.03	0.02	0.12	0.84	0.54	0.00	0.03	0.02
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.19	1.30	0.72	0.01	0.03	0.03	0.19	1.32	0.69	0.01	0.03	0.03
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	0.52	3.30	3.94	0.01	0.15	0.14	0.52	3.30	3.94	0.01	0.15	0.14
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	0.65	24.29	0.48	0.00	0.27	0.20	0.65	24.28	0.48	0.00	0.27	0.20
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.06	0.64	0.47	0.00	0.01	0.01	0.06	0.64	0.46	0.00	0.01	0.01
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.04	0.54	0.46	0.00	0.01	0.01	0.04	0.55	0.46	0.00	0.01	0.01
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.03	1.00	0.22	0.00	0.01	0.01	0.03	1.01	0.21	0.00	0.01	0.01
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.08	0.75	0.39	0.00	0.02	0.02	0.08	0.76	0.38	0.00	0.02	0.02
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.04	0.19	0.30	0.00	0.01	0.01	0.04	0.19	0.30	0.00	0.01	0.01
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.05	0.22	0.34	0.00	0.01	0.01	0.04	0.22	0.34	0.00	0.01	0.01
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.05	0.24	0.37	0.00	0.01	0.01	0.05	0.24	0.37	0.00	0.01	0.01
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.05	0.53	0.41	0.00	0.01	0.01	0.05	0.52	0.40	0.00	0.01	0.01
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.03	0.16	0.22	0.00	0.01	0.01	0.03	0.16	0.22	0.00	0.01	0.01
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.03	0.16	0.22	0.00	0.01	0.01	0.03	0.16	0.22	0.00	0.01	0.01

Table A-104. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Annual Emissions - 2029 (tons per year)					
			ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment								
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.11	1.24	0.82	0.00	0.05	0.04
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	0.34	3.84	2.55	0.01	0.14	0.13
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	0.97	7.64	8.31	0.01	0.37	0.34
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.09	0.69	0.53	0.00	0.02	0.02
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	0.40	2.63	2.31	0.01	0.09	0.08
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	0.36	2.45	1.45	0.01	0.05	0.04
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.14	0.93	1.24	0.00	0.05	0.05
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.03	0.38	0.34	0.00	0.01	0.01
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	0.25	1.55	2.05	0.01	0.07	0.07
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.04	0.37	0.28	0.00	0.01	0.01
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.11	0.84	0.71	0.00	0.03	0.03
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.09	0.80	0.53	0.00	0.02	0.02
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.13	1.03	0.87	0.00	0.04	0.03
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.13	1.04	0.88	0.00	0.04	0.03
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.04	0.83	0.41	0.00	0.01	0.01
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	1.08	7.24	5.16	0.03	0.18	0.17
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	0.94	5.98	6.02	0.02	0.22	0.20
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	1.20	11.02	17.04	0.01	0.56	0.52
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	0.01	0.05	0.07	0.00	0.00	0.00
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.04	1.06	0.27	0.00	0.01	0.01
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.05	1.28	0.33	0.00	0.01	0.01
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.05	1.28	0.33	0.00	0.01	0.01
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.05	1.46	0.37	0.00	0.02	0.02
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.11	0.85	0.95	0.00	0.04	0.04
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.14	1.41	1.23	0.00	0.05	0.04
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.15	1.19	0.32	0.01	0.01	0.01
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.18	1.39	0.38	0.01	0.01	0.01
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.13	2.91	0.30	0.01	0.01	0.01
Concrete Equipment								
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.02	0.15	0.19	0.00	0.01	0.01
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.05	0.57	0.12	0.00	0.01	0.01
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.07	0.84	0.22	0.00	0.01	0.01
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.06	0.32	0.46	0.00	0.02	0.02
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.03	0.87	0.28	0.00	0.02	0.02
Utility Equipment								
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	0.31	19.11	0.24	0.00	0.02	0.02
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.05	1.17	0.17	0.00	0.01	0.01
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.12	0.85	0.51	0.00	0.03	0.02
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.19	1.33	0.69	0.01	0.03	0.03
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	0.52	3.30	3.94	0.01	0.15	0.14
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	0.65	24.28	0.48	0.00	0.27	0.20
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.06	0.63	0.45	0.00	0.01	0.01
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.04	0.55	0.46	0.00	0.01	0.01
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.03	1.02	0.21	0.00	0.01	0.01
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.08	0.77	0.34	0.00	0.02	0.02
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.04	0.19	0.29	0.00	0.01	0.01
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.04	0.22	0.34	0.00	0.01	0.01
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.05	0.24	0.37	0.00	0.01	0.01
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.04	0.52	0.39	0.00	0.01	0.01
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.03	0.16	0.22	0.00	0.01	0.01
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.03	0.16	0.22	0.00	0.01	0.01

Table A-104. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Annual Emissions - 2024 (tons per year)					
							ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment												
20 Ton Truck Crane	ConstMin - Cranes	Diesel	50	123	1	g/hp-hr	0.11	0.97	1.08	0.00	0.06	0.05
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	148	170	1	g/hp-hr	0.16	1.34	1.49	0.00	0.08	0.07
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	26,245	178	1	g/hp-hr	0.12	0.70	1.30	0.00	0.05	0.05
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	14,545	308	1	g/hp-hr	0.15	1.20	1.52	0.00	0.06	0.06
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	6,457	123	1	g/hp-hr	0.11	0.97	1.08	0.00	0.06	0.05
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	300	130	1	g/hp-hr	0.12	1.02	1.14	0.00	0.06	0.06
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	1,050	355	1	g/hp-hr	0.17	1.38	1.75	0.00	0.07	0.06
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	375	63	1	g/hp-hr	0.02	0.49	0.26	0.00	0.01	0.01
Drilling & Tunneling Equipment												
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	54,435	221	2	g/hp-hr	0.21	1.89	2.00	0.01	0.06	0.06
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	4,319	221	1	g/hp-hr	0.10	0.95	1.00	0.00	0.03	0.03
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	338	44	1	g/hp-hr	0.11	0.78	0.75	0.00	0.04	0.04
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	19	63	1	g/hp-hr	0.02	0.49	0.26	0.00	0.01	0.01
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,585	98	1	g/hp-hr	0.06	1.02	0.64	0.00	0.03	0.03
Service & Maintenance Equipment												
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	1,287	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	404,389	n/a	10	g/hr	0.07	1.53	0.08	0.00	0.06	0.03
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	117,268	n/a	3	g/hr	0.02	0.46	0.02	0.00	0.02	0.01
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
5 Ton Flat Bed Truck	n/a - onroad	Diesel	22,262	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
10 Ton Flat Bed Truck	n/a - onroad	Diesel	3,158	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
1- Ton Mechanic Truck	n/a - onroad	Diesel	3,250	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
2-Ton Mechanic Truck	n/a - onroad	Diesel	116,578	n/a	3	g/hr	0.02	0.46	0.02	0.00	0.02	0.01
Lube Truck	n/a - onroad	Diesel	76,667	n/a	2	g/hr	0.01	0.31	0.02	0.00	0.01	0.01
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	38,333	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
1000 Gallon Watertruck	n/a - onroad	Diesel	2,091	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
3000 Gallon Watertruck	n/a - onroad	Diesel	26,605	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
5000 Gallon Watertanker	n/a - onroad	Diesel	597	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	74,735	500	2	g/hp-hr	0.46	3.72	3.06	0.02	0.10	0.10
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	3,803	500	1	g/hp-hr	0.23	1.86	1.53	0.01	0.05	0.05
5 Ton Boomtruck	n/a - onroad	Diesel	212	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
10 Ton Boomtruck	n/a - onroad	Diesel	249	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
20 Ton Boomtruck	n/a - onroad	Diesel	375	n/a	1	g/hr	0.01	0.15	0.01	0.00	0.01	0.00
		Total	**2,461,104**	**n/a**	**n/a**	**n/a**	**2,037.78**	**2,174.30**	**2,136.41**	**2,024.29**	**2,029.01**	**2,028.46**

Table A-104. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Annual Emissions - 2025 (tons per year)						Annual Emissions - 2026 (tons per year)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment														
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.10	0.96	0.95	0.00	0.05	0.05	0.09	0.95	0.84	0.00	0.05	0.04
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.14	1.33	1.31	0.00	0.07	0.07	0.13	1.31	1.16	0.00	0.06	0.06
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.11	0.63	1.14	0.00	0.05	0.04	0.10	0.61	1.04	0.00	0.04	0.04
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.14	1.19	1.39	0.00	0.06	0.05	0.14	1.17	1.31	0.00	0.05	0.05
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.10	0.96	0.95	0.00	0.05	0.05	0.09	0.95	0.84	0.00	0.05	0.04
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.11	1.01	1.00	0.00	0.05	0.05	0.10	1.00	0.89	0.00	0.05	0.04
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.17	1.37	1.60	0.00	0.07	0.06	0.16	1.35	1.51	0.00	0.06	0.06
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.02	0.49	0.24	0.00	0.00	0.00	0.02	0.49	0.24	0.00	0.00	0.00
Drilling & Tunneling Equipment														
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	0.20	1.89	1.89	0.01	0.06	0.06	0.21	1.90	1.92	0.01	0.06	0.06
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.10	0.94	0.94	0.00	0.03	0.03	0.10	0.95	0.96	0.00	0.03	0.03
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.11	0.77	0.71	0.00	0.03	0.03	0.11	0.78	0.71	0.00	0.03	0.03
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.02	0.49	0.24	0.00	0.00	0.00	0.02	0.49	0.24	0.00	0.00	0.00
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.06	1.01	0.58	0.00	0.02	0.02	0.05	1.01	0.55	0.00	0.02	0.02
Service & Maintenance Equipment														
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.07	1.51	0.07	0.00	0.06	0.03	0.07	1.49	0.07	0.00	0.06	0.03
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.02	0.45	0.02	0.00	0.02	0.01	0.02	0.45	0.02	0.00	0.02	0.01
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.02	0.45	0.02	0.00	0.02	0.01	0.02	0.45	0.02	0.00	0.02	0.01
Lube Truck	n/a - onroad	Diesel	0.01	0.30	0.01	0.00	0.01	0.01	0.01	0.30	0.01	0.00	0.01	0.01
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
1000 Gallon Watertruck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
3000 Gallon Watertruck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
5000 Gallon Watertanker	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	0.44	3.68	2.63	0.02	0.09	0.08	0.45	3.70	2.59	0.02	0.09	0.08
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	0.22	1.84	1.31	0.01	0.05	0.04	0.23	1.85	1.29	0.01	0.04	0.04
5 Ton Boomtruck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
10 Ton Boomtruck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
20 Ton Boomtruck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.15	0.01	0.00	0.01	0.00
		Total	**2,038.06**	**2,173.22**	**2,125.66**	**2,025.29**	**2,029.50**	**2,029.00**	**2,038.74**	**2,173.30**	**2,121.27**	**2,026.29**	**2,030.22**	**2,029.74**

Table A-104. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Annual Emissions - 2027 (tons per year)						Annual Emissions - 2028 (tons per year)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment														
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.09	0.94	0.76	0.00	0.04	0.04	0.08	0.95	0.73	0.00	0.04	0.04
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.12	1.30	1.06	0.00	0.06	0.05	0.12	1.31	1.01	0.00	0.05	0.05
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.10	0.60	0.93	0.00	0.04	0.04	0.09	0.58	0.87	0.00	0.04	0.03
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.14	1.16	1.25	0.00	0.05	0.05	0.13	1.16	1.14	0.00	0.05	0.04
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.09	0.94	0.76	0.00	0.04	0.04	0.08	0.95	0.73	0.00	0.04	0.04
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.09	1.00	0.81	0.00	0.04	0.04	0.09	1.00	0.77	0.00	0.04	0.04
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.16	1.34	1.44	0.00	0.06	0.05	0.15	1.34	1.32	0.00	0.05	0.05
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.02	0.50	0.24	0.00	0.00	0.00	0.02	0.50	0.24	0.00	0.00	0.00
Drilling & Tunneling Equipment														
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	0.20	1.89	1.84	0.01	0.06	0.06	0.20	1.88	1.80	0.01	0.06	0.05
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.10	0.95	0.92	0.00	0.03	0.03	0.10	0.94	0.90	0.00	0.03	0.03
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.10	0.77	0.69	0.00	0.03	0.03	0.10	0.76	0.67	0.00	0.03	0.03
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.02	0.50	0.24	0.00	0.00	0.00	0.02	0.50	0.24	0.00	0.00	0.00
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.05	1.01	0.53	0.00	0.02	0.01	0.05	1.02	0.51	0.00	0.01	0.01
Service & Maintenance Equipment														
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.06	1.47	0.06	0.00	0.06	0.03	0.06	1.45	0.06	0.00	0.06	0.03
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.02	0.44	0.02	0.00	0.02	0.01	0.02	0.43	0.02	0.00	0.02	0.01
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.02	0.44	0.02	0.00	0.02	0.01	0.02	0.43	0.02	0.00	0.02	0.01
Lube Truck	n/a - onroad	Diesel	0.01	0.29	0.01	0.00	0.01	0.01	0.01	0.29	0.01	0.00	0.01	0.01
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
1000 Gallon Watertruck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
3000 Gallon Watertruck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
5000 Gallon Watertanker	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	0.45	3.72	2.29	0.02	0.08	0.07	0.43	3.72	2.00	0.02	0.07	0.06
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	0.22	1.86	1.15	0.01	0.04	0.04	0.22	1.86	1.00	0.01	0.03	0.03
5 Ton Boomtruck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
10 Ton Boomtruck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
20 Ton Boomtruck	n/a - onroad	Diesel	0.01	0.15	0.01	0.00	0.01	0.00	0.01	0.14	0.01	0.00	0.01	0.00
		Total	**2,039.41**	**2,172.88**	**2,116.23**	**2,027.29**	**2,030.95**	**2,030.49**	**2,040.18**	**2,173.83**	**2,112.79**	**2,028.29**	**2,031.75**	**2,031.31**

Table A-104. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Annual Emissions - 2029 (tons per year)					
			ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment								
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.08	0.95	0.71	0.00	0.04	0.03
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.11	1.31	0.98	0.00	0.05	0.05
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.09	0.58	0.84	0.00	0.04	0.03
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.13	1.15	1.06	0.00	0.04	0.04
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.08	0.95	0.71	0.00	0.04	0.03
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.09	1.00	0.75	0.00	0.04	0.04
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.15	1.32	1.22	0.00	0.05	0.05
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.02	0.50	0.25	0.00	0.01	0.01
Drilling & Tunneling Equipment								
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	0.20	1.88	1.74	0.01	0.06	0.05
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.10	0.94	0.87	0.00	0.03	0.03
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.10	0.77	0.67	0.00	0.03	0.03
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.02	0.50	0.25	0.00	0.01	0.01
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.05	1.02	0.50	0.00	0.01	0.01
Service & Maintenance Equipment								
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.06	1.43	0.05	0.00	0.06	0.03
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.02	0.43	0.02	0.00	0.02	0.01
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.02	0.43	0.02	0.00	0.02	0.01
Lube Truck	n/a - onroad	Diesel	0.01	0.29	0.01	0.00	0.01	0.01
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
1000 Gallon Watertruck	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
3000 Gallon Watertruck	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
5000 Gallon Watertanker	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	0.42	3.71	1.90	0.02	0.07	0.06
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	0.21	1.85	0.95	0.01	0.03	0.03
5 Ton Boomtruck	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
10 Ton Boomtruck	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
20 Ton Boomtruck	n/a - onroad	Diesel	0.01	0.14	0.01	0.00	0.01	0.00
		Total	**2,040.91**	**2,172.96**	**2,109.18**	**2,029.29**	**2,032.54**	**2,032.11**

Pacheco Reservoir Expansion Alternative
Offsite Construction Emissions

Table A-105. Construction Worker Commuting Emissions

Year	Maximum Daily Trips	Annual Trips	Emission Factors, grams per mile						Maximum Daily Emissions, pounds per day						Annual Emissions, tons per year					
			ROG	NOx	CO	SOx	PM10	PM2.5	ROG	NOx	CO	SOx	PM10	PM2.5	ROG	NOx	CO	SOx	PM10	PM2.5
2024	600	159,250	0.0093	0.0475	0.5237	0.0025	0.1469	0.0444	0.49	2.51	27.71	0.13	7.77	2.35	0.07	0.33	3.68	0.02	1.03	0.31
2025	600	191,889	0.0085	0.0435	0.4900	0.0024	0.1469	0.0444	0.45	2.30	25.93	0.13	7.77	2.35	0.07	0.37	4.15	0.02	1.24	0.38
2026	900	291,261	0.0078	0.0402	0.4617	0.0023	0.1468	0.0444	0.62	3.19	36.64	0.19	11.65	3.52	0.10	0.52	5.93	0.03	1.89	0.57
2027	950	309,400	0.0072	0.0372	0.4367	0.0023	0.1468	0.0443	0.60	3.12	36.58	0.19	12.29	3.71	0.10	0.51	5.96	0.03	2.00	0.60
2028	950	309,400	0.0066	0.0346	0.4144	0.0022	0.1466	0.0442	0.56	2.90	34.72	0.18	12.28	3.70	0.09	0.47	5.65	0.03	2.00	0.60
2029	550	142,567	0.0062	0.0323	0.3939	0.0021	0.1465	0.0441	0.30	1.57	19.10	0.10	7.11	2.14	0.04	0.20	2.48	0.01	0.92	0.28
								Maximum	**0.62**	**3.19**	**36.64**	**0.19**	**12.29**	**3.71**	**0.10**	**0.52**	**5.96**	**0.03**	**2.00**	**0.60**

Note: Particulate matter (PM10 and PM2.5) emissions contain exhaust, tire wear, brake wear, and paved road dust.

Table A-106. Unmitigated Haul Trucks Emissions

Year	Maximum Daily Trips	Annual Trips	Emission Factors, grams per mile						Maximum Daily Emissions, pounds per day						Annual Emissions, tons per year					
			ROG	NOx	CO	SOx	PM10	PM2.5	ROG	NOx	CO	SOx	PM10	PM2.5	ROG	NOx	CO	SOx	PM10	PM2.5
2024	245	48,230	0.0654	1.3103	0.3823	0.0147	0.2029	0.0650	1.41	28.31	8.26	0.32	4.38	1.41	0.14	2.79	0.81	0.03	0.43	0.14
2025	430	132,253	0.0658	1.2988	0.3852	0.0146	0.2028	0.0650	2.49	49.25	14.60	0.55	7.69	2.47	0.38	7.57	2.25	0.09	1.18	0.38
2026	430	156,520	0.0661	1.2883	0.3877	0.0146	0.2028	0.0650	2.51	48.85	14.70	0.55	7.69	2.46	0.46	8.89	2.68	0.10	1.40	0.45
2027	430	144,387	0.0664	1.2757	0.3896	0.0145	0.2028	0.0650	2.52	48.37	14.77	0.55	7.69	2.46	0.42	8.12	2.48	0.09	1.29	0.41
2028	30	10,920	0.0666	1.2655	0.3915	0.0145	0.2028	0.0650	0.18	3.35	1.04	0.04	0.54	0.17	0.03	0.61	0.19	0.01	0.10	0.03
2029	30	4,550	0.0669	1.2558	0.3930	0.0145	0.2028	0.0649	0.18	3.32	1.04	0.04	0.54	0.17	0.01	0.25	0.08	0.00	0.04	0.01
								Maximum	**2.52**	**49.25**	**14.77**	**0.55**	**7.69**	**2.47**	**0.46**	**8.89**	**2.68**	**0.10**	**1.40**	**0.45**

Note: Particulate matter (PM10 and PM2.5) emissions contain exhaust, tire wear, brake wear, and paved road dust.

One-way trip distance
Workers 40 miles
Trucks 40 miles

Conversions
453.6 grams per pound
2,000 pounds per ton

Emission Factors
Paved Road Dust Emissions

Equation 1:

$$E = k(sL)^{0.91} \times (W)^{1.02}$$

where: E = particulate emission factor (having units matching the units of k),
k = particle size multiplier for particle size range and units of interest (see below),
sL = road surface silt loading (grams per square meter) (g/m2), and
W = average weight (tons) of the vehicles traveling the road.

Equation 2:

$$E_{ext} = [k(sL)^{0.91} \times (W)^{1.02}](1 - P/4N)$$

where: k, sL, and W are as defined in Equation 1 and
E_{ext} = annual or other long-term average emission factor in the same units as k,
P = number of "wet" days with at least 0.254 mm (0.01 in) of precipitation during the averaging period, and
N = number of days in the averaging period (e.g., 365 for annual, 91 for seasonal, 30 for monthly).

Table A-107. Particle Size Multipliers for Paved Road Equation

Size Range [a]	Ref.	Particle Size Multiplier, k [b]		
		g/VKT	g/VMT	lb/VMT
$PM_{2.5}$	[c]	0.15	0.25	0.00054
PM_{10}		0.62	1.00	0.0022
PM_{15}		0.77	1.23	0.0027
PM_{30}	[d]	3.23	5.24	0.011

Source: USEPA. 2011. Compilation of Air Pollutant Emission Factors (AP-42). Fifth Edition, Volume I. Chapter 13.2.1 Paved Roads. January. Available online at: http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf [Accessed July 17, 2012].

Notes:

[a] Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.

[b] Units shown are grams per vehicle kilometer traveled (g/VKT), grams per vehicle mile traveled (g/VMT), and pounds per vehicle mile traveled (lb/VMT). The multiplier k includes unit conversions to produce emission factors in the units shown for the indicated size range from the mixed units required in Equation 1.

[c] The k-factors for $PM_{2.5}$ were based on the average $PM_{2.5}$:PM_{10} ratio of test runs in Reference 30.

[d] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

Offsite Construction Vehicles

Number precipitation days >0.1 inches
Santa Clara County 58

Road silt loading 0.03 g/m^2 (AP-42, Table 13.2.1-2, ADT > 10,000, ubiquitous baseline)
Average vehicle weight 2.4 tons

Source: CAPCOA. 2017. California Emissions Estimator Model User's Guide, Version 2016.3.2, Appendix D: Default Data Tables. Prepared by BREEZE Software, A Division of Trinity Consultants. October. Available online at: http://www.caleemod.com/ [Accessed on November 9, 2018].

Table A-108. Paved Road Dust Emission Factors - Offsite Construction Vehicles

County	Emission Factor (g/VMT)			
	Uncontrolled		Controlled	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Merced	0.100	0.025	0.096	0.024

Note:
Controlled emission factor only valid for long-term (annual) emissions; uncontrolled emission factor used for daily emissions.

EMFAC2014 Emission Factors
On-Road Motor Vehicles

Table A-109. Emission Factors for Construction Worker Commutes

		grams per mile												
Air Basin	Year	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
San Francisco Bay Area	2024	0.0093	0.0135	0.0475	0.5237	0.0025	0.0017	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0193
	2025	0.0085	0.0123	0.0435	0.4900	0.0024	0.0017	0.0080	0.0368	0.0464	0.0016	0.0020	0.0158	0.0193
	2026	0.0078	0.0113	0.0402	0.4617	0.0023	0.0016	0.0080	0.0368	0.0464	0.0015	0.0020	0.0158	0.0193
	2027	0.0072	0.0104	0.0372	0.4367	0.0023	0.0015	0.0080	0.0368	0.0463	0.0014	0.0020	0.0158	0.0192
	2028	0.0066	0.0097	0.0346	0.4144	0.0022	0.0014	0.0080	0.0368	0.0462	0.0013	0.0020	0.0158	0.0191
	2029	0.0062	0.0090	0.0323	0.3939	0.0021	0.0013	0.0080	0.0368	0.0461	0.0012	0.0020	0.0158	0.0190

Note:
Vehicle fleet mix includes gasoline, diesel, and electric automobiles (LDA) and light-duty trucks (LDT1 and LDT2).

Table A-110. Unmitigated Emission Factors for Haul and Delivery Trucks

		grams per mile												
Air Basin	Year	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
San Francisco Bay Area	2024	0.065	0.074	1.310	0.382	0.015	0.005	0.036	0.062	0.102	0.004	0.009	0.026	0.040
	2025	0.066	0.075	1.299	0.385	0.015	0.005	0.036	0.062	0.102	0.004	0.009	0.026	0.040
	2026	0.066	0.075	1.288	0.388	0.015	0.005	0.036	0.062	0.102	0.004	0.009	0.026	0.040
	2027	0.066	0.076	1.276	0.390	0.015	0.005	0.036	0.062	0.102	0.004	0.009	0.026	0.040
	2028	0.067	0.076	1.266	0.391	0.014	0.005	0.036	0.062	0.102	0.004	0.009	0.026	0.040
	2029	0.067	0.076	1.256	0.393	0.014	0.005	0.036	0.062	0.102	0.004	0.009	0.026	0.040

Table A-111. Unmitigated Emission Factors for On-Site Heavy-Duty Vehicles (San Francisco Bay Area Air Basin)

		grams per mile												
Year	Speed	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
2024	5	0.167	0.190	0.112	3.443	0.004	0.012	0.008	0.037	0.057	0.011	0.002	0.016	0.029
2024	10	0.124	0.141	0.094	2.576	0.004	0.009	0.008	0.037	0.054	0.009	0.002	0.016	0.027
2024	15	0.062	0.070	0.066	1.268	0.004	0.008	0.008	0.037	0.053	0.007	0.002	0.016	0.025
2024	20	0.025	0.028	0.046	0.493	0.004	0.006	0.008	0.037	0.051	0.006	0.002	0.016	0.024
2024	25	0.015	0.017	0.037	0.299	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2024	30	0.012	0.013	0.033	0.227	0.004	0.005	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2024	35	0.010	0.011	0.031	0.182	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2024	40	0.008	0.009	0.029	0.151	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2024	45	0.007	0.008	0.027	0.129	0.004	0.004	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2024	50	0.006	0.007	0.026	0.113	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2024	55	0.006	0.006	0.026	0.102	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2024	60	0.005	0.006	0.024	0.097	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2024	65	0.006	0.007	0.027	0.101	0.004	0.004	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2025	5	0.158	0.180	0.104	3.399	0.004	0.010	0.008	0.037	0.055	0.010	0.002	0.016	0.028
2025	10	0.118	0.134	0.087	2.541	0.004	0.008	0.008	0.037	0.053	0.008	0.002	0.016	0.026
2025	15	0.059	0.067	0.061	1.250	0.004	0.007	0.008	0.037	0.052	0.007	0.002	0.016	0.024
2025	20	0.023	0.027	0.042	0.486	0.004	0.006	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2025	25	0.014	0.016	0.034	0.294	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.022
2025	30	0.011	0.013	0.030	0.223	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2025	35	0.009	0.010	0.028	0.179	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.021
2025	40	0.008	0.009	0.026	0.148	0.004	0.004	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2025	45	0.006	0.007	0.024	0.126	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021

Table A-111. Unmitigated Emission Factors for On-Site Heavy-Duty Vehicles (San Francisco Bay Area Air Basin)

		grams per mile												
Year	Speed	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
2025	50	0.006	0.006	0.023	0.110	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2025	55	0.005	0.006	0.023	0.099	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2025	60	0.005	0.006	0.022	0.094	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2025	65	0.005	0.006	0.024	0.098	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2026	5	0.151	0.172	0.097	3.358	0.004	0.010	0.008	0.037	0.054	0.009	0.002	0.016	0.027
2026	10	0.112	0.128	0.081	2.509	0.004	0.008	0.008	0.037	0.052	0.007	0.002	0.016	0.025
2026	15	0.056	0.063	0.057	1.233	0.004	0.006	0.008	0.037	0.051	0.006	0.002	0.016	0.024
2026	20	0.022	0.025	0.039	0.479	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2026	25	0.014	0.015	0.031	0.290	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2026	30	0.010	0.012	0.027	0.220	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.021
2026	35	0.008	0.010	0.026	0.176	0.004	0.004	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2026	40	0.007	0.008	0.024	0.146	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2026	45	0.006	0.007	0.022	0.124	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2026	50	0.005	0.006	0.021	0.108	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.020
2026	55	0.005	0.006	0.021	0.097	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.020
2026	60	0.005	0.005	0.020	0.092	0.004	0.003	0.008	0.037	0.047	0.003	0.002	0.016	0.020
2026	65	0.005	0.006	0.021	0.095	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2027	5	0.143	0.163	0.090	3.318	0.004	0.008	0.008	0.037	0.052	0.007	0.002	0.016	0.025
2027	10	0.106	0.121	0.075	2.478	0.004	0.006	0.008	0.037	0.051	0.006	0.002	0.016	0.024
2027	15	0.053	0.060	0.052	1.216	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2027	20	0.021	0.024	0.035	0.472	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2027	25	0.013	0.014	0.028	0.285	0.004	0.004	0.008	0.037	0.048	0.004	0.002	0.016	0.021
2027	30	0.010	0.011	0.024	0.216	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2027	35	0.008	0.009	0.022	0.172	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2027	40	0.006	0.007	0.020	0.143	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.020
2027	45	0.006	0.006	0.019	0.122	0.004	0.003	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2027	50	0.005	0.005	0.018	0.106	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2027	55	0.004	0.005	0.017	0.094	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2027	60	0.004	0.005	0.016	0.089	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2027	65	0.004	0.005	0.018	0.091	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2028	5	0.136	0.155	0.084	3.278	0.003	0.006	0.008	0.037	0.051	0.006	0.002	0.016	0.024
2028	10	0.102	0.116	0.070	2.447	0.003	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2028	15	0.050	0.057	0.048	1.199	0.003	0.005	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2028	20	0.020	0.022	0.032	0.465	0.003	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.021
2028	25	0.012	0.014	0.025	0.280	0.003	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2028	30	0.009	0.010	0.021	0.212	0.003	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2028	35	0.007	0.008	0.019	0.169	0.003	0.003	0.008	0.037	0.047	0.003	0.002	0.016	0.020
2028	40	0.006	0.007	0.018	0.140	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2028	45	0.005	0.006	0.016	0.119	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2028	50	0.004	0.005	0.015	0.103	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2028	55	0.004	0.005	0.015	0.092	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2028	60	0.004	0.004	0.014	0.087	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2028	65	0.004	0.004	0.015	0.088	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2029	5	0.130	0.148	0.079	3.238	0.003	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2029	10	0.097	0.111	0.065	2.416	0.003	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.022
2029	15	0.048	0.054	0.045	1.183	0.003	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2029	20	0.019	0.021	0.030	0.459	0.003	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2029	25	0.011	0.013	0.023	0.276	0.003	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2029	30	0.009	0.010	0.020	0.209	0.003	0.003	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2029	35	0.007	0.008	0.017	0.166	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2029	40	0.006	0.006	0.016	0.137	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2029	45	0.005	0.005	0.015	0.117	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2029	50	0.004	0.005	0.014	0.101	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2029	55	0.004	0.004	0.013	0.089	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.019
2029	60	0.003	0.004	0.012	0.084	0.003	0.002	0.008	0.037	0.046	0.002	0.002	0.016	0.019
2029	65	0.004	0.004	0.013	0.085	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.019

Criteria Pollutant Emissions Summary
Off-Road Construction Equipment

Table A-112. Summary of Peak Daily Mitigated Emissions by Alternative

	Daily Emissions (lbs/day)					
Alternative	**VOC**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**
Lower San Felipe Intake Alternative						
Tunnel Option	10.70	25.65	99.89	0.47	1.62	1.33
Pipeline Option	8.94	20.53	90.06	0.45	1.65	1.18

Table A-113. Summary of Annual Mitigated Emissions by Alternative

	Annual Emissions (tons per year)					
Alternative	**VOC**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**
	2020					
Lower San Felipe Intake Alternative						
Tunnel Option	1.64	4.55	16.85	0.08	0.28	0.22
Pipeline Option	1.11	3.17	12.32	0.06	0.21	0.16
	2021					
Lower San Felipe Intake Alternative						
Tunnel Option	1.67	4.36	17.01	0.08	0.27	0.21
Pipeline Option	1.14	3.07	12.46	0.06	0.21	0.15
	2022					
Lower San Felipe Intake Alternative						
Tunnel Option	1.73	5.47	17.17	0.08	0.32	0.25
Pipeline Option	1.17	3.70	12.55	0.06	0.23	0.18
	2023					
Lower San Felipe Intake Alternative						
Tunnel Option	1.79	5.35	17.44	0.08	0.31	0.25
Pipeline Option	-	-	-	-	-	-
	Annual Maximum					
Lower San Felipe Intake Alternative						
Tunnel Option	1.79	5.47	17.44	0.08	0.32	0.25
Pipeline Option	1.17	3.70	12.55	0.06	0.23	0.18

Lower San Felipe Intake Alternative - Tunnel Option

Table A-114. Equipment List

Equipment	Quantity	Mobilization	Site Improvements	Construct Vertical Shaft	Set up TBM	Tunneling and Spreading of Soils	Cofferdam and TBM Out	Connect to Existing Intake	Fabricate Inlet	Set Inlet and Flood Tunnel	Construct Aeration Facility	Fab and Set Air Tubing	Final Work and Testing	Demobilization
Bulldozer	2	X	X											
Concrete Pumpers	2			X				X	X		X			
Cranes	4			X	X		X		X	X	X			
Drill Rig	1			X										
Excavator	1		X	X							X			
Flatbed Trucks (on site)	3	X	X	X	X	X	X	X	X	X	X	X	X	X
Grader	2		X			X					X			X
Loaders	2	X	X								X			
Portable Diesel Generators	7	X	X	X	X	X	X	X	X	X	X	X	X	X
Scraper	1		X			X					X			
Water Truck	2	X	X			X					X			X

Source: Equipment Tables_08012012.docx; EngineeringDataNeeds_July30_2012.xlsx

Table A-115. Peak Daily Mitigated Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day)					
							VOC	NOx	CO	SO2	PM10	PM2.5
Mobilization	Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	2020	0.74	2.33	8.78	0.04	0.08	0.08
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202		0.52	1.72	6.47	0.03	0.06	0.06
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		7.54	11.09	56.01	0.25	0.77	0.71
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	2	20	n/a		0.00	0.00	0.01	0.02	0.16	0.06
Mobilization Subtotal							**8.80**	**15.14**	**71.29**	**0.36**	**1.31**	**1.00**
Site Improvements	Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	2020	0.74	2.33	8.78	0.04	0.08	0.08
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	1	20	158		0.18	0.71	7.67	0.01	0.03	0.02
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	2	20	188		0.47	1.79	6.63	0.03	0.06	0.06
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202		0.52	1.72	6.47	0.03	0.06	0.06
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		7.54	11.09	56.01	0.25	0.77	0.71
	Scraper	ConstMin - Scrapers	1	20	367		0.52	2.07	7.52	0.04	0.07	0.07
	Water Truck	N/A - Onroad engine	2	20	n/a		0.00	0.00	0.01	0.02	0.16	0.06
Site Improvements Subtotal							**9.98**	**19.71**	**93.12**	**0.44**	**1.47**	**1.15**

Table A-115. Peak Daily Mitigated Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day)					
							VOC	NOx	CO	SO2	PM10	PM2.5
Construct Vertical Shaft	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2020	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	20	18		0.65	4.96	3.49	0.01	0.19	0.17
	Cranes	ConstMin - Cranes	4	20	231		0.73	3.08	11.32	0.06	0.11	0.10
	Drill Rig	ConstMin - Bore/Drill Rigs	1	20	221		0.31	1.28	4.73	0.02	0.04	0.04
	Excavator	ConstMin - Excavators	1	20	158		0.18	0.71	7.67	0.01	0.03	0.02
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		7.54	11.09	56.01	0.25	0.77	0.71
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Construct Vertical Shaft Subtotal							**9.42**	**21.12**	**83.24**	**0.37**	**1.37**	**1.14**
Set Up TBM	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	4	20	231		0.79	3.10	11.46	0.06	0.11	0.10
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		7.44	9.35	56.29	0.25	0.70	0.65
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Set Up TBM Subtotal							**8.23**	**12.46**	**67.77**	**0.33**	**1.05**	**0.84**
Tunneling and Spreading of Soils	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	2	20	188		0.50	1.80	6.68	0.03	0.06	0.06
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		7.44	9.35	56.29	0.25	0.70	0.65
	Scraper	ConstMin - Scrapers	1	20	367		0.54	2.08	7.57	0.04	0.07	0.07
	Water Truck	N/A - Onroad engine	2	20	n/a		0.00	0.00	0.01	0.02	0.16	0.06
Tunneling and Spreading of Soils Subtotal							**8.49**	**13.23**	**70.57**	**0.36**	**1.23**	**0.93**
Cofferdam and TBM Out	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	4	20	231		0.84	3.12	11.59	0.06	0.11	0.10
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		8.15	17.56	58.49	0.25	1.04	0.96
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Cofferdam and TBM Out Subtotal							**8.99**	**20.69**	**70.10**	**0.33**	**1.39**	**1.15**

Table A-115. Peak Daily Mitigated Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day)					
							VOC	NOx	CO	SO2	PM10	PM2.5
Connect to Existing Intake	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	20	18		0.65	4.96	3.49	0.01	0.19	0.17
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		8.15	17.56	58.49	0.25	1.04	0.96
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Connect to Existing Intake Subtotal							**8.80**	**22.53**	**62.00**	**0.29**	**1.47**	**1.22**
Fabricate Inlet	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	20	18		0.65	4.96	3.49	0.01	0.19	0.17
	Cranes	ConstMin - Cranes	4	20	231		0.84	3.12	11.59	0.06	0.11	0.10
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		8.15	17.56	58.49	0.25	1.04	0.96
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Fabricate Inlet Subtotal							**9.64**	**25.65**	**73.59**	**0.34**	**1.58**	**1.33**
Set Inlet and Flood Tunnel	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	4	20	231		0.84	3.12	11.59	0.06	0.11	0.10
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		8.15	17.56	58.49	0.25	1.04	0.96
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Set Inlet and Flood Tunnel Subtotal							**8.99**	**20.69**	**70.10**	**0.33**	**1.39**	**1.15**
Construct Aeration Facility	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	20	18		0.65	4.96	3.49	0.01	0.19	0.17
	Cranes	ConstMin - Cranes	4	20	231		0.79	3.10	11.46	0.06	0.11	0.10
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	1	20	158		0.19	0.71	7.75	0.01	0.03	0.02
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	2	20	188		0.50	1.80	6.68	0.03	0.06	0.06
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202		0.58	1.74	6.61	0.03	0.06	0.06
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		7.44	9.35	56.29	0.25	0.70	0.65
	Scraper	ConstMin - Scrapers	1	20	367		0.54	2.08	7.57	0.04	0.07	0.07
	Water Truck	N/A - Onroad engine	2	20	n/a		0.00	0.00	0.01	0.02	0.16	0.06
Construct Aeration Facility Subtotal							**10.70**	**23.75**	**99.89**	**0.47**	**1.62**	**1.29**

Table A-115. Peak Daily Mitigated Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day)					
							VOC	NOx	CO	SO2	PM10	PM2.5
Fab and Set Air Tubing	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		7.44	9.35	56.29	0.25	0.70	0.65
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Fab and Set Air Tubing Subtotal							**7.44**	**9.36**	**56.31**	**0.27**	**0.94**	**0.74**
Final Work and Testing	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		8.15	17.56	58.49	0.25	1.04	0.96
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Final Work and Testing Subtotal							**8.15**	**17.57**	**58.51**	**0.28**	**1.28**	**1.05**
Demobilization	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	2	20	188		0.53	1.82	6.80	0.03	0.07	0.06
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559		8.15	17.56	58.49	0.25	1.04	0.96
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	2	20	n/a		0.00	0.00	0.01	0.01	0.16	0.06
Demobilization Subtotal							**8.68**	**19.39**	**65.32**	**0.32**	**1.50**	**1.17**

Peak Day Analysis (Overlapping Phases)						
Mobilization + Site Improvements	9.98	19.71	93.12	0.44	1.47	1.15
Tunneling and Spreading of Soils + Construct Aeration Facility	10.70	23.75	99.89	0.47	1.62	1.29
Tunneling and Spreading of Soils + Construct Aeration Facility + Fab and Set Air Tubing	10.70	23.75	99.89	0.47	1.62	1.29
Cofferdam and TBM Out + Connect to Existing Intake + Fabricate Inlet	9.64	25.65	73.59	0.34	1.58	1.33
Maximum Daily Emissions (lbs/day)	**10.70**	**25.65**	**99.89**	**0.47**	**1.62**	**1.33**

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of grams per hour (g/hr). Emission factors from EMFAC2014 for diesel-fueled medium-duty vehicles in San Joaquin Valley Air Basin.
Peak daily emissions based on construction start year because that would represent worst-case (highest) emissions. Emissions typically decrease in future years with improvements in engine technology and as older vehicles are rotated out of service.

Onroad Vehicle Speed

40 mph

Air Basin
San Joaquin Valley

Conversions

453.6 grams per pound

Lower San Felipe Intake Alternative - Pipeline Option

Table A-116. Annual Mitigated Emissions from Construction Equipment

Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Annual Emissions - 2020 (tons per year)					
					VOC	NOx	CO	SO2	PM10	PM2.5
Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	0.13	0.42	1.58	0.01	0.02	0.01
Concrete Pumpers	OFF - Light Commercial - Pumps	2	20	18	0.12	0.89	0.63	0.00	0.03	0.03
Cranes	ConstMin - Cranes	4	20	231	0.13	0.55	2.04	0.01	0.02	0.02
Drill Rig	ConstMin - Bore/Drill Rigs	1	20	221	0.06	0.23	0.85	0.00	0.01	0.01
Excavator	ConstMin - Excavators	1	20	158	0.03	0.13	1.38	0.00	0.00	0.00
Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a	0.00	0.00	0.00	0.00	0.04	0.02
Grader	ConstMin - Graders	2	20	188	0.09	0.32	1.19	0.01	0.01	0.01
Loaders	ConstMin - Rubber Tired Loaders	2	20	202	0.09	0.31	1.16	0.01	0.01	0.01
Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	369	0.90	1.32	6.66	0.03	0.09	0.08
Scraper	ConstMin - Scrapers	1	20	367	0.09	0.37	1.35	0.01	0.01	0.01
Water Truck	N/A - Onroad engine	2	20	n/a	0.00	0.00	0.00	0.00	0.03	0.01
				Grand Total (tons per year)	**1.64**	**4.55**	**16.85**	**0.08**	**0.28**	**0.22**

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of grams per hour (g/hr). Emission factors from EMFAC2014 for diesel-fueled medium-duty vehicles in San Joaquin Valley Air Basin.
Calculations assume that equipment quantity is the total pieces of equipment that could operate at a given time, regardless of the phase.

Onroad Vehicle Speed

40 mph

Air Basin
San Joaquin Valley

Conversions

453.6 grams per pound
2,000 pounds per ton
7 days per week
30 days per month

Lower San Felipe Intake Alternative - Pipeline Option

Table A-116. Annual Mitigated Emissions from Construction Equipment

Equipment	OFFROAD Description	Annual Emissions - 2021 (tons per year)						Annual Emissions - 2022 (tons per year)					
		VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5
Bulldozer	ConstMin - Rubber Tired Dozers	0.15	0.43	1.62	0.01	0.02	0.01	0.13	0.42	1.59	0.01	0.02	0.01
Concrete Pumpers	OFF - Light Commercial - Pumps	0.12	0.89	0.63	0.00	0.03	0.03	0.12	0.89	0.63	0.00	0.03	0.03
Cranes	ConstMin - Cranes	0.14	0.56	2.06	0.01	0.02	0.02	0.14	0.56	2.07	0.01	0.02	0.02
Drill Rig	ConstMin - Bore/Drill Rigs	0.06	0.23	0.85	0.00	0.01	0.01	0.06	0.23	0.85	0.00	0.01	0.01
Excavator	ConstMin - Excavators	0.04	0.13	1.39	0.00	0.00	0.00	0.04	0.13	1.40	0.00	0.00	0.00
Flatbed Trucks (on site)	N/A - Onroad engine	0.00	0.00	0.00	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.04	0.02
Grader	ConstMin - Graders	0.09	0.32	1.20	0.01	0.01	0.01	0.09	0.33	1.21	0.01	0.01	0.01
Loaders	ConstMin - Rubber Tired Loaders	0.10	0.31	1.19	0.01	0.01	0.01	0.10	0.31	1.19	0.01	0.01	0.01
Portable Diesel Generators	Portable Equipment - Non-Rental Generator	0.88	1.11	6.69	0.03	0.08	0.08	0.95	2.22	6.86	0.03	0.13	0.12
Scraper	ConstMin - Scrapers	0.10	0.37	1.36	0.01	0.01	0.01	0.10	0.37	1.37	0.01	0.01	0.01
Water Truck	N/A - Onroad engine	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.03	0.01
		1.67	**4.36**	**17.01**	**0.08**	**0.27**	**0.21**	**1.73**	**5.47**	**17.17**	**0.08**	**0.32**	**0.25**

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of grams
Calculations assume that equipment quantity is the total pieces of equipment that could operate at a giv

Onroad Vehicle Speed

40 mph

Air Basin
San Joaquin Valley

Conversions

453.6 grams per pound
2,000 pounds per ton
7 days per week
30 days per month

Lower San Felipe Intake Alternative - Pipeline Option

Table A-116. Annual Mitigated Emissions from Construction Equipment

Equipment	OFFROAD Description	Annual Emissions - 2023 (tons per year)					
		VOC	NOx	CO	SO2	PM10	PM2.5
Bulldozer	ConstMin - Rubber Tired Dozers	0.15	0.43	1.71	0.01	0.02	0.01
Concrete Pumpers	OFF - Light Commercial - Pumps	0.12	0.89	0.63	0.00	0.03	0.03
Cranes	ConstMin - Cranes	0.15	0.56	2.09	0.01	0.02	0.02
Drill Rig	ConstMin - Bore/Drill Rigs	0.06	0.23	0.85	0.00	0.01	0.01
Excavator	ConstMin - Excavators	0.04	0.13	1.41	0.00	0.00	0.00
Flatbed Trucks (on site)	N/A - Onroad engine	0.00	0.00	0.00	0.00	0.04	0.02
Grader	ConstMin - Graders	0.10	0.33	1.22	0.01	0.01	0.01
Loaders	ConstMin - Rubber Tired Loaders	0.11	0.32	1.20	0.01	0.01	0.01
Portable Diesel Generators	Portable Equipment - Non-Rental Generator	0.97	2.09	6.95	0.03	0.12	0.11
Scraper	ConstMin - Scrapers	0.10	0.38	1.38	0.01	0.01	0.01
Water Truck	N/A - Onroad engine	0.00	0.00	0.00	0.00	0.03	0.01
		1.79	**5.35**	**17.44**	**0.08**	**0.31**	**0.25**

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of grams
Calculations assume that equipment quantity is the total pieces of equipment that could operate at a giv

Onroad Vehicle Speed

40 mph

Air Basin
San Joaquin Valley

Conversions

453.6 grams per pound
2,000 pounds per ton
7 days per week
30 days per month

Lower San Felipe Intake Alternative - Pipeline Option

Table A-117. Equipment List

Equipment	Quantity	Mobilization	Site Improvements	Fabricate Inlet	Build Cofferdam and Set Lower Inlet	Lay Pipe	Connect to Existing Intake	Construct Aeration Facility	Fab and Set Air Tubing	Final Work and Testing	Demobilization
Bulldozer	2	X	X								
Concrete Pumpers	1		X					X			
Cranes	3			X	X	X	X	X			
Excavator	1		X					X			
Flatbed Trucks (on site)	3	X	X	X	X	X	X	X	X	X	X
Grader	2	X	X					X			X
Loaders	2	X	X					X			
Portable Diesel Generators	4	X	X	X	X	X	X	X	X	X	X
Scraper	1		X					X			
Water Truck	2	X	X					X			X

Source: Equipment Tables_08012012.docx; EngineeringDataNeeds_July30_2012.xlsx

Table A-118. Peak Daily Mitigated Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day)					
							VOC	NOx	CO	SO2	PM10	PM2.5
Mobilization	Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	2020	0.74	2.33	8.78	0.04	0.08	0.08
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	2	20	188		0.47	1.79	6.63	0.03	0.06	0.06
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202		0.52	1.72	6.47	0.03	0.06	0.06
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		2.85	4.18	21.13	0.09	0.29	0.27
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	2	20	n/a		0.00	0.00	0.01	0.02	0.16	0.06
						Mobilization Subtotal	**4.58**	**10.03**	**43.04**	**0.24**	**0.90**	**0.62**
Site Improvements	Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	2020	0.74	2.33	8.78	0.04	0.08	0.08
	Concrete Pumpers	OFF - Light Commercial - Pumps	1	20	18		0.33	2.48	1.75	0.00	0.10	0.09
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	1	20	158		0.18	0.71	7.67	0.01	0.03	0.02
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	2	20	188		0.47	1.79	6.63	0.03	0.06	0.06
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202		0.52	1.72	6.47	0.03	0.06	0.06
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		2.85	4.18	21.13	0.09	0.29	0.27
	Scraper	ConstMin - Scrapers	1	20	367		0.52	2.07	7.52	0.04	0.07	0.07
	Water Truck	N/A - Onroad engine	2	20	n/a		0.00	0.00	0.01	0.02	0.16	0.06
						Site Improvements Subtotal	**5.61**	**15.29**	**59.98**	**0.29**	**1.09**	**0.80**
Fabricate Inlet	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2020	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	3	20	231		0.54	2.31	8.49	0.04	0.08	0.07
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		2.85	4.18	21.13	0.09	0.29	0.27
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
						Fabricate Inlet Subtotal	**3.39**	**6.50**	**29.63**	**0.16**	**0.61**	**0.44**

Table A-118. Peak Daily Mitigated Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day)					
							VOC	NOx	CO	SO2	PM10	PM2.5
Build Cofferdam and Set Lower Inlet	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2020	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	3	20	231		0.54	2.31	8.49	0.04	0.08	0.07
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		2.85	4.18	21.13	0.09	0.29	0.27
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Build Cofferdam and Set Lower Inlet Subtotal							**3.39**	**6.50**	**29.63**	**0.16**	**0.61**	**0.44**
Lay Pipe	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	3	20	231		0.59	2.33	8.60	0.04	0.08	0.07
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		2.81	3.53	21.23	0.09	0.26	0.24
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Lay Pipe Subtotal							**3.40**	**5.86**	**29.85**	**0.16**	**0.58**	**0.41**
Connect to Existing Intake	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2022	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	3	20	231		0.60	2.33	8.62	0.04	0.08	0.08
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		3.01	7.05	21.78	0.09	0.41	0.37
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Connect to Existing Intake Subtotal							**3.62**	**9.38**	**30.42**	**0.16**	**0.73**	**0.54**
Construct Aeration Facility	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	1	20	18		0.33	2.48	1.75	0.00	0.10	0.09
	Cranes	ConstMin - Cranes	3	20	231		0.59	2.33	8.60	0.04	0.08	0.07
	Excavator	ConstMin - Excavators	1	20	158		0.19	0.71	7.75	0.01	0.03	0.02
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	2	20	188		0.50	1.80	6.68	0.03	0.06	0.06
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202		0.58	1.74	6.61	0.03	0.06	0.06
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		2.81	3.53	21.23	0.09	0.26	0.24
	Scraper	ConstMin - Scrapers	1	20	367		0.54	2.08	7.57	0.04	0.07	0.07
	Water Truck	N/A - Onroad engine	2	20	n/a		0.00	0.00	0.01	0.02	0.16	0.06
Construct Aeration Facility Subtotal							**5.54**	**14.67**	**60.22**	**0.29**	**1.06**	**0.77**
Fab and Set Air Tubing	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		2.81	3.53	21.23	0.09	0.26	0.24
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Fab and Set Air Tubing Subtotal							**2.81**	**3.53**	**21.25**	**0.12**	**0.50**	**0.34**

Table A-118. Peak Daily Mitigated Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Peak Daily Emissions (lbs/day)					
							VOC	NOx	CO	SO2	PM10	PM2.5
Final Work and Testing	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2022	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	-	20	188		-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		3.01	7.05	21.78	0.09	0.41	0.37
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a		-	-	-	-	-	-
Final Work and Testing Subtotal							**3.01**	**7.05**	**21.80**	**0.12**	**0.64**	**0.47**
Demobilization	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2022	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18		-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231		-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158		-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a		0.00	0.00	0.02	0.02	0.24	0.09
	Grader	ConstMin - Graders	2	20	188		0.51	1.81	6.73	0.03	0.06	0.06
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202		-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369		3.01	7.05	21.78	0.09	0.41	0.37
	Scraper	ConstMin - Scrapers	-	20	367		-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	2	20	n/a		0.00	0.00	0.01	0.01	0.16	0.06
Demobilization Subtotal							**3.53**	**8.86**	**28.54**	**0.16**	**0.87**	**0.59**

Peak Day Analysis (Overlapping Phases)						
Mobilization + Site Improvements	5.61	15.29	59.98	0.29	1.09	0.80
Site Improvements + Fabricate Inlet	6.15	17.60	68.47	0.34	1.17	0.87
Fabricate Inlet + Build Cofferdam and Set Lower Inlet	3.39	6.50	29.63	0.16	0.61	0.44
Lay Pipe + Construct Aeration Facility	8.94	20.53	90.06	0.45	1.65	1.18
Lay Pipe + Construct Aeration Facility + Fab and Set Air Tubing	8.94	20.53	90.06	0.45	1.65	1.18
Maximum Daily Emissions (lbs/day)	**8.94**	**20.53**	**90.06**	**0.45**	**1.65**	**1.18**

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of grams per hour (g/hr). Emission factors from EMFAC2014 for diesel-fueled medium-duty vehicles in San Joaquin Valley Air Basin.
Peak daily emissions based on construction start year because that would represent worst-case (highest) emissions. Emissions typically decrease in future years with improvements in engine technology and as older vehicles are rotated out of service.

Onroad Vehicle Speed
40 mph

Air Basin
San Joaquin Valley

Conversions
453.6 grams per pound

Lower San Felipe Intake Alternative - Tunnel Option

Table A-119. Annual Mitigated Emissions from Construction Equipment

Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Annual Emissions - 2020 (tons per year)					
					VOC	NOx	CO	SO2	PM10	PM2.5
Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	0.13	0.42	1.58	0.01	0.02	0.01
Concrete Pumpers	OFF - Light Commercial - Pumps	1	20	18	0.06	0.45	0.31	0.00	0.02	0.02
Cranes	ConstMin - Cranes	3	20	231	0.10	0.42	1.53	0.01	0.01	0.01
Excavator	ConstMin - Excavators	1	20	158	0.03	0.13	1.38	0.00	0.00	0.00
Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a	0.00	0.00	0.00	0.00	0.04	0.02
Grader	ConstMin - Graders	2	20	188	0.09	0.32	1.19	0.01	0.01	0.01
Loaders	ConstMin - Rubber Tired Loaders	2	20	202	0.09	0.31	1.16	0.01	0.01	0.01
Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	369	0.51	0.75	3.80	0.02	0.05	0.05
Scraper	ConstMin - Scrapers	1	20	367	0.09	0.37	1.35	0.01	0.01	0.01
Water Truck	N/A - Onroad engine	2	20	n/a	0.00	0.00	0.00	0.00	0.03	0.01
Grand Total (tons per year)					**1.11**	**3.17**	**12.32**	**0.06**	**0.21**	**0.16**

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of grams per hour (g/hr). Emission factors from EMFAC2014 for diesel-fueled medium-duty vehicles in San Joaquin Valley Air Basin.
Calculations assume that equipment quantity is the total pieces of equipment that could operate at a given time, regardless of the phase.

Onroad Vehicle Speed

40 mph

Air Basin
San Joaquin Valley

Conversions

453.6	grams per pound
2,000	pounds per ton
7	days per week
30	days per month

Lower San Felipe Intake Alternative - Tunnel Option

Table A-119. Annual Mitigated Emissions from Construction Equipment

Equipment	OFFROAD Description	Annual Emissions - 2021 (tons per year)						Annual Emissions - 2022 (tons per year)					
		VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5
Bulldozer	ConstMin - Rubber Tired Dozers	0.15	0.43	1.62	0.01	0.02	0.01	0.13	0.42	1.59	0.01	0.02	0.01
Concrete Pumpers	OFF - Light Commercial - Pumps	0.06	0.45	0.31	0.00	0.02	0.02	0.06	0.45	0.31	0.00	0.02	0.02
Cranes	ConstMin - Cranes	0.11	0.42	1.55	0.01	0.01	0.01	0.11	0.42	1.55	0.01	0.01	0.01
Excavator	ConstMin - Excavators	0.04	0.13	1.39	0.00	0.00	0.00	0.04	0.13	1.40	0.00	0.00	0.00
Flatbed Trucks (on site)	N/A - Onroad engine	0.00	0.00	0.00	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.04	0.02
Grader	ConstMin - Graders	0.09	0.32	1.20	0.01	0.01	0.01	0.09	0.33	1.21	0.01	0.01	0.01
Loaders	ConstMin - Rubber Tired Loaders	0.10	0.31	1.19	0.01	0.01	0.01	0.10	0.31	1.19	0.01	0.01	0.01
Portable Diesel Generators	Portable Equipment - Non-Rental Generator	0.51	0.64	3.82	0.02	0.05	0.04	0.54	1.27	3.92	0.02	0.07	0.07
Scraper	ConstMin - Scrapers	0.10	0.37	1.36	0.01	0.01	0.01	0.10	0.37	1.37	0.01	0.01	0.01
Water Truck	N/A - Onroad engine	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.03	0.01
		1.14	**3.07**	**12.46**	**0.06**	**0.21**	**0.15**	**1.17**	**3.70**	**12.55**	**0.06**	**0.23**	**0.18**

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of grams per h
Calculations assume that equipment quantity is the total pieces of equipment that could operate at a given tim

Onroad Vehicle Speed

40 mph

Air Basin
San Joaquin Valley

Conversions

453.6	grams per pound
2,000	pounds per ton
7	days per week
30	days per month

San Luis Low Point Improvement Project
OFFROAD2017 Emission Factor Summary

Table A-120. Mitigated In-Use Off-Road Construction Equipment Emission Factors (San Joaquin Valley Air Basin)

Equipment Type	Average HP	Emission Factors - 2020 (g/bhp-hr)						Emission Factors - 2021 (g/bhp-hr)						Emission Factors - 2022 (g/bhp-hr)					
		VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5
ConstMin - Bore/Drill Rigs	221	0.0320	0.1317	0.4850	0.0024	0.0046	0.0042	0.0323	0.1316	0.4848	0.0024	0.0046	0.0042	0.0325	0.1311	0.4835	0.0024	0.0046	0.0042
ConstMin - Cranes	231	0.0178	0.0756	0.2778	0.0014	0.0026	0.0024	0.0193	0.0762	0.2813	0.0014	0.0027	0.0025	0.0197	0.0763	0.2822	0.0014	0.0027	0.0025
ConstMin - Crawler Tractors	212	0.0276	0.1128	0.4156	0.0021	0.0039	0.0036	0.0286	0.1132	0.4183	0.0021	0.0040	0.0036	0.0292	0.1135	0.4197	0.0021	0.0040	0.0037
ConstMin - Excavators	158	0.0265	0.1013	1.1017	0.0019	0.0037	0.0034	0.0280	0.1018	1.1118	0.0019	0.0037	0.0034	0.0288	0.1021	1.1171	0.0019	0.0038	0.0035
ConstMin - Graders	188	0.0286	0.1081	0.3999	0.0020	0.0038	0.0035	0.0302	0.1085	0.4032	0.0020	0.0039	0.0036	0.0310	0.1091	0.4059	0.0020	0.0039	0.0036
ConstMin - Off-Highway Tractors	124	0.0296	0.1150	1.2488	0.0021	0.0042	0.0038	0.0308	0.1156	1.2587	0.0021	0.0042	0.0039	0.0314	0.1158	1.2632	0.0021	0.0042	0.0039
ConstMin - Off-Highway Trucks	403	0.0398	0.1061	0.3935	0.0019	0.0040	0.0037	0.0427	0.1072	0.3990	0.0019	0.0041	0.0038	0.0438	0.1075	0.4009	0.0019	0.0041	0.0038
ConstMin - Other Construction Equipment	172	0.0269	0.1091	1.1805	0.0020	0.0039	0.0036	0.0278	0.1095	1.1872	0.0020	0.0039	0.0036	0.0285	0.1096	1.1909	0.0020	0.0040	0.0036
ConstMin - Pavers	129	0.0248	0.1089	1.1709	0.0020	0.0038	0.0035	0.0260	0.1092	1.1782	0.0020	0.0039	0.0036	0.0262	0.1093	1.1796	0.0020	0.0039	0.0036
ConstMin - Paving Equipment	131	0.0217	0.0929	1.0011	0.0017	0.0033	0.0030	0.0231	0.0935	1.0111	0.0017	0.0033	0.0031	0.0242	0.0939	1.0195	0.0017	0.0034	0.0031
ConstMin - Rollers	80	0.0302	0.5072	1.1847	0.0018	0.0036	0.0033	0.0313	0.5088	1.1914	0.0018	0.0037	0.0034	0.0319	0.5090	1.1935	0.0018	0.0037	0.0034
ConstMin - Rough Terrain Forklifts	100	0.0299	0.5402	1.2555	0.0020	0.0037	0.0034	0.0309	0.5412	1.2607	0.0020	0.0038	0.0035	0.0318	0.5422	1.2653	0.0020	0.0039	0.0035
ConstMin - Rubber Tired Dozers	249	0.0337	0.1061	0.4001	0.0019	0.0039	0.0036	0.0374	0.1079	0.4106	0.0019	0.0040	0.0037	0.0330	0.1070	0.4022	0.0019	0.0039	0.0036
ConstMin - Rubber Tired Loaders	202	0.0291	0.0967	0.3632	0.0018	0.0035	0.0032	0.0323	0.0979	0.3713	0.0018	0.0036	0.0033	0.0320	0.0978	0.3704	0.0018	0.0036	0.0033
ConstMin - Scrapers	367	0.0320	0.1277	0.4649	0.0024	0.0045	0.0041	0.0337	0.1283	0.4678	0.0024	0.0045	0.0042	0.0342	0.1285	0.4689	0.0024	0.0045	0.0042
ConstMin - Skid Steer Loaders	65	0.0297	0.4979	1.1632	0.0018	0.0036	0.0033	0.0307	0.4991	1.1688	0.0018	0.0036	0.0033	0.0312	0.4996	1.1711	0.0018	0.0037	0.0034
ConstMin - Surfacing Equipment	263	0.0161	0.0781	0.2842	0.0015	0.0027	0.0024	0.0164	0.0782	0.2847	0.0015	0.0027	0.0025	0.0167	0.0784	0.2859	0.0015	0.0027	0.0025
ConstMin - Sweepers/Scrubbers	64	0.0323	0.6100	1.4138	0.0022	0.0041	0.0038	0.0323	0.6100	1.4138	0.0022	0.0041	0.0038	0.0368	0.6153	1.4380	0.0022	0.0044	0.0041
ConstMin - Tractors/Loaders/Backhoes	98	0.0359	0.5058	1.1978	0.0018	0.0039	0.0036	0.0376	0.5078	1.2066	0.0018	0.0040	0.0037	0.0389	0.5099	1.2150	0.0018	0.0041	0.0038
ConstMin - Trenchers	79	0.0423	0.6914	1.6182	0.0025	0.0050	0.0046	0.0429	0.6914	1.6199	0.0025	0.0050	0.0046	0.0446	0.6906	1.6231	0.0025	0.0051	0.0047
Industrial - Aerial Lifts	63	0.0231	0.4141	0.9630	0.0015	0.0029	0.0026	0.0235	0.4144	0.9648	0.0015	0.0029	0.0027	0.0244	0.4156	0.9700	0.0015	0.0030	0.0027
Industrial - Forklifts	89	0.0196	0.2752	0.6517	0.0010	0.0021	0.0020	0.0207	0.2765	0.6577	0.0010	0.0022	0.0020	0.0218	0.2778	0.6635	0.0010	0.0023	0.0021
Industrial - Other General Industrial Equipment	88	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Industrial - Other Material Handling Equipment	167	0.0281	0.1049	1.1429	0.0019	0.0038	0.0035	0.0301	0.1056	1.1573	0.0019	0.0039	0.0036	0.0306	0.1058	1.1608	0.0019	0.0039	0.0036
OFF - ConstMin - Bore/Drill Rigs	15	0.4236	3.2336	1.9286	0.0057	0.1219	0.1121	0.4230	3.2294	1.9191	0.0057	0.1217	0.1119	0.4237	3.2344	1.9176	0.0057	0.1218	0.1121
OFF - ConstMin - Cement and Mortar Mixers	10	0.3080	2.3366	1.8693	0.0048	0.0908	0.0835	0.3078	2.3352	1.8669	0.0048	0.0907	0.0835	0.3078	2.3356	1.8615	0.0048	0.0907	0.0835
OFF - ConstMin - Concrete/Industrial Saws	31	0.1294	2.0790	2.3732	0.0053	0.0077	0.0070	0.1376	2.0951	2.4331	0.0053	0.0079	0.0072	0.1446	2.0959	2.4745	0.0053	0.0080	0.0074
OFF - ConstMin - Dumpers/Tenders	16	0.2159	1.6506	0.8915	0.0027	0.0617	0.0567	0.2140	1.6364	0.8839	0.0027	0.0611	0.0563	0.2140	1.6366	0.8840	0.0027	0.0612	0.0563
OFF - ConstMin - Excavators	23	0.3225	2.4662	1.3320	0.0041	0.0921	0.0848	0.3233	2.4719	1.3351	0.0041	0.0924	0.0850	0.3229	2.4688	1.3335	0.0041	0.0922	0.0849
OFF - ConstMin - Other Construction Equipment	14	0.3410	2.5881	2.0372	0.0053	0.1004	0.0923	0.3410	2.5881	2.0319	0.0053	0.1003	0.0923	0.3412	2.5899	2.0297	0.0053	0.1004	0.0924
OFF - ConstMin - Pavers	24	0.3549	2.7139	1.4659	0.0045	0.1014	0.0933	0.3530	2.6994	1.4580	0.0045	0.1009	0.0928	0.3537	2.7048	1.4609	0.0045	0.1011	0.0930
OFF - ConstMin - Paving Equipment	19	0.3026	2.3136	1.2496	0.0039	0.0864	0.0795	0.3019	2.3087	1.2470	0.0038	0.0863	0.0794	0.3001	2.2946	1.2394	0.0038	0.0857	0.0789
OFF - ConstMin - Plate Compactors	8	0.2350	1.7809	1.4917	0.0038	0.0696	0.0640	0.2350	1.7808	1.4916	0.0038	0.0696	0.0640	0.2352	1.7819	1.4925	0.0038	0.0696	0.0641
OFF - ConstMin - Rollers	12	0.3110	2.3659	1.6656	0.0046	0.0906	0.0834	0.3112	2.3677	1.6584	0.0045	0.0907	0.0834	0.3113	2.3688	1.6536	0.0045	0.0907	0.0834
OFF - ConstMin - Rubber Tired Loaders	25	0.3035	2.3208	1.2535	0.0039	0.0867	0.0798	0.3061	2.3406	1.2642	0.0039	0.0875	0.0805	0.3074	2.3506	1.2696	0.0039	0.0878	0.0808
OFF - ConstMin - Signal Boards	6	0.4483	3.3972	2.8455	0.0073	0.1327	0.1221	0.4483	3.3971	2.8454	0.0073	0.1327	0.1221	0.4483	3.3970	2.8454	0.0073	0.1327	0.1221
OFF - ConstMin - Skid Steer Loaders	20	0.3116	2.3828	1.2870	0.0040	0.0890	0.0819	0.3116	2.3829	1.2871	0.0040	0.0890	0.0819	0.3116	2.3829	1.2870	0.0040	0.0890	0.0819
OFF - ConstMin - Tractors/Loaders/Backhoes	23	0.3118	2.3839	1.2876	0.0040	0.0891	0.0819	0.3117	2.3833	1.2873	0.0040	0.0891	0.0819	0.3116	2.3826	1.2869	0.0040	0.0890	0.0819
OFF - ConstMin - Trenchers	22	0.4222	3.2222	1.9325	0.0057	0.1215	0.1118	0.4216	3.2183	1.9247	0.0057	0.1213	0.1116	0.4220	3.2214	1.9234	0.0057	0.1214	0.1117
OFF - Industrial - Aerial Lifts	17	0.2561	1.9495	1.3359	0.0037	0.0745	0.0685	0.2565	1.9528	1.3202	0.0037	0.0745	0.0685	0.2566	1.9547	1.3081	0.0037	0.0745	0.0685
OFF - Industrial - Other General Industrial Equipment	18	0.2791	2.1854	1.3321	0.0039	0.0825	0.0759	0.2791	2.1849	1.3296	0.0039	0.0825	0.0759	0.2792	2.1852	1.3292	0.0039	0.0825	0.0759
OFF - Industrial - Sweepers/Scrubbers	18	0.3637	2.8940	1.8953	0.0053	0.1100	0.1012	0.3652	2.9028	1.8931	0.0053	0.1103	0.1015	0.3634	2.8867	1.8781	0.0053	0.1097	0.1009
OFF - Light Commercial - Air Compressors	35	0.1019	1.3965	1.6815	0.0035	0.0055	0.0050	0.1066	1.4038	1.7144	0.0035	0.0056	0.0052	0.1150	1.4160	1.7730	0.0035	0.0058	0.0054
OFF - Light Commercial - Generator Sets	21	0.3933	3.1442	2.1012	0.0059	0.1198	0.1102	0.3933	3.1440	2.1011	0.0059	0.1198	0.1102	0.3933	3.1441	2.1011	0.0059	0.1198	0.1102
OFF - Light Commercial - Pressure Washers	21	0.1510	1.2476	0.9475	0.0025	0.0482	0.0443	0.1512	1.2492	0.9487	0.0025	0.0483	0.0444	0.1519	1.2551	0.9532	0.0025	0.0485	0.0446
OFF - Light Commercial - Pumps	18	0.4109	3.1266	2.1998	0.0060	0.1198	0.1102	0.4110	3.1272	2.2002	0.0060	0.1198	0.1102	0.4110	3.1270	2.2001	0.0060	0.1198	0.1102
OFF - Light Commercial - Welders	33	0.0849	1.2947	1.5029	0.0033	0.0049	0.0045	0.0883	1.2993	1.5262	0.0033	0.0050	0.0046	0.0945	1.3084	1.5696	0.0033	0.0051	0.0047
Portable Equipment - Non-Rental Compressor	210	0.0486	0.2849	0.3547	0.0014	0.0107	0.0099	0.0332	0.1743	0.3207	0.0014	0.0075	0.0069	0.0284	0.1208	0.3119	0.0015	0.0054	0.0050
Portable Equipment - Non-Rental Generator	559	0.0437	0.0643	0.3246	0.0014	0.0045	0.0041	0.0431	0.0542	0.3263	0.0014	0.0041	0.0037	0.0463	0.1083	0.3346	0.0015	0.0063	0.0058
Portable Equipment - Non-Rental Other Portable Equipment	382	0.0258	0.0870	0.2926	0.0014	0.0053	0.0048	0.0256	0.0958	0.2949	0.0014	0.0056	0.0051	0.0266	0.0642	0.2995	0.0015	0.0037	0.0034
Portable Equipment - Non-Rental Pump	593	0.0230	0.1263	0.2876	0.0014	0.0066	0.0061	0.0231	0.1374	0.2905	0.0014	0.0068	0.0062	0.0243	0.1046	0.2954	0.0015	0.0055	0.0051
Portable Equipment - Rental Compressor	233	0.0259	0.0436	0.3008	0.0014	0.0027	0.0025	0.0262	0.0441	0.3041	0.0014	0.0027	0.0025	0.0263	0.0428	0.3068	0.0015	0.0028	0.0025
Portable Equipment - Rental Generator	232	0.0473	0.0417	0.3517	0.0014	0.0033	0.0031	0.0477	0.0410	0.3553	0.0014	0.0034	0.0031	0.0482	0.0400	0.3590	0.0015	0.0034	0.0031
Portable Equipment - Rental Other Portable Equipment	169	0.0381	0.2249	0.9681	0.0014	0.0039	0.0036	0.0386	0.2001	0.9793	0.0014	0.0038	0.0035	0.0409	0.1491	1.0028	0.0015	0.0040	0.0037
Portable Equipment - Rental Pump	212	0.0411	0.0555	0.3370	0.0014	0.0036	0.0033	0.0399	0.0529	0.3367	0.0014	0.0035	0.0032	0.0386	0.0499	0.3362	0.0015	0.0034	0.0031

Source:
California Air Resources Board (CARB). 2017. OFFROAD2017 - ORION Web Database. Available online at https://www.arb.ca.gov/orion/ [Accessesd October 17, 2018].
Notes:
1. Horsepower used in modeling is average calculated from OFFROAD2017 (e.g., "Horsepower_Hours_hhpy" divided by "Total_Activity_hpy.")

San Luis Low Point Improvement Project
OFFROAD2017 Emission Factor Summary

Table A-120. Mitigated In-Use Off-Road Construction Equipment Emiss

Equipment Type	Average HP	Emission Factors - 2023 (g/bhp-hr)						Emission Factors - 2024 (g/bhp-hr)					
		VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5
ConstMin - Bore/Drill Rigs	221	0.0336	0.1315	0.4862	0.0024	0.0046	0.0042	0.0340	0.1320	0.4884	0.0024	0.0046	0.0043
ConstMin - Cranes	231	0.0206	0.0766	0.2844	0.0014	0.0027	0.0025	0.0213	0.0768	0.2861	0.0014	0.0027	0.0025
ConstMin - Crawler Tractors	212	0.0299	0.1136	0.4210	0.0021	0.0040	0.0037	0.0315	0.1143	0.4253	0.0021	0.0041	0.0037
ConstMin - Excavators	158	0.0301	0.1025	1.1259	0.0019	0.0038	0.0035	0.0311	0.1028	1.1326	0.0019	0.0039	0.0035
ConstMin - Graders	188	0.0321	0.1099	0.4099	0.0020	0.0039	0.0036	0.0337	0.1103	0.4133	0.0020	0.0040	0.0037
ConstMin - Off-Highway Tractors	124	0.0314	0.1157	1.2616	0.0021	0.0042	0.0039	0.0328	0.1162	1.2713	0.0021	0.0043	0.0039
ConstMin - Off-Highway Trucks	403	0.0450	0.1080	0.4032	0.0019	0.0042	0.0038	0.0467	0.1084	0.4056	0.0019	0.0042	0.0039
ConstMin - Other Construction Equipment	172	0.0294	0.1100	1.1977	0.0020	0.0040	0.0037	0.0309	0.1105	1.2085	0.0020	0.0041	0.0037
ConstMin - Pavers	129	0.0271	0.1096	1.1861	0.0020	0.0039	0.0036	0.0283	0.1100	1.1944	0.0020	0.0040	0.0037
ConstMin - Paving Equipment	131	0.0256	0.0943	1.0283	0.0017	0.0034	0.0032	0.0269	0.0948	1.0381	0.0017	0.0035	0.0032
ConstMin - Rollers	80	0.0327	0.5102	1.1983	0.0018	0.0038	0.0035	0.0337	0.5112	1.2033	0.0018	0.0038	0.0035
ConstMin - Rough Terrain Forklifts	100	0.0325	0.5433	1.2697	0.0020	0.0039	0.0036	0.0333	0.5444	1.2742	0.0020	0.0039	0.0036
ConstMin - Rubber Tired Dozers	249	0.0369	0.1081	0.4316	0.0019	0.0040	0.0037	0.0407	0.1094	0.4198	0.0019	0.0041	0.0038
ConstMin - Rubber Tired Loaders	202	0.0336	0.0984	0.3744	0.0018	0.0036	0.0033	0.0351	0.0989	0.3779	0.0018	0.0037	0.0034
ConstMin - Scrapers	367	0.0359	0.1292	0.4722	0.0024	0.0046	0.0042	0.0374	0.1296	0.4747	0.0024	0.0046	0.0043
ConstMin - Skid Steer Loaders	65	0.0318	0.5002	1.1740	0.0018	0.0037	0.0034	0.0322	0.5009	1.1768	0.0018	0.0037	0.0034
ConstMin - Surfacing Equipment	263	0.0173	0.0787	0.2874	0.0015	0.0027	0.0025	0.0178	0.0789	0.2889	0.0015	0.0027	0.0025
ConstMin - Sweepers/Scrubbers	64	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ConstMin - Tractors/Loaders/Backhoes	98	0.0406	0.5120	1.2243	0.0018	0.0042	0.0039	0.0428	0.5148	1.2366	0.0018	0.0043	0.0040
ConstMin - Trenchers	79	0.0465	0.6928	1.6331	0.0025	0.0052	0.0048	0.0479	0.6932	1.6380	0.0025	0.0053	0.0049
Industrial - Aerial Lifts	63	0.0215	0.4121	0.9542	0.0015	0.0028	0.0026	0.0229	0.4137	0.9616	0.0015	0.0029	0.0026
Industrial - Forklifts	89	0.0228	0.2790	0.6692	0.0010	0.0023	0.0021	0.0239	0.2803	0.6751	0.0010	0.0024	0.0022
Industrial - Other General Industrial Equipment	88	0.0248	0.4583	1.0637	0.0017	0.0031	0.0029	0.0277	0.4618	1.0794	0.0017	0.0033	0.0031
Industrial - Other Material Handling Equipment	167	0.0314	0.1061	1.1661	0.0019	0.0040	0.0036	0.0366	0.1623	1.2057	0.0019	0.0042	0.0039
OFF - ConstMin - Bore/Drill Rigs	15	0.4204	3.2098	1.9000	0.0056	0.1209	0.1112	0.4216	3.2184	1.9032	0.0056	0.1212	0.1115
OFF - ConstMin - Cement and Mortar Mixers	10	0.3081	2.3377	1.8569	0.0048	0.0908	0.0835	0.3084	2.3400	1.8524	0.0048	0.0908	0.0836
OFF - ConstMin - Concrete/Industrial Saws	31	0.1527	2.1137	2.5355	0.0053	0.0083	0.0076	0.1602	2.1235	2.5868	0.0053	0.0085	0.0078
OFF - ConstMin - Dumpers/Tenders	16	0.2139	1.6354	0.8833	0.0027	0.0611	0.0562	0.2143	1.6389	0.8852	0.0027	0.0612	0.0563
OFF - ConstMin - Excavators	23	0.3241	2.4778	1.3383	0.0041	0.0926	0.0852	0.3233	2.4722	1.3353	0.0041	0.0924	0.0850
OFF - ConstMin - Other Construction Equipment	14	0.3412	2.5896	2.0270	0.0053	0.1004	0.0923	0.3411	2.5892	2.0250	0.0053	0.1003	0.0923
OFF - ConstMin - Pavers	24	0.3552	2.7157	1.4668	0.0045	0.1015	0.0934	0.3535	2.7030	1.4599	0.0045	0.1010	0.0929
OFF - ConstMin - Paving Equipment	19	0.3003	2.2958	1.2400	0.0038	0.0858	0.0789	0.3004	2.2966	1.2404	0.0038	0.0858	0.0789
OFF - ConstMin - Plate Compactors	8	0.2351	1.7812	1.4920	0.0038	0.0696	0.0640	0.2352	1.7819	1.4926	0.0038	0.0696	0.0641
OFF - ConstMin - Rollers	12	0.3114	2.3697	1.6504	0.0045	0.0907	0.0834	0.3114	2.3698	1.6481	0.0045	0.0907	0.0834
OFF - ConstMin - Rubber Tired Loaders	25	0.3045	2.3285	1.2577	0.0039	0.0870	0.0800	0.3062	2.3409	1.2644	0.0039	0.0875	0.0805
OFF - ConstMin - Signal Boards	6	0.4483	3.3971	2.8454	0.0073	0.1327	0.1221	0.4483	3.3972	2.8455	0.0073	0.1327	0.1221
OFF - ConstMin - Skid Steer Loaders	20	0.3116	2.3824	1.2868	0.0040	0.0890	0.0819	0.3117	2.3830	1.2871	0.0040	0.0890	0.0819
OFF - ConstMin - Tractors/Loaders/Backhoes	23	0.3115	2.3817	1.2864	0.0040	0.0890	0.0819	0.3117	2.3831	1.2872	0.0040	0.0890	0.0819
OFF - ConstMin - Trenchers	22	0.4223	3.2232	1.9229	0.0057	0.1215	0.1118	0.4228	3.2273	1.9248	0.0057	0.1216	0.1119
OFF - Industrial - Aerial Lifts	17	0.2564	1.9534	1.2947	0.0036	0.0744	0.0684	0.2566	1.9552	1.2850	0.0036	0.0744	0.0684
OFF - Industrial - Other General Industrial Equipment	18	0.2793	2.1864	1.3300	0.0039	0.0826	0.0759	0.2791	2.1848	1.3290	0.0039	0.0825	0.0759
OFF - Industrial - Sweepers/Scrubbers	18	0.3653	2.9010	1.8851	0.0053	0.1102	0.1014	0.3657	2.9041	1.8864	0.0053	0.1103	0.1015
OFF - Light Commercial - Air Compressors	35	0.1234	1.4276	1.8307	0.0035	0.0060	0.0056	0.1317	1.4401	1.8887	0.0035	0.0062	0.0057
OFF - Light Commercial - Generator Sets	21	0.3933	3.1440	2.1011	0.0059	0.1198	0.1102	0.3933	3.1439	2.1010	0.0059	0.1198	0.1102
OFF - Light Commercial - Pressure Washers	21	0.1525	1.2595	0.9566	0.0025	0.0487	0.0448	0.1515	1.2513	0.9503	0.0025	0.0483	0.0445
OFF - Light Commercial - Pumps	18	0.4110	3.1270	2.2001	0.0060	0.1198	0.1102	0.4111	3.1277	2.2005	0.0060	0.1198	0.1102
OFF - Light Commercial - Welders	33	0.1007	1.3172	1.6126	0.0033	0.0053	0.0049	0.1068	1.3260	1.6550	0.0033	0.0054	0.0050
Portable Equipment - Non-Rental Compressor	210	0.0289	0.1129	0.3156	0.0015	0.0052	0.0048	0.0281	0.0945	0.3165	0.0015	0.0046	0.0042
Portable Equipment - Non-Rental Generator	559	0.0472	0.1018	0.3390	0.0015	0.0060	0.0055	0.0475	0.1114	0.3423	0.0015	0.0065	0.0060
Portable Equipment - Non-Rental Other Portable Equipment	382	0.0269	0.0640	0.3028	0.0015	0.0037	0.0034	0.0270	0.0663	0.3057	0.0015	0.0038	0.0035
Portable Equipment - Non-Rental Pump	593	0.0246	0.1052	0.2986	0.0015	0.0056	0.0051	0.0245	0.1003	0.3012	0.0015	0.0055	0.0051
Portable Equipment - Rental Compressor	233	0.0268	0.0366	0.3107	0.0015	0.0028	0.0026	0.0271	0.0370	0.3141	0.0015	0.0028	0.0026
Portable Equipment - Rental Generator	232	0.0483	0.0404	0.3620	0.0015	0.0034	0.0031	0.0489	0.0408	0.3661	0.0015	0.0035	0.0032
Portable Equipment - Rental Other Portable Equipment	169	0.0417	0.1434	1.0164	0.0015	0.0043	0.0039	0.0425	0.1382	1.0298	0.0015	0.0046	0.0043
Portable Equipment - Rental Pump	212	0.0377	0.0477	0.3367	0.0015	0.0034	0.0031	0.0379	0.0491	0.3400	0.0015	0.0034	0.0032

Source:
California Air Resources Board (CARB). 2017. OFFROAD2017 - ORION Web Databa
Notes:
1. Horsepower used in modeling is average calculated from OFFROAD2017 (e.g., "H

Table A-121. Mitigated In-Use Off-Road Construction Equipment Emission Factors (San Francisco Bay Area Air Basin)

Equipment Type	Average HP	Emission Factors - 2020 (g/bhp-hr)						Emission Factors - 2021 (g/bhp-hr)						Emission Factors - 2022 (g/bhp-hr)					
		VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5
ConstMin - Bore/Drill Rigs	221	0.0320	0.1317	0.4850	0.0024	0.0046	0.0042	0.0323	0.1316	0.4848	0.0024	0.0046	0.0042	0.0325	0.1311	0.4835	0.0024	0.0046	0.0042
ConstMin - Cranes	231	0.0178	0.0756	0.2778	0.0014	0.0026	0.0024	0.0193	0.0762	0.2813	0.0014	0.0027	0.0025	0.0197	0.0763	0.2822	0.0014	0.0027	0.0025
ConstMin - Crawler Tractors	212	0.0276	0.1128	0.4156	0.0021	0.0039	0.0036	0.0286	0.1132	0.4183	0.0021	0.0040	0.0036	0.0292	0.1135	0.4197	0.0021	0.0040	0.0037
ConstMin - Excavators	158	0.0265	0.1013	1.1017	0.0019	0.0037	0.0034	0.0280	0.1018	1.1118	0.0019	0.0037	0.0034	0.0288	0.1021	1.1171	0.0019	0.0038	0.0035
ConstMin - Graders	188	0.0286	0.1081	0.3999	0.0020	0.0038	0.0035	0.0302	0.1085	0.4032	0.0020	0.0039	0.0036	0.0310	0.1091	0.4059	0.0020	0.0039	0.0036
ConstMin - Off-Highway Tractors	124	0.0296	0.1150	1.2488	0.0021	0.0042	0.0038	0.0308	0.1156	1.2587	0.0021	0.0042	0.0039	0.0314	0.1158	1.2632	0.0021	0.0042	0.0039
ConstMin - Off-Highway Trucks	403	0.0398	0.1061	0.3935	0.0019	0.0040	0.0037	0.0427	0.1072	0.3990	0.0019	0.0041	0.0038	0.0438	0.1075	0.4009	0.0019	0.0041	0.0038
ConstMin - Other Construction Equipment	172	0.0269	0.1091	1.1805	0.0020	0.0039	0.0036	0.0278	0.1095	1.1872	0.0020	0.0039	0.0036	0.0285	0.1096	1.1909	0.0020	0.0040	0.0036
ConstMin - Pavers	129	0.0248	0.1089	1.1709	0.0020	0.0038	0.0035	0.0260	0.1092	1.1782	0.0020	0.0039	0.0036	0.0262	0.1093	1.1796	0.0020	0.0039	0.0036
ConstMin - Paving Equipment	131	0.0217	0.0929	1.0011	0.0017	0.0033	0.0030	0.0231	0.0935	1.0111	0.0017	0.0033	0.0031	0.0242	0.0939	1.0195	0.0017	0.0034	0.0031
ConstMin - Rollers	80	0.0302	0.5072	1.1847	0.0018	0.0036	0.0033	0.0313	0.5088	1.1914	0.0018	0.0037	0.0034	0.0319	0.5090	1.1935	0.0018	0.0037	0.0034
ConstMin - Rough Terrain Forklifts	100	0.0299	0.5402	1.2555	0.0020	0.0037	0.0034	0.0309	0.5412	1.2607	0.0020	0.0038	0.0035	0.0318	0.5422	1.2653	0.0020	0.0039	0.0035
ConstMin - Rubber Tired Dozers	249	0.0337	0.1061	0.4001	0.0019	0.0039	0.0036	0.0374	0.1079	0.4106	0.0019	0.0040	0.0037	0.0330	0.1070	0.4022	0.0019	0.0039	0.0036
ConstMin - Rubber Tired Loaders	202	0.0291	0.0967	0.3632	0.0018	0.0035	0.0032	0.0323	0.0979	0.3713	0.0018	0.0036	0.0033	0.0320	0.0978	0.3704	0.0018	0.0036	0.0033
ConstMin - Scrapers	367	0.0320	0.1277	0.4649	0.0024	0.0045	0.0041	0.0337	0.1283	0.4678	0.0024	0.0045	0.0042	0.0342	0.1285	0.4689	0.0024	0.0045	0.0042
ConstMin - Skid Steer Loaders	65	0.0297	0.4979	1.1632	0.0018	0.0036	0.0033	0.0307	0.4991	1.1688	0.0018	0.0036	0.0033	0.0312	0.4996	1.1711	0.0018	0.0037	0.0034
ConstMin - Surfacing Equipment	263	0.0161	0.0781	0.2842	0.0015	0.0027	0.0024	0.0164	0.0782	0.2847	0.0015	0.0027	0.0025	0.0167	0.0784	0.2859	0.0015	0.0027	0.0025
ConstMin - Sweepers/Scrubbers	64	0.0323	0.6100	1.4138	0.0022	0.0041	0.0038	0.0323	0.6100	1.4138	0.0022	0.0041	0.0038	0.0368	0.6153	1.4380	0.0022	0.0044	0.0041
ConstMin - Tractors/Loaders/Backhoes	98	0.0359	0.5058	1.1978	0.0018	0.0039	0.0036	0.0376	0.5078	1.2066	0.0018	0.0040	0.0037	0.0389	0.5099	1.2150	0.0018	0.0041	0.0038
ConstMin - Trenchers	79	0.0423	0.6914	1.6182	0.0025	0.0050	0.0046	0.0429	0.6914	1.6199	0.0025	0.0050	0.0046	0.0446	0.6906	1.6231	0.0025	0.0051	0.0047
Industrial - Aerial Lifts	63	0.0231	0.4141	0.9630	0.0015	0.0029	0.0026	0.0235	0.4144	0.9648	0.0015	0.0029	0.0027	0.0244	0.4156	0.9700	0.0015	0.0030	0.0027
Industrial - Forklifts	89	0.0196	0.2752	0.6517	0.0010	0.0021	0.0020	0.0207	0.2765	0.6577	0.0010	0.0022	0.0020	0.0218	0.2778	0.6635	0.0010	0.0023	0.0021
Industrial - Other General Industrial Equipment	88	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Industrial - Other Material Handling Equipment	167	0.0281	0.1049	1.1429	0.0019	0.0038	0.0035	0.0301	0.1056	1.1573	0.0019	0.0039	0.0036	0.0306	0.1058	1.1608	0.0019	0.0039	0.0036
OFF - ConstMin - Bore/Drill Rigs	16	0.4222	3.2230	1.9223	0.0057	0.1215	0.1118	0.4221	3.2220	1.9148	0.0056	0.1214	0.1117	0.4230	3.2295	1.9147	0.0056	0.1217	0.1119
OFF - ConstMin - Cement and Mortar Mixers	10	0.3076	2.3335	1.8668	0.0048	0.0907	0.0834	0.3077	2.3341	1.8661	0.0048	0.0907	0.0834	0.3078	2.3351	1.8611	0.0048	0.0907	0.0834
OFF - ConstMin - Concrete/Industrial Saws	31	0.1301	2.0890	2.3846	0.0054	0.0077	0.0071	0.1377	2.0973	2.4357	0.0054	0.0079	0.0073	0.1455	2.1093	2.4903	0.0054	0.0081	0.0074
OFF - ConstMin - Dumpers/Tenders	16	0.2148	1.6426	0.8872	0.0027	0.0614	0.0565	0.2155	1.6474	0.8898	0.0027	0.0616	0.0566	0.2155	1.6481	0.8902	0.0027	0.0616	0.0567
OFF - ConstMin - Excavators	23	0.3229	2.4692	1.3337	0.0041	0.0923	0.0849	0.3227	2.4673	1.3326	0.0041	0.0922	0.0848	0.3230	2.4696	1.3339	0.0041	0.0923	0.0849
OFF - ConstMin - Other Construction Equipment	14	0.3410	2.5879	2.0370	0.0053	0.1004	0.0923	0.3411	2.5889	2.0325	0.0053	0.1004	0.0924	0.3411	2.5891	2.0291	0.0053	0.1004	0.0923
OFF - ConstMin - Pavers	24	0.3506	2.6811	1.4481	0.0045	0.1002	0.0922	0.3510	2.6839	1.4496	0.0045	0.1003	0.0923	0.3512	2.6855	1.4505	0.0045	0.1003	0.0923
OFF - ConstMin - Paving Equipment	19	0.3000	2.2938	1.2390	0.0038	0.0857	0.0789	0.3008	2.3000	1.2423	0.0038	0.0859	0.0791	0.3008	2.2996	1.2421	0.0038	0.0859	0.0791
OFF - ConstMin - Plate Compactors	8	0.2351	1.7813	1.4921	0.0038	0.0696	0.0640	0.2351	1.7818	1.4924	0.0038	0.0696	0.0641	0.2351	1.7817	1.4923	0.0038	0.0696	0.0641
OFF - ConstMin - Rollers	12	0.3111	2.3666	1.6661	0.0046	0.0907	0.0834	0.3112	2.3676	1.6584	0.0045	0.0906	0.0834	0.3113	2.3686	1.6535	0.0045	0.0907	0.0834
OFF - ConstMin - Rubber Tired Loaders	25	0.3061	2.3408	1.2643	0.0039	0.0875	0.0805	0.3067	2.3454	1.2668	0.0039	0.0876	0.0806	0.3066	2.3441	1.2661	0.0039	0.0876	0.0806
OFF - ConstMin - Signal Boards	6	0.4483	3.3971	2.8454	0.0073	0.1327	0.1221	0.4483	3.3971	2.8454	0.0073	0.1327	0.1221	0.4483	3.3971	2.8454	0.0073	0.1327	0.1221
OFF - ConstMin - Skid Steer Loaders	20	0.3116	2.3829	1.2871	0.0040	0.0890	0.0819	0.3116	2.3828	1.2870	0.0040	0.0890	0.0819	0.3116	2.3828	1.2870	0.0040	0.0890	0.0819
OFF - ConstMin - Tractors/Loaders/Backhoes	23	0.3116	2.3822	1.2867	0.0040	0.0890	0.0819	0.3117	2.3833	1.2873	0.0040	0.0891	0.0819	0.3116	2.3828	1.2870	0.0040	0.0890	0.0819
OFF - ConstMin - Trenchers	22	0.4220	3.2206	1.9316	0.0057	0.1214	0.1117	0.4222	3.2228	1.9274	0.0057	0.1215	0.1118	0.4219	3.2200	1.9226	0.0056	0.1214	0.1117
OFF - Industrial - Aerial Lifts	17	0.2562	1.9508	1.3302	0.0037	0.0745	0.0685	0.2564	1.9525	1.3174	0.0037	0.0745	0.0685	0.2566	1.9545	1.3057	0.0036	0.0745	0.0685
OFF - Industrial - Other General Industrial Equipment	18	0.2792	2.1863	1.3325	0.0039	0.0826	0.0760	0.2793	2.1864	1.3305	0.0039	0.0826	0.0760	0.2794	2.1867	1.3302	0.0039	0.0826	0.0760
OFF - Industrial - Sweepers/Scrubbers	18	0.3637	2.8934	1.8940	0.0053	0.1100	0.1012	0.3644	2.8965	1.8887	0.0053	0.1101	0.1013	0.3644	2.8950	1.8834	0.0053	0.1100	0.1012
OFF - Light Commercial - Air Compressors	35	0.1016	1.3968	1.6797	0.0035	0.0055	0.0050	0.1087	1.4069	1.7292	0.0035	0.0057	0.0052	0.1161	1.4175	1.7803	0.0035	0.0058	0.0054
OFF - Light Commercial - Generator Sets	21	0.3933	3.1441	2.1011	0.0059	0.1198	0.1102	0.3933	3.1441	2.1012	0.0059	0.1198	0.1102	0.3933	3.1441	2.1012	0.0059	0.1198	0.1102
OFF - Light Commercial - Pressure Washers	21	0.1521	1.2566	0.9544	0.0025	0.0485	0.0447	0.1529	1.2630	0.9592	0.0025	0.0488	0.0449	0.1527	1.2619	0.9584	0.0025	0.0487	0.0448
OFF - Light Commercial - Pumps	18	0.4110	3.1273	2.2003	0.0060	0.1198	0.1102	0.4111	3.1277	2.2006	0.0060	0.1198	0.1102	0.4110	3.1274	2.2004	0.0060	0.1198	0.1102
OFF - Light Commercial - Welders	33	0.0846	1.2941	1.5006	0.0033	0.0049	0.0045	0.0899	1.3018	1.5374	0.0033	0.0050	0.0046	0.0953	1.3095	1.5751	0.0033	0.0051	0.0047
Portable Equipment - Non-Rental Compressor	167	0.0301	0.2014	0.9121	0.0014	0.0038	0.0035	0.0294	0.1996	0.9149	0.0014	0.0039	0.0036	0.0292	0.1598	0.9212	0.0015	0.0034	0.0031
Portable Equipment - Non-Rental Generator	369	0.0374	0.0545	0.3133	0.0014	0.0048	0.0045	0.0371	0.0548	0.3156	0.0014	0.0048	0.0044	0.0414	0.0522	0.3258	0.0015	0.0042	0.0039
Portable Equipment - Non-Rental Other Portable Equipment	407	0.0296	0.0412	0.2994	0.0014	0.0033	0.0031	0.0296	0.0418	0.3021	0.0014	0.0034	0.0031	0.0278	0.0708	0.3016	0.0015	0.0042	0.0038
Portable Equipment - Non-Rental Pump	197	0.0257	0.0438	0.3002	0.0014	0.0027	0.0025	0.0256	0.0439	0.3027	0.0014	0.0027	0.0025	0.0250	0.0547	0.3038	0.0015	0.0031	0.0028
Portable Equipment - Rental Compressor	361	0.0250	0.0454	0.2911	0.0014	0.0043	0.0039	0.0253	0.0447	0.2944	0.0014	0.0042	0.0039	0.0253	0.0445	0.2972	0.0015	0.0041	0.0038
Portable Equipment - Rental Generator	406	0.0403	0.0779	0.3186	0.0014	0.0055	0.0051	0.0414	0.0756	0.3232	0.0014	0.0053	0.0049	0.0413	0.0606	0.3258	0.0015	0.0045	0.0041
Portable Equipment - Rental Other Portable Equipment	657	0.0486	0.0609	0.3333	0.0014	0.0065	0.0060	0.0488	0.0586	0.3364	0.0014	0.0061	0.0056	0.0494	0.0508	0.3401	0.0015	0.0051	0.0047
Portable Equipment - Rental Pump	165	0.0378	0.2560	0.9659	0.0014	0.0060	0.0055	0.0376	0.2504	0.9724	0.0014	0.0059	0.0054	0.0382	0.1886	0.9840	0.0015	0.0042	0.0038

Source:
California Air Resources Board (CARB). 2017. OFFROAD2017 - ORION Web Database. Available online at https://www.arb.ca.gov/orion/ [Accessesd October 17, 2018].
Notes:
1. Horsepower used in modeling is average calculated from OFFROAD2017 (e.g., "Horsepower_Hours_hhpy" divided by "Total_Activity_hpy.")

Table A-121. Mitigated In-Use Off-Road Construction Equipment Emiss

Equipment Type	Average HP	Emission Factors - 2023 (g/bhp-hr)						Emission Factors - 2024 (g/bhp-hr)					
		VOC	NOx	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2	PM10	PM2.5
ConstMin - Bore/Drill Rigs	221	0.0336	0.1315	0.4862	0.0024	0.0046	0.0042	0.0340	0.1320	0.4884	0.0024	0.0046	0.0043
ConstMin - Cranes	231	0.0206	0.0766	0.2844	0.0014	0.0027	0.0025	0.0213	0.0768	0.2861	0.0014	0.0027	0.0025
ConstMin - Crawler Tractors	212	0.0299	0.1136	0.4210	0.0021	0.0040	0.0037	0.0315	0.1143	0.4253	0.0021	0.0041	0.0037
ConstMin - Excavators	158	0.0301	0.1025	1.1259	0.0019	0.0038	0.0035	0.0311	0.1028	1.1326	0.0019	0.0039	0.0035
ConstMin - Graders	188	0.0321	0.1099	0.4099	0.0020	0.0039	0.0036	0.0337	0.1103	0.4133	0.0020	0.0040	0.0037
ConstMin - Off-Highway Tractors	124	0.0314	0.1157	1.2616	0.0021	0.0042	0.0039	0.0328	0.1162	1.2713	0.0021	0.0043	0.0039
ConstMin - Off-Highway Trucks	403	0.0450	0.1080	0.4032	0.0019	0.0042	0.0038	0.0467	0.1084	0.4056	0.0019	0.0042	0.0039
ConstMin - Other Construction Equipment	172	0.0294	0.1100	1.1977	0.0020	0.0040	0.0037	0.0309	0.1105	1.2085	0.0020	0.0041	0.0037
ConstMin - Pavers	129	0.0271	0.1096	1.1861	0.0020	0.0039	0.0036	0.0283	0.1100	1.1944	0.0020	0.0040	0.0037
ConstMin - Paving Equipment	131	0.0256	0.0943	1.0283	0.0017	0.0034	0.0032	0.0269	0.0948	1.0381	0.0017	0.0035	0.0032
ConstMin - Rollers	80	0.0327	0.5102	1.1983	0.0018	0.0038	0.0035	0.0337	0.5112	1.2033	0.0018	0.0038	0.0035
ConstMin - Rough Terrain Forklifts	100	0.0325	0.5433	1.2697	0.0020	0.0039	0.0036	0.0333	0.5444	1.2742	0.0020	0.0039	0.0036
ConstMin - Rubber Tired Dozers	249	0.0369	0.1081	0.4316	0.0019	0.0040	0.0037	0.0407	0.1094	0.4198	0.0019	0.0041	0.0038
ConstMin - Rubber Tired Loaders	202	0.0336	0.0984	0.3744	0.0018	0.0036	0.0033	0.0351	0.0989	0.3779	0.0018	0.0037	0.0034
ConstMin - Scrapers	367	0.0359	0.1292	0.4722	0.0024	0.0046	0.0042	0.0374	0.1296	0.4747	0.0024	0.0046	0.0043
ConstMin - Skid Steer Loaders	65	0.0318	0.5002	1.1740	0.0018	0.0037	0.0034	0.0322	0.5009	1.1768	0.0018	0.0037	0.0034
ConstMin - Surfacing Equipment	263	0.0173	0.0787	0.2874	0.0015	0.0027	0.0025	0.0178	0.0789	0.2889	0.0015	0.0027	0.0025
ConstMin - Sweepers/Scrubbers	64	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ConstMin - Tractors/Loaders/Backhoes	98	0.0406	0.5120	1.2243	0.0018	0.0042	0.0039	0.0428	0.5148	1.2366	0.0018	0.0043	0.0040
ConstMin - Trenchers	79	0.0465	0.6928	1.6331	0.0025	0.0052	0.0048	0.0479	0.6932	1.6380	0.0025	0.0053	0.0049
Industrial - Aerial Lifts	63	0.0215	0.4121	0.9542	0.0015	0.0028	0.0026	0.0229	0.4137	0.9616	0.0015	0.0029	0.0026
Industrial - Forklifts	89	0.0228	0.2790	0.6692	0.0010	0.0023	0.0021	0.0239	0.2803	0.6751	0.0010	0.0024	0.0022
Industrial - Other General Industrial Equipment	88	0.0248	0.4583	1.0637	0.0017	0.0031	0.0029	0.0277	0.4618	1.0794	0.0017	0.0033	0.0031
Industrial - Other Material Handling Equipment	167	0.0314	0.1061	1.1661	0.0019	0.0040	0.0036	0.0366	0.1623	1.2057	0.0019	0.0042	0.0039
OFF - ConstMin - Bore/Drill Rigs	16	0.4235	3.2328	1.9136	0.0056	0.1218	0.1120	0.4226	3.2261	1.9078	0.0056	0.1215	0.1118
OFF - ConstMin - Cement and Mortar Mixers	10	0.3078	2.3357	1.8553	0.0048	0.0907	0.0834	0.3080	2.3368	1.8498	0.0048	0.0907	0.0834
OFF - ConstMin - Concrete/Industrial Saws	31	0.1531	2.1193	2.5423	0.0054	0.0083	0.0076	0.1606	2.1297	2.5945	0.0054	0.0085	0.0078
OFF - ConstMin - Dumpers/Tenders	16	0.2153	1.6461	0.8891	0.0027	0.0615	0.0566	0.2158	1.6497	0.8911	0.0027	0.0616	0.0567
OFF - ConstMin - Excavators	23	0.3228	2.4683	1.3332	0.0041	0.0922	0.0849	0.3231	2.4707	1.3345	0.0041	0.0923	0.0849
OFF - ConstMin - Other Construction Equipment	14	0.3412	2.5895	2.0269	0.0053	0.1004	0.0923	0.3411	2.5891	2.0249	0.0053	0.1003	0.0923
OFF - ConstMin - Pavers	24	0.3529	2.6984	1.4574	0.0045	0.1008	0.0928	0.3506	2.6809	1.4480	0.0045	0.1002	0.0922
OFF - ConstMin - Paving Equipment	19	0.2997	2.2917	1.2378	0.0038	0.0856	0.0788	0.3004	2.2968	1.2405	0.0038	0.0858	0.0790
OFF - ConstMin - Plate Compactors	8	0.2351	1.7814	1.4921	0.0038	0.0696	0.0640	0.2351	1.7814	1.4921	0.0038	0.0696	0.0640
OFF - ConstMin - Rollers	12	0.3113	2.3691	1.6500	0.0045	0.0907	0.0834	0.3113	2.3691	1.6476	0.0045	0.0906	0.0834
OFF - ConstMin - Rubber Tired Loaders	25	0.3055	2.3357	1.2616	0.0039	0.0873	0.0803	0.3061	2.3408	1.2643	0.0039	0.0875	0.0805
OFF - ConstMin - Signal Boards	6	0.4483	3.3972	2.8455	0.0073	0.1327	0.1221	0.4483	3.3971	2.8454	0.0073	0.1327	0.1221
OFF - ConstMin - Skid Steer Loaders	20	0.3116	2.3828	1.2870	0.0040	0.0890	0.0819	0.3116	2.3827	1.2870	0.0040	0.0890	0.0819
OFF - ConstMin - Tractors/Loaders/Backhoes	23	0.3116	2.3824	1.2868	0.0040	0.0890	0.0819	0.3116	2.3827	1.2870	0.0040	0.0890	0.0819
OFF - ConstMin - Trenchers	22	0.4219	3.2201	1.9210	0.0056	0.1214	0.1117	0.4215	3.2174	1.9189	0.0056	0.1213	0.1116
OFF - Industrial - Aerial Lifts	17	0.2568	1.9564	1.2950	0.0036	0.0745	0.0685	0.2570	1.9582	1.2846	0.0036	0.0745	0.0685
OFF - Industrial - Other General Industrial Equipment	18	0.2794	2.1869	1.3303	0.0039	0.0826	0.0760	0.2794	2.1866	1.3301	0.0039	0.0826	0.0760
OFF - Industrial - Sweepers/Scrubbers	18	0.3652	2.9005	1.8847	0.0053	0.1102	0.1014	0.3647	2.8959	1.8811	0.0053	0.1100	0.1012
OFF - Light Commercial - Air Compressors	35	0.1235	1.4281	1.8315	0.0035	0.0060	0.0056	0.1308	1.4386	1.8824	0.0035	0.0062	0.0057
OFF - Light Commercial - Generator Sets	21	0.3933	3.1440	2.1011	0.0059	0.1198	0.1102	0.3933	3.1440	2.1011	0.0059	0.1198	0.1102
OFF - Light Commercial - Pressure Washers	21	0.1524	1.2588	0.9560	0.0025	0.0486	0.0447	0.1523	1.2584	0.9557	0.0025	0.0486	0.0447
OFF - Light Commercial - Pumps	18	0.4110	3.1273	2.2003	0.0060	0.1198	0.1102	0.4110	3.1272	2.2002	0.0060	0.1198	0.1102
OFF - Light Commercial - Welders	33	0.1008	1.3174	1.6130	0.0033	0.0053	0.0049	0.1062	1.3250	1.6505	0.0033	0.0054	0.0050
Portable Equipment - Non-Rental Compressor	167	0.0294	0.1346	0.9299	0.0015	0.0032	0.0030	0.0295	0.1430	0.9386	0.0015	0.0037	0.0034
Portable Equipment - Non-Rental Generator	369	0.0424	0.0529	0.3304	0.0015	0.0040	0.0036	0.0428	0.0592	0.3339	0.0015	0.0042	0.0039
Portable Equipment - Non-Rental Other Portable Equipment	407	0.0280	0.0667	0.3048	0.0015	0.0040	0.0037	0.0274	0.0661	0.3064	0.0015	0.0040	0.0037
Portable Equipment - Non-Rental Pump	197	0.0252	0.0599	0.3070	0.0015	0.0033	0.0031	0.0248	0.0703	0.3087	0.0015	0.0036	0.0033
Portable Equipment - Rental Compressor	361	0.0252	0.0443	0.2997	0.0015	0.0040	0.0037	0.0252	0.0444	0.3025	0.0015	0.0039	0.0036
Portable Equipment - Rental Generator	406	0.0416	0.0606	0.3290	0.0015	0.0044	0.0041	0.0421	0.0688	0.3326	0.0015	0.0048	0.0044
Portable Equipment - Rental Other Portable Equipment	657	0.0499	0.0513	0.3439	0.0015	0.0051	0.0047	0.0505	0.0519	0.3476	0.0015	0.0052	0.0048
Portable Equipment - Rental Pump	165	0.0382	0.1858	0.9922	0.0015	0.0042	0.0039	0.0379	0.1768	0.9980	0.0015	0.0041	0.0038

Source:
California Air Resources Board (CARB). 2017. OFFROAD2017 - ORION Web Databa
Notes:
1. Horsepower used in modeling is average calculated from OFFROAD2017 (e.g., "H

San Luis Low Point Improvement Project
EMFAC2014 Emission Factor Summary

Table A-122. Mitigated On-Road Medium-Duty Vehicle Diesel Emission Factors (San Joaquin Valley Air Basin), grams per hour

Calendar Year	Speed	VOC	NOx	CO	SO2	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
2020	5	0.1852	0.1414	3.2060	0.0219	0.0075	0.0400	0.1838	0.2312	0.0071	0.0100	0.0788	0.0959
2020	10	0.1385	0.1175	2.3976	0.0439	0.0070	0.0800	0.3675	0.4545	0.0067	0.0200	0.1575	0.1842
2020	15	0.0676	0.0786	1.1697	0.0658	0.0061	0.1200	0.5513	0.6774	0.0058	0.0300	0.2363	0.2721
2020	20	0.0263	0.0516	0.4553	0.0878	0.0052	0.1600	0.7350	0.9002	0.0050	0.0400	0.3150	0.3600
2020	25	0.0158	0.0391	0.2731	0.1097	0.0045	0.2000	0.9188	1.1232	0.0043	0.0500	0.3938	0.4480
2020	30	0.0119	0.0325	0.2063	0.1317	0.0040	0.2400	1.1025	1.3465	0.0038	0.0600	0.4725	0.5363
2020	35	0.0095	0.0281	0.1641	0.1536	0.0036	0.2800	1.2863	1.5698	0.0034	0.0700	0.5513	0.6247
2020	40	0.0078	0.0249	0.1354	0.1756	0.0033	0.3200	1.4700	1.7933	0.0031	0.0800	0.6300	0.7131
2020	45	0.0066	0.0226	0.1145	0.1975	0.0030	0.3600	1.6538	2.0168	0.0029	0.0900	0.7088	0.8017
2020	50	0.0057	0.0207	0.0989	0.2195	0.0028	0.4000	1.8375	2.2403	0.0027	0.1000	0.7875	0.8902
2020	55	0.0050	0.0192	0.0869	0.2414	0.0027	0.4400	2.0213	2.4639	0.0026	0.1100	0.8663	0.9788
2020	60	0.0047	0.0186	0.0819	0.2634	0.0026	0.4800	2.2050	2.6876	0.0025	0.1200	0.9450	1.0675
2020	65	0.0047	0.0186	0.0818	0.2853	0.0026	0.5200	2.3888	2.9114	0.0025	0.1300	1.0238	1.1562
2020	70	0.0047	0.0186	0.0819	0.3073	0.0026	0.5600	2.5725	3.1351	0.0025	0.1400	1.1025	1.2450
2021	5	0.1703	0.1251	3.1454	0.0214	0.0068	0.0400	0.1838	0.2306	0.0065	0.0100	0.0788	0.0953
2021	10	0.1273	0.1038	2.3513	0.0427	0.0064	0.0800	0.3675	0.4539	0.0061	0.0200	0.1575	0.1836
2021	15	0.0620	0.0693	1.1462	0.0641	0.0056	0.1200	0.5513	0.6768	0.0053	0.0300	0.2363	0.2716
2021	20	0.0242	0.0456	0.4463	0.0855	0.0048	0.1600	0.7350	0.8998	0.0046	0.0400	0.3150	0.3596
2021	25	0.0145	0.0345	0.2677	0.1068	0.0041	0.2000	0.9188	1.1228	0.0039	0.0500	0.3938	0.4477
2021	30	0.0109	0.0287	0.2023	0.1282	0.0036	0.2400	1.1025	1.3461	0.0035	0.0600	0.4725	0.5360
2021	35	0.0087	0.0248	0.1610	0.1496	0.0033	0.2800	1.2863	1.5695	0.0031	0.0700	0.5513	0.6244
2021	40	0.0072	0.0221	0.1328	0.1710	0.0030	0.3200	1.4700	1.7930	0.0029	0.0800	0.6300	0.7129
2021	45	0.0061	0.0199	0.1123	0.1923	0.0028	0.3600	1.6538	2.0165	0.0027	0.0900	0.7088	0.8014
2021	50	0.0052	0.0183	0.0970	0.2137	0.0026	0.4000	1.8375	2.2401	0.0025	0.1000	0.7875	0.8900
2021	55	0.0046	0.0170	0.0852	0.2351	0.0025	0.4400	2.0213	2.4637	0.0023	0.1100	0.8663	0.9786
2021	60	0.0043	0.0164	0.0803	0.2564	0.0024	0.4800	2.2050	2.6874	0.0023	0.1200	0.9450	1.0673
2021	65	0.0043	0.0164	0.0803	0.2778	0.0024	0.5200	2.3888	2.9111	0.0023	0.1300	1.0238	1.1560
2021	70	0.0043	0.0164	0.0803	0.2992	0.0024	0.5600	2.5725	3.1349	0.0023	0.1400	1.1025	1.2448
2022	5	0.1583	0.1121	3.1035	0.0208	0.0063	0.0400	0.1838	0.2300	0.0060	0.0100	0.0788	0.0948
2022	10	0.1182	0.0929	2.3190	0.0416	0.0059	0.0800	0.3675	0.4534	0.0056	0.0200	0.1575	0.1831
2022	15	0.0576	0.0620	1.1298	0.0624	0.0051	0.1200	0.5513	0.6764	0.0049	0.0300	0.2363	0.2711
2022	20	0.0224	0.0408	0.4402	0.0832	0.0044	0.1600	0.7350	0.8994	0.0042	0.0400	0.3150	0.3592
2022	25	0.0135	0.0309	0.2640	0.1040	0.0037	0.2000	0.9188	1.1225	0.0036	0.0500	0.3938	0.4473
2022	30	0.0102	0.0257	0.1995	0.1248	0.0033	0.2400	1.1025	1.3458	0.0032	0.0600	0.4725	0.5357
2022	35	0.0081	0.0223	0.1588	0.1456	0.0030	0.2800	1.2863	1.5693	0.0029	0.0700	0.5513	0.6241
2022	40	0.0067	0.0198	0.1311	0.1663	0.0028	0.3200	1.4700	1.7928	0.0026	0.0800	0.6300	0.7126
2022	45	0.0056	0.0179	0.1108	0.1871	0.0026	0.3600	1.6538	2.0163	0.0025	0.0900	0.7088	0.8012
2022	50	0.0049	0.0164	0.0956	0.2079	0.0024	0.4000	1.8375	2.2399	0.0023	0.1000	0.7875	0.8898
2022	55	0.0043	0.0152	0.0840	0.2287	0.0023	0.4400	2.0213	2.4635	0.0022	0.1100	0.8663	0.9784
2022	60	0.0040	0.0147	0.0792	0.2495	0.0022	0.4800	2.2050	2.6872	0.0021	0.1200	0.9450	1.0671
2022	65	0.0040	0.0147	0.0792	0.2703	0.0022	0.5200	2.3888	2.9109	0.0021	0.1300	1.0238	1.1558
2022	70	0.0040	0.0147	0.0792	0.2911	0.0022	0.5600	2.5725	3.1347	0.0021	0.1400	1.1025	1.2446
2023	5	0.1496	0.1026	3.0846	0.0202	0.0059	0.0400	0.1838	0.2296	0.0056	0.0100	0.0788	0.0944
2023	10	0.1117	0.0850	2.3041	0.0404	0.0055	0.0800	0.3675	0.4530	0.0052	0.0200	0.1575	0.1827
2023	15	0.0543	0.0567	1.1221	0.0606	0.0048	0.1200	0.5513	0.6760	0.0046	0.0300	0.2363	0.2708
2023	20	0.0212	0.0374	0.4374	0.0808	0.0041	0.1600	0.7350	0.8991	0.0039	0.0400	0.3150	0.3589
2023	25	0.0127	0.0283	0.2623	0.1010	0.0035	0.2000	0.9188	1.1222	0.0033	0.0500	0.3938	0.4471
2023	30	0.0096	0.0235	0.1982	0.1212	0.0031	0.2400	1.1025	1.3456	0.0030	0.0600	0.4725	0.5355
2023	35	0.0076	0.0204	0.1578	0.1414	0.0028	0.2800	1.2863	1.5691	0.0027	0.0700	0.5513	0.6239
2023	40	0.0063	0.0181	0.1303	0.1616	0.0026	0.3200	1.4700	1.7926	0.0025	0.0800	0.6300	0.7125
2023	45	0.0053	0.0163	0.1101	0.1818	0.0024	0.3600	1.6538	2.0161	0.0023	0.0900	0.7088	0.8010
2023	50	0.0046	0.0150	0.0950	0.2020	0.0022	0.4000	1.8375	2.2397	0.0021	0.1000	0.7875	0.8896
2023	55	0.0040	0.0139	0.0835	0.2221	0.0021	0.4400	2.0213	2.4633	0.0020	0.1100	0.8663	0.9783
2023	60	0.0038	0.0135	0.0788	0.2423	0.0020	0.4800	2.2050	2.6870	0.0020	0.1200	0.9450	1.0670
2023	65	0.0038	0.0135	0.0787	0.2625	0.0020	0.5200	2.3888	2.9108	0.0020	0.1300	1.0238	1.1557
2023	70	0.0038	0.0135	0.0787	0.2827	0.0020	0.5600	2.5725	3.1345	0.0020	0.1400	1.1025	1.2445

Table A-123. Mitigated On-Road Medium-Duty Vehicle Diesel Emission Factors (San Francisco Bay Area Air Basin), grams per hour

Calendar Year	Speed	VOC	NOx	CO	SO2	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
2020	5	0.1843	0.1402	3.1812	0.0217	0.0074	0.0400	0.1838	0.2312	0.0071	0.0100	0.0788	0.0958
2020	10	0.1378	0.1166	2.3786	0.0433	0.0070	0.0800	0.3675	0.4545	0.0067	0.0200	0.1575	0.1842
2020	15	0.0673	0.0780	1.1613	0.0650	0.0061	0.1200	0.5513	0.6773	0.0058	0.0300	0.2363	0.2721
2020	20	0.0262	0.0512	0.4516	0.0867	0.0052	0.1600	0.7350	0.9002	0.0050	0.0400	0.3150	0.3600
2020	25	0.0157	0.0389	0.2711	0.1084	0.0044	0.2000	0.9188	1.1232	0.0042	0.0500	0.3938	0.4480
2020	30	0.0119	0.0323	0.2048	0.1300	0.0039	0.2400	1.1025	1.3464	0.0038	0.0600	0.4725	0.5363
2020	35	0.0094	0.0279	0.1628	0.1517	0.0036	0.2800	1.2863	1.5698	0.0034	0.0700	0.5513	0.6247
2020	40	0.0078	0.0248	0.1342	0.1734	0.0033	0.3200	1.4700	1.7933	0.0031	0.0800	0.6300	0.7131
2020	45	0.0066	0.0224	0.1138	0.1950	0.0030	0.3600	1.6538	2.0168	0.0029	0.0900	0.7088	0.8016
2020	50	0.0057	0.0206	0.0982	0.2167	0.0028	0.4000	1.8375	2.2403	0.0027	0.1000	0.7875	0.8902
2020	55	0.0050	0.0191	0.0863	0.2384	0.0027	0.4400	2.0213	2.4639	0.0025	0.1100	0.8663	0.9788
2020	60	0.0047	0.0184	0.0812	0.2600	0.0026	0.4800	2.2050	2.6876	0.0025	0.1200	0.9450	1.0675
2020	65	0.0047	0.0184	0.0811	0.2817	0.0026	0.5200	2.3888	2.9113	0.0025	0.1300	1.0238	1.1562
2021	5	0.1675	0.1223	3.1000	0.0211	0.0067	0.0400	0.1838	0.2304	0.0064	0.0100	0.0788	0.0952
2021	10	0.1251	0.1016	2.3152	0.0422	0.0063	0.0800	0.3675	0.4538	0.0060	0.0200	0.1575	0.1835
2021	15	0.0610	0.0679	1.1302	0.0632	0.0055	0.1200	0.5513	0.6767	0.0052	0.0300	0.2363	0.2715
2021	20	0.0238	0.0446	0.4397	0.0843	0.0047	0.1600	0.7350	0.8997	0.0045	0.0400	0.3150	0.3595
2021	25	0.0143	0.0339	0.2639	0.1054	0.0040	0.2000	0.9188	1.1228	0.0038	0.0500	0.3938	0.4476
2021	30	0.0108	0.0281	0.1995	0.1265	0.0035	0.2400	1.1025	1.3460	0.0034	0.0600	0.4725	0.5359
2021	35	0.0086	0.0243	0.1584	0.1475	0.0032	0.2800	1.2863	1.5695	0.0031	0.0700	0.5513	0.6243
2021	40	0.0071	0.0216	0.1306	0.1686	0.0029	0.3200	1.4700	1.7929	0.0028	0.0800	0.6300	0.7128
2021	45	0.0060	0.0196	0.1109	0.1897	0.0027	0.3600	1.6538	2.0165	0.0026	0.0900	0.7088	0.8014
2021	50	0.0052	0.0179	0.0956	0.2108	0.0026	0.4000	1.8375	2.2401	0.0024	0.1000	0.7875	0.8899
2021	55	0.0045	0.0166	0.0840	0.2319	0.0024	0.4400	2.0213	2.4637	0.0023	0.1100	0.8663	0.9786
2021	60	0.0043	0.0161	0.0791	0.2529	0.0023	0.4800	2.2050	2.6873	0.0022	0.1200	0.9450	1.0672
2021	65	0.0043	0.0160	0.0790	0.2740	0.0023	0.5200	2.3888	2.9111	0.0022	0.1300	1.0238	1.1560
2022	5	0.1546	0.1088	3.0466	0.0205	0.0061	0.0400	0.1838	0.2299	0.0058	0.0100	0.0788	0.0946
2022	10	0.1153	0.0902	2.2736	0.0409	0.0057	0.0800	0.3675	0.4532	0.0055	0.0200	0.1575	0.1830
2022	15	0.0563	0.0603	1.1098	0.0614	0.0050	0.1200	0.5513	0.6762	0.0048	0.0300	0.2363	0.2710
2022	20	0.0219	0.0396	0.4318	0.0819	0.0043	0.1600	0.7350	0.8993	0.0041	0.0400	0.3150	0.3591
2022	25	0.0131	0.0301	0.2592	0.1024	0.0036	0.2000	0.9188	1.1224	0.0035	0.0500	0.3938	0.4472
2022	30	0.0099	0.0250	0.1960	0.1228	0.0032	0.2400	1.1025	1.3457	0.0031	0.0600	0.4725	0.5356
2022	35	0.0079	0.0216	0.1555	0.1433	0.0029	0.2800	1.2863	1.5692	0.0028	0.0700	0.5513	0.6240
2022	40	0.0065	0.0192	0.1283	0.1638	0.0027	0.3200	1.4700	1.7927	0.0026	0.0800	0.6300	0.7126
2022	45	0.0055	0.0174	0.1090	0.1843	0.0025	0.3600	1.6538	2.0162	0.0024	0.0900	0.7088	0.8011
2022	50	0.0048	0.0159	0.0939	0.2047	0.0023	0.4000	1.8375	2.2398	0.0022	0.1000	0.7875	0.8897
2022	55	0.0042	0.0148	0.0826	0.2252	0.0022	0.4400	2.0213	2.4634	0.0021	0.1100	0.8663	0.9783
2022	60	0.0039	0.0143	0.0777	0.2457	0.0021	0.4800	2.2050	2.6871	0.0020	0.1200	0.9450	1.0670
2022	65	0.0039	0.0142	0.0775	0.2662	0.0021	0.5200	2.3888	2.9109	0.0020	0.1300	1.0238	1.1558
2023	5	0.1453	0.0989	3.0180	0.0199	0.0056	0.0400	0.1838	0.2294	0.0054	0.0100	0.0788	0.0942
2023	10	0.1082	0.0819	2.2509	0.0397	0.0053	0.0800	0.3675	0.4528	0.0050	0.0200	0.1575	0.1825
2023	15	0.0528	0.0548	1.0985	0.0596	0.0046	0.1200	0.5513	0.6758	0.0044	0.0300	0.2363	0.2706
2023	20	0.0206	0.0360	0.4275	0.0794	0.0039	0.1600	0.7350	0.8989	0.0038	0.0400	0.3150	0.3588
2023	25	0.0123	0.0273	0.2566	0.0993	0.0034	0.2000	0.9188	1.1221	0.0032	0.0500	0.3938	0.4470
2023	30	0.0093	0.0227	0.1940	0.1191	0.0030	0.2400	1.1025	1.3455	0.0029	0.0600	0.4725	0.5354
2023	35	0.0074	0.0196	0.1540	0.1390	0.0027	0.2800	1.2863	1.5689	0.0026	0.0700	0.5513	0.6238
2023	40	0.0061	0.0174	0.1270	0.1588	0.0025	0.3200	1.4700	1.7925	0.0024	0.0800	0.6300	0.7124
2023	45	0.0052	0.0158	0.1080	0.1787	0.0023	0.3600	1.6538	2.0161	0.0022	0.0900	0.7088	0.8010
2023	50	0.0045	0.0145	0.0930	0.1985	0.0021	0.4000	1.8375	2.2396	0.0021	0.1000	0.7875	0.8896
2023	55	0.0039	0.0134	0.0818	0.2184	0.0020	0.4400	2.0213	2.4633	0.0019	0.1100	0.8663	0.9782
2023	60	0.0037	0.0130	0.0770	0.2382	0.0020	0.4800	2.2050	2.6870	0.0019	0.1200	0.9450	1.0669
2023	65	0.0037	0.0129	0.0767	0.2581	0.0020	0.5200	2.3888	2.9107	0.0019	0.1300	1.0238	1.1556

Lower San Felipe Intake Alternative - Tunnel Option
Haul Truck and Construction Worker Commuting Emissions

Construction Duration 47 months
3.9 years
Months in Final Year 11

Table A-124. Trip Rate Information

Vehicle Type	Round Trips		One-Way Trips		One-Way Distance	VMT		Annual VMT	
	Max Day Trips	Total Trips	Max Day Trips	Total Trips	(miles)	Daily	Total	2020 - 2022	2023
Dump Truck	6	100	12	200	40	480	8,000	2,043	1,872
Concrete Trucks	15	7,500	30	15,000	40	1,200	600,000	153,191	140,426
Delivery Trucks (non-soil)	5	1,300	10	2,600	40	400	104,000	26,553	24,340
Gravel/paving trucks	3	250	6	500	40	240	20,000	5,106	4,681
Haul trucks (soil)	40	19,420	80	38,840	5	400	194,200	49,583	45,451
Total Truck Trips	69	28,570	138	57,140	165	2,720	926,200	236,476	216,770
Workers	100	43,800	200	87,600	40	8,000	3,504,000	894,638	820,085
Grand Total	**169**	**72,370**	**338**	**144,740**	**205**	**10,720**	**4,430,200**	**1,131,114**	**1,036,855**

Source: EngineeringDataNeeds_July30_2012.xlsx

Table A-125. Maximum Mitigated Daily Emissions

Truck Emission Factors (g/mi)		0.053	0.755	0.311	0.014	0.193	0.062
Worker Emission Factors (g/mi)		0.015	0.078	0.753	0.003	0.139	0.042
	Maximum Daily VMT	Peak Daily Emissions (lbs/day)					
Truck Type	(miles/day)	ROG	NOx	CO	SOx	PM10	PM2.5
Dump Truck	480	0.06	0.80	0.33	0.01	0.20	0.07
Concrete Trucks	1,200	0.14	2.00	0.82	0.04	0.51	0.16
Delivery Trucks (non-soil)	400	0.05	0.67	0.27	0.01	0.17	0.05
Gravel/paving trucks	240	0.03	0.40	0.16	0.01	0.10	0.03
Haul trucks (soil)	400	0.05	0.67	0.27	0.01	0.17	0.05
Truck Subtotal	2,720	0.32	4.53	1.86	0.08	1.16	0.37
Workers	8,000	0.27	1.37	13.29	0.05	2.44	0.75
Grand Total	**10,720**	**0.59**	**5.90**	**15.15**	**0.14**	**3.60**	**1.12**

Note:
PM_{10} and $PM_{2.5}$ emission factors include exhaust, tire wear, brake wear, and resuspension of loose material on the road surface (paved road dust).

Lower San Felipe Intake Alternative - Tunnel Option
Haul Truck and Construction Worker Commuting Emissions

Table A-126. Annual Mitigated Emissions

	Truck Emission Factors (g/mi)		0.053	0.755	0.311	0.014	0.190	0.061	0.053	0.774	0.315	0.014	0.190	0.061
	Worker Emission Factors (g/mi)		0.015	0.078	0.753	0.003	0.136	0.042	0.014	0.069	0.692	0.003	0.136	0.042
	Annual VMT (miles/year)		**Annual Emissions - 2020 (tons/year)**						**Annual Emissions - 2021 (tons/year)**					
Truck Type	**2020 - 2022**	**2023**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**
Dump Truck	2,043	1,872	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Concrete Trucks	153,191	140,426	0.01	0.13	0.05	0.00	0.03	0.01	0.01	0.13	0.05	0.00	0.03	0.01
Delivery Trucks (non-soil)	26,553	24,340	0.00	0.02	0.01	0.00	0.01	0.00	0.00	0.02	0.01	0.00	0.01	0.00
Gravel/paving trucks	5,106	4,681	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haul trucks (soil)	49,583	45,451	0.00	0.04	0.02	0.00	0.01	0.00	0.00	0.04	0.02	0.00	0.01	0.00
Truck Subtotal	236,476	216,770	0.01	0.20	0.08	0.00	0.05	0.02	0.01	0.20	0.08	0.00	0.05	0.02
Workers	894,638	820,085	0.02	0.08	0.74	0.00	0.13	0.04	0.01	0.07	0.68	0.00	0.13	0.04
Grand Total	**1,131,114**	**1,036,855**	**0.03**	**0.27**	**0.82**	**0.01**	**0.18**	**0.06**	**0.03**	**0.27**	**0.76**	**0.01**	**0.18**	**0.06**

Note:
PM_{10} and $PM_{2.5}$ emission factors include exhaust, tire wear, brake wear, and resuspension of loose material on the road surface (paved road dust). Annual emissions include natural control efficiency from precipitation.

Start Year: 2020
Air Basin: San Joaquin Valley

Conversions

1 pound = 453.6 grams
1 ton = 2000 pounds

Lower San Felipe Intake Alternative - Tunnel Option
Haul Truck and Construction Worker Commuting Em

Table A-126. Annual Mitigated Emissions

	Truck Emission Factors (g/mi)		0.054	0.797	0.321	0.014	0.190	0.061	0.056	0.840	0.332	0.014	0.190	0.061
	Worker Emission Factors (g/mi)		0.012	0.062	0.640	0.003	0.136	0.042	0.011	0.056	0.594	0.003	0.136	0.042
	Annual VMT (miles/year)		**Annual Emissions - 2022 (tons/year)**						**Annual Emissions - 2023 (tons/year)**					
Truck Type	**2020 - 2022**	**2023**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**
Dump Truck	2,043	1,872	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Concrete Trucks	153,191	140,426	0.01	0.13	0.05	0.00	0.03	0.01	0.01	0.13	0.05	0.00	0.03	0.01
Delivery Trucks (non-soil)	26,553	24,340	0.00	0.02	0.01	0.00	0.01	0.00	0.00	0.02	0.01	0.00	0.01	0.00
Gravel/paving trucks	5,106	4,681	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haul trucks (soil)	49,583	45,451	0.00	0.04	0.02	0.00	0.01	0.00	0.00	0.04	0.02	0.00	0.01	0.00
Truck Subtotal	236,476	216,770	0.01	0.21	0.08	0.00	0.05	0.02	0.01	0.20	0.08	0.00	0.05	0.01
Workers	894,638	820,085	0.01	0.06	0.63	0.00	0.13	0.04	0.01	0.06	0.59	0.00	0.13	0.04
Grand Total	**1,131,114**	**1,036,855**	**0.03**	**0.27**	**0.71**	**0.01**	**0.18**	**0.06**	**0.02**	**0.26**	**0.67**	**0.01**	**0.18**	**0.06**

Note:
PM_{10} and $PM_{2.5}$ emission factors include exhaust, tire wear, brake wear, and r

Start Year: 2020
Air Basin: San Joaquin Valley

Conversions

1 pound = 453.6 grams
1 ton = 2000 pounds

Lower San Felipe Intake Alternative - Pipeline Option
Haul Truck and Construction Worker Commuting Emissions

Construction Duration 33 months
2.8 years
Months in Final Year 9

Table A-127. Trip Rate Information

Vehicle Type	Round Trips		One-Way Trips		One-Way Distance	VMT		Annual VMT	
	Max Day Trips	Total Trips	Max Day Trips	Total Trips	(miles)	Daily	Total	2020 - 2021	2022
Dump Truck	6	100	12	200	40	480	8,000	2,909	2,182
Concrete Trucks	2	5	4	10	40	160	400	145	109
Delivery Trucks (non-soil)	5	1,950	10	3,900	40	400	156,000	56,727	42,545
Gravel/paving trucks	3	250	6	500	40	240	20,000	7,273	5,455
Haul trucks (soil)	2	4,100	4	8,200	5	20	41,000	14,909	11,182
Total Truck Trips	18	6,405	36	12,810	165	1,300	225,400	81,963	61,473
Workers	30	15,000	60	30,000	40	2,400	1,200,000	436,364	327,273
Grand Total	**48**	**21,405**	**96**	**42,810**	**205**	**3,700**	**1,425,400**	**518,327**	**388,746**

Source: EngineeringDataNeeds_July30_2012.xlsx

Note:

Assume construction starts in 2018 (earliest possible date following publication of EIS/EIR and feasibility study).

Table A-128. Maximum Daily Mitigated Emissions

Truck Emission Factors (g/mi)		0.053	0.755	0.311	0.014	0.193	0.062
Worker Emission Factors (g/mi)		0.015	0.078	0.753	0.003	0.139	0.042
	Maximum Daily VMT	Peak Daily Emissions (lbs/day)					
Truck Type	(miles/day)	ROG	NOx	CO	SOx	PM10	PM2.5
Dump Truck	480	0.06	0.80	0.33	0.01	0.20	0.07
Concrete Trucks	160	0.02	0.27	0.11	0.00	0.07	0.02
Delivery Trucks (non-soil)	400	0.05	0.67	0.27	0.01	0.17	0.05
Gravel/paving trucks	240	0.03	0.40	0.16	0.01	0.10	0.03
Haul trucks (soil)	20	0.00	0.03	0.01	0.00	0.01	0.00
Truck Subtotal	1,300	0.15	2.16	0.89	0.04	0.55	0.18
Workers	2,400	0.08	0.41	3.99	0.02	0.73	0.22
Grand Total	**3,700**	**0.23**	**2.58**	**4.88**	**0.06**	**1.29**	**0.40**

Note:

PM_{10} and $PM_{2.5}$ emission factors include exhaust, tire wear, brake wear, and resuspension of loose material on the road surface.

Lower San Felipe Intake Alternative - Pipeline Option
Haul Truck and Construction Worker Commuting Emissions

Table A-129. Annual Mitigated Emissions

Truck Emission Factors (g/mi)			0.053	0.755	0.311	0.014	0.190	0.061	0.053	0.774	0.315	0.014	0.190	0.061	0.054	0.797	0.321	0.014	0.190	0.061
Worker Emission Factors (g/mi)			0.015	0.078	0.753	0.003	0.136	0.042	0.014	0.069	0.692	0.003	0.136	0.042	0.012	0.062	0.640	0.003	0.136	0.042
	Annual VMT (miles/year)		**Annual Emissions - 2020 (tons/year)**						**Annual Emissions - 2021 (tons/year)**						**Annual Emissions - 2022 (tons/year)**					
Truck Type	**2020 - 2021**	**2022**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SOx**	**PM10**	**PM2.5**
Dump Truck	2,909	2,182	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Concrete Trucks	145	109	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Delivery Trucks (non-soil)	56,727	42,545	0.00	0.05	0.02	0.00	0.01	0.00	0.00	0.05	0.02	0.00	0.01	0.00	0.00	0.04	0.02	0.00	0.01	0.00
Gravel/paving trucks	7,273	5,455	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haul trucks (soil)	14,909	11,182	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Truck Subtotal	81,963	61,473	0.00	0.07	0.03	0.00	0.02	0.01	0.00	0.07	0.03	0.00	0.02	0.01	0.00	0.05	0.02	0.00	0.01	0.00
Workers	436,364	327,273	0.01	0.04	0.36	0.00	0.07	0.02	0.01	0.03	0.33	0.00	0.07	0.02	0.00	0.02	0.23	0.00	0.05	0.02
Grand Total	**518,327**	**388,746**	**0.01**	**0.11**	**0.39**	**0.00**	**0.08**	**0.03**	**0.01**	**0.10**	**0.36**	**0.00**	**0.08**	**0.03**	**0.01**	**0.08**	**0.25**	**0.00**	**0.06**	**0.02**

Note:
PM_{10} and $PM_{2.5}$ emission factors include exhaust, tire wear, brake wear, and resuspension of loose material on the road surface (paved road dust). Annual emissions include natural control efficiency from precipitation.

Start Year: 2020
County: San Joaquin Valley

Conversions

1 pound = 453.6 grams
1 ton = 2000 pounds

Emission Factors - Weighted Average
Passenger Vehicles (Light duty automobiles and trucks)

Table A-130. Emission Factors for Construction Worker Commutes

		grams per mile												
Air Basin	Year	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
San Joaquin Valley	2020	0.0153	0.0223	0.0776	0.7533	0.0031	0.0018	0.0080	0.0368	0.0466	0.0017	0.0020	0.0158	0.0194
	2021	0.0137	0.0199	0.0692	0.6917	0.0030	0.0018	0.0080	0.0368	0.0465	0.0017	0.0020	0.0158	0.0194
	2022	0.0123	0.0179	0.0621	0.6401	0.0029	0.0018	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0194
	2023	0.0111	0.0161	0.0560	0.5941	0.0028	0.0017	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0193
	2024	0.0100	0.0146	0.0507	0.5567	0.0026	0.0017	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0193
San Francisco Bay Area	2020	0.0139	0.0202	0.0711	0.6967	0.0030	0.0018	0.0080	0.0368	0.0466	0.0017	0.0020	0.0158	0.0195
	2021	0.0125	0.0182	0.0638	0.6437	0.0029	0.0018	0.0080	0.0368	0.0466	0.0017	0.0020	0.0158	0.0194
	2022	0.0113	0.0164	0.0576	0.5996	0.0028	0.0018	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0194
	2023	0.0102	0.0149	0.0522	0.5596	0.0027	0.0017	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0194
	2024	0.0093	0.0135	0.0475	0.5237	0.0025	0.0017	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0193

Note:
Vehicle fleet mix includes gasoline, diesel, and electric automobiles (LDA) and light-duty trucks (LDT1 and LDT2).

Emission Factors - Weighted Average
Heavy-Duty Trucks (Diesel)

Table A-131. Mitigated Emission Factors for Haul and Delivery Trucks

		grams per mile												
County	Year	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
San Joaquin Valley	2020	0.053	0.060	0.755	0.311	0.014	0.003	0.036	0.062	0.101	0.003	0.009	0.026	0.039
	2021	0.053	0.061	0.774	0.315	0.014	0.003	0.036	0.062	0.101	0.003	0.009	0.026	0.039
	2022	0.054	0.062	0.797	0.321	0.014	0.003	0.036	0.062	0.101	0.003	0.009	0.026	0.039
	2023	0.056	0.064	0.840	0.332	0.014	0.004	0.036	0.062	0.101	0.003	0.009	0.026	0.039
	2024	0.057	0.065	0.855	0.336	0.014	0.004	0.036	0.062	0.101	0.004	0.009	0.026	0.039
San Francisco Bay Area	2020	0.054	0.062	0.782	0.322	0.014	0.003	0.036	0.062	0.101	0.003	0.009	0.026	0.039
	2021	0.055	0.063	0.802	0.327	0.014	0.003	0.036	0.062	0.101	0.003	0.009	0.026	0.039
	2022	0.056	0.064	0.826	0.333	0.014	0.003	0.036	0.062	0.101	0.003	0.009	0.026	0.039
	2023	0.058	0.066	0.871	0.344	0.014	0.004	0.036	0.062	0.101	0.003	0.009	0.026	0.039
	2024	0.059	0.067	0.886	0.348	0.014	0.004	0.036	0.062	0.101	0.004	0.009	0.026	0.039

Emission Factors
Paved Road Dust Emissions

Equation 1:

$$E = k(sL)^{0.91} \times (W)^{1.02}$$

where: E = particulate emission factor (having units matching the units of k),
k = particle size multiplier for particle size range and units of interest (see below),
sL = road surface silt loading (grams per square meter) (g/m2), and
W = average weight (tons) of the vehicles traveling the road.

Equation 2:

$$E_{ext} = [k(sL)^{0.91} \times (W)^{1.02}](1 - P/4N)$$

where: k, sL, and W are as defined in Equation 1 and
E_{ext} = annual or other long-term average emission factor in the same units as k,
P = number of "wet" days with at least 0.254 mm (0.01 in) of precipitation during the averaging period, and
N = number of days in the averaging period (e.g., 365 for annual, 91 for seasonal, 30 for monthly).

Table A-132. Particle Size Multipliers for Paved Road Equation

Size Range [a]	Ref.	Particle Size Multiplier, k [b]		
		g/VKT	g/VMT	lb/VMT
$PM_{2.5}$	[c]	0.15	0.25	0.00054
PM_{10}		0.62	1.00	0.0022
PM_{15}		0.77	1.23	0.0027
PM_{30}	[d]	3.23	5.24	0.011

Source: USEPA. 2011. Compilation of Air Pollutant Emission Factors (AP-42). Fifth Edition, Volume I. Chapter 13.2.1 Paved Roads. January. Available online at: http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf [Accessed October 18, 2018].

Notes:

[a] Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.

[b] Units shown are grams per vehicle kilometer traveled (g/VKT), grams per vehicle mile traveled (g/VMT), and pounds per vehicle mile traveled (lb/VMT). The multiplier k includes unit conversions to produce emission factors in the units shown for the indicated size range from the mixed units required in Equation 1.

[c] The k-factors for $PM_{2.5}$ were based on the average $PM_{2.5}$:PM_{10} ratio of test runs in Reference 30.

[d] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

Default Assumptions

Number precipitation days >0.1 inches

San Joaquin Valley Air Basin	45
San Francisco Bay Area Air Basin	64

Road silt loading	0.03	g/m^2	(AP-42, ADT > 10,000, ubiquitous baseline)
Average vehicle weight	2.2	tons	

Source: CAPCOA. 2017. California Emissions Estimator Model User's Guide, Version 2016.3.2, Appendix D: Default Data Tables. Prepared by BREEZE Software, A Division of Trinity Consultants in collaboration with South Coast Air Quality Management District and the California Air Districts. November. Available online at: http://www.caleemod.com/ [Accessed on October 18, 2018].

Table A-133. Paved Road Dust Emission Factors

Air Basin	Emission Factor (g/VMT)			
	Uncontrolled		Controlled	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
San Joaquin Valley	0.092	0.023	0.089	0.022
San Francisco Bay Area	0.092	0.023	0.088	0.022

Note:

Controlled emission factor only valid for long-term (annual) emissions; uncontrolled emission factor used for daily emissions.

Lower San Felipe Intake Alternative - Tunnel Option
Marine Emissions

Table A-134. Mitigated Propulsion Engine Emission Factor Equation Variables

Vessel Type	Average HP	Average Age	Model Year	Useful Life	Load Factor	Fuel Correction Factor			Deterioration Factor				Zero-Hour Emission Factor (g/bhp-hr)			
						NOx	PM	ROG	NOx	PM	ROG	CO	NOx	PM	ROG	CO
Tug Boats	1,274	6	2015	21	0.50	0.948	0.852	0.720	0.21	0.67	0.44	0.25	4.09	0.08	0.68	3.73
Crew and Supply	439	6	2015	22	0.45	0.948	0.852	0.720	0.21	0.67	0.44	0.25	3.99	0.08	0.68	3.73

Note:
Barges and dredgers are not typically self-propelled and emissions from barge/dredger propulsion engines are not estimated.
Model year equal to construction start date (year) minus average age of vessel.
A fuel correction factor of 0.72 for hydrocarbon emissions applied to all diesel-powered engines beginning with the 1994 calendar year.

Table A-135. Mitigated Propulsion Engine Emission Factors

Vessel Type	Aged Emission Factor - 2021 (g/bhp-hr)					Aged Emission Factor - 2022 (g/bhp-hr)					Aged Emission Factor - 2023 (g/bhp-hr)				
	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2
Tug Boats	0.31	0.04	0.28	2.00	0.0055	0.31	0.04	0.28	2.02	0.0055	0.31	0.04	0.29	2.04	0.0055
Crew and Supply	0.27	0.04	0.25	1.79	0.0055	0.27	0.04	0.25	1.81	0.0055	0.27	0.04	0.26	1.83	0.0055

Note:
Starting in 2007, California required the use of ultra low sulfur diesel fuel (ULSD - 15 ppmw sulfur).
SO2 (g/hp-hr) = (S content in X/1,000,000) x (2 SO2/g S) x BSFC (184 g/hp-hr)

Table A-136. Mitigated Auxiliary Engine Emission Factor Equation Variables

Vessel Type	Average HP	Average Age	Model Year	Useful Life	Load Factor	Fuel Correction Factor			Deterioration Factor				Zero-Hour Emission Factor (g/bhp-hr)			
						NOx	PM	ROG	NOx	PM	ROG	CO	NOx	PM	ROG	CO
Tug Boats	111	6	2015	23	0.31	0.948	0.852	0.720	0.14	0.44	0.28	0.16	5.32	0.22	0.99	3.73
Crew and Supply	79	6	2015	22	0.43	0.948	0.852	0.720	0.14	0.44	0.28	0.16	5.32	0.22	0.99	3.73

Note:
Model year equal to construction start date (year) minus average age of vessel.
A fuel correction factor of 0.72 for hydrocarbon emissions will be applied to all diesel-powered engines beginning with the 1994 calendar year.

Table A-137. Mitigated Auxiliary Engine Emission Factors

Vessel Type	Aged Emission Factor - 2021 (g/bhp-hr)					Aged Emission Factor - 2022 (g/bhp-hr)					Aged Emission Factor - 2023 (g/bhp-hr)				
	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2
Tug Boats	0.24	0.06	0.24	1.20	0.0055	0.24	0.07	0.24	1.21	0.0055	0.25	0.07	0.24	1.22	0.0055
Crew and Supply	0.34	0.09	0.33	1.67	0.0055	0.34	0.09	0.33	1.69	0.0055	0.34	0.09	0.34	1.70	0.0055

Note:
Starting in 2007, California required the use of ultra low sulfur diesel fuel (ULSD - 15 ppmw sulfur).
SO2 (g/hp-hr) = (S content in X/1,000,000) x (2 SO2/g S) x BSFC (184 g/hp-hr)

Construction Start Date 2021 (Tunneling and Spreading of Spoils)

Table A-138. Maximum Daily Mitigated Marine Vessel Emissions

Vessel Type	Quantity	Trips per Day	Hours per Trip	No. Propulsion Engines	No. Auxiliary Engines	Propulsion Engine Emissions (lbs/day)						Auxiliary Engine Emissions (lbs/day)						Total Engine Emissions (lbs/day)					
						ROG	NOx	CO	SO2	PM10	PM2.5	ROG	NOx	CO	SO2	PM10	PM2.5	ROG	NOx	CO	SO2	PM10	PM2.5
Tug Boats	2	2	2	2	2	12.38	13.85	89.80	0.25	1.82	1.68	0.93	0.95	4.72	0.02	0.25	0.23	13.31	14.80	94.51	0.27	2.08	1.91
Crew and Supply	2	2	2	3	1	5.73	6.27	41.65	0.13	0.84	0.78	0.46	0.47	2.33	0.01	0.13	0.12	6.19	6.74	43.98	0.14	0.97	0.89
Total	**4**	**4**	**4**	**5**	**3**	**18.12**	**20.12**	**131.44**	**0.38**	**2.67**	**2.45**	**1.39**	**1.42**	**7.05**	**0.03**	**0.38**	**0.35**	**19.50**	**21.54**	**138.49**	**0.41**	**3.05**	**2.80**

Note:
Hours per trip estimated to assume that marine vessels would be operating 8 hours per day.
PM2.5 emissions estimated using PM10 emissions and the California Emission Inventory and Reporting System (CEIDARS) particulate matter (PM) speciation profile no. 425 for diesel vehicle exhaust.
"Trips" represent one-day trips and are double the data provided by the engineers.

Table A-139. Annual Mitigated Marine Vessel Emissions by Year

	Annual Emissions - 2021 (tons per year)						Annual Emissions - 2022 (tons per year)						Annual Emissions - 2023 (tons per year)					
Vessel Type	**ROG**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**
Tug Boats																		
Propulsion Engines	0.29	0.33	2.11	0.01	0.04	0.04	0.50	0.56	3.64	0.01	0.07	0.07	0.04	0.05	0.31	0.00	0.01	0.01
Auxiliary Engines	0.02	0.02	0.11	0.00	0.01	0.01	0.04	0.04	0.19	0.00	0.01	0.01	0.00	0.00	0.02	0.00	0.00	0.00
Tug Boats Subtotal	0.31	0.35	2.22	0.01	0.05	0.04	0.54	0.60	3.83	0.01	0.08	0.08	0.05	0.05	0.33	0.00	0.01	0.01
Crew and Supply																		
Propulsion Engines	0.13	0.15	0.98	0.00	0.02	0.02	0.23	0.25	1.69	0.01	0.03	0.03	0.02	0.02	0.15	0.00	0.00	0.00
Auxiliary Engines	0.01	0.01	0.05	0.00	0.00	0.00	0.02	0.02	0.09	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Crew and Supply Subtotal	0.15	0.16	1.03	0.00	0.02	0.02	0.25	0.27	1.78	0.01	0.04	0.04	0.02	0.02	0.15	0.00	0.00	0.00
Grand Total	**0.46**	**0.51**	**3.25**	**0.01**	**0.07**	**0.07**	**0.79**	**0.87**	**5.61**	**0.02**	**0.12**	**0.11**	**0.07**	**0.08**	**0.48**	**0.00**	**0.01**	**0.01**

Note:
Hours per trip estimated to assume that marine vessels would be operating 8 hours per day.
PM2.5 emissions estimated using PM10 emissions and the California Emission Inventory and Reporting System (CEIDARS) particulate matter (PM) speciation profile no. 425 for diesel vehicle exhaust.
"Trips" represent one-day trips and are double the data provided by the engineers.

ROG, CO, NOx, or PM Emission Estimation Method

$$E = EF_0 \times F \times \left(1 + D \times \frac{A}{UL}\right) \times HP \times LF \times Hr$$

Where:
E = amount of emissions of a pollutant (PM and NOx) emitted during one period
EF_0 = the model year, horsepower, and engine use (propulsion or auxiliary) specific zero hour emission factor (when engine is new)
F = fuel correction factor that accounts for emission reduction benefits from burning cleaner fuel
D = horsepower and pollutant specific engine deterioration factor, which is the percentage increase of emission factors at the end of the useful life of the engine
A = age of the engine when the emissions are estimated
UL = vessel type and engine use specific engine useful life
HP = rated horsepower of the engine
LF = vessel type and engine use specific engine load factor
Hr = number of annual operating hours of the engine

Source: California Air Resources Board. 2010. Staff Report: Initial Statement of Reasons for the Proposed Rulemaking. Amendments to the Regulations to Reduce Emissions from Diesel Engines on Commercial Harbor Craft Operated Within California Waters and 24 Nautical Miles of the California Baseline.
http://www.arb.ca.gov/ports/marinevess/harborcraft/hcdocuments.htm

SOx Emission Estimation Method

$$F_c = HP \times LF \times Hr \times BSFC$$

Where:	Fc	=	fuel consumed per engine per year
	HP	=	rated horsepower of the engine
	Hr	=	number of annual operating hours of the engine
	LF	=	vessel type specific engine load factor
	BSFC	=	brake specific fuel consumption rate; 0.078 gal/kW-hr or 184 g/hp-hr

The sulfur content is assumed to be 15ppm per 13 CCR 2281(a).

Conversion Factors

453.6	grams per pound
2000	pounds per ton

PMSIZE Profile

0.92	PM2.5:PM10

Profile No. 425, Diesel Vehicle Exhaust

Trips per Project

2021	94
2022	162
2023	14
Total	270

Mitigation Measures

Ships, Propulsion Engines

-Selective Catalytic Reduction with low sulfur fuel	85%	NOx reduction

Ships, Auxiliary Engines

-Selective Catalytic Reduction with low sulfur fuel	85%	NOx reduction

Tug Boats	61%	VOC reduction
Crew and Supply	52%	VOC reduction

Lower San Felipe Intake Alternative - Pipeline Option
Marine Emissions

Table A-140. Mitigated Propulsion Engine Emission Factor Equation Variables

Vessel Type	Average HP	Average Age	Model Year	Useful Life	Load Factor	Fuel Correction Factor			Deterioration Factor				Zero-Hour Emission Factor (g/bhp-hr)			
						NOx	PM	ROG	NOx	PM	ROG	CO	NOx	PM	ROG	CO
Tug Boats	1,274	6	2015	21	0.50	0.948	0.852	0.720	0.21	0.67	0.44	0.25	4.09	0.08	0.68	3.73
Crew and Supply	439	6	2015	22	0.45	0.948	0.852	0.720	0.21	0.67	0.44	0.25	3.99	0.08	0.68	3.73

Note:
Barges and dredgers are not typically self-propelled and emissions from barge/dredger propulsion engines are not estimated.
Model year equal to construction start date (year) minus average age of vessel.
A fuel correction factor of 0.72 for hydrocarbon emissions applied to all diesel-powered engines beginning with the 1994 calendar year.

Table A-141. Mitigated Propulsion Engine Emission Factors

Vessel Type	Aged Emission Factor - 2021 (g/bhp-hr)					Aged Emission Factor - 2022 (g/bhp-hr)					Aged Emission Factor - 2023 (g/bhp-hr)				
	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2
Tug Boats	0.31	0.04	0.28	2.00	0.0055	0.31	0.04	0.28	2.02	0.0055	0.31	0.04	0.29	2.04	0.0055
Crew and Supply	0.27	0.04	0.25	1.79	0.0055	0.27	0.04	0.25	1.81	0.0055	0.27	0.04	0.26	1.83	0.0055

Note:
Starting in 2007, California required the use of ultra low sulfur diesel fuel (ULSD - 15 ppmw sulfur).
SO2 (g/hp-hr) = (S content in X/1,000,000) x (2 SO2/g S) x BSFC (184 g/hp-hr)

Table A-142. Mitigated Auxiliary Engine Emission Factor Equation Variables

Vessel Type	Average HP	Average Age	Model Year	Useful Life	Load Factor	Fuel Correction Factor			Deterioration Factor				Zero-Hour Emission Factor (g/bhp-hr)			
						NOx	PM	ROG	NOx	PM	ROG	CO	NOx	PM	ROG	CO
Tug Boats	111	6	2015	23	0.31	0.948	0.852	0.720	0.14	0.44	0.28	0.16	5.32	0.22	0.99	3.73
Crew and Supply	79	6	2015	22	0.43	0.948	0.852	0.720	0.14	0.44	0.28	0.16	5.32	0.22	0.99	3.73

Note:
Model year equal to construction start date (year) minus average age of vessel.
A fuel correction factor of 0.72 for hydrocarbon emissions will be applied to all diesel-powered engines beginning with the 1994 calendar year.

Table A-143. Mitigated Auxiliary Engine Emission Factors

Vessel Type	Aged Emission Factor - 2021 (g/bhp-hr)					Aged Emission Factor - 2022 (g/bhp-hr)					Aged Emission Factor - 2023 (g/bhp-hr)				
	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2
Tug Boats	0.24	0.06	0.24	1.20	0.0055	0.24	0.07	0.24	1.21	0.0055	0.25	0.07	0.24	1.22	0.0055
Crew and Supply	0.34	0.09	0.33	1.67	0.0055	0.34	0.09	0.33	1.69	0.0055	0.34	0.09	0.34	1.70	0.0055

Note:
Starting in 2007, California required the use of ultra low sulfur diesel fuel (ULSD - 15 ppmw sulfur).
SO2 (g/hp-hr) = (S content in X/1,000,000) x (2 SO2/g S) x BSFC (184 g/hp-hr)

Construction Start Date 2021 (Lay Pipeline)

Table A-144. Maximum Daily Mitigated Marine Vessel Emissions

Vessel Type	Quantity	Trips per Day	Hours per Trip	No. Propulsion Engines	No. Auxiliary Engines	Propulsion Engine Emissions (lbs/day)						Auxiliary Engine Emissions (lbs/day)						Total Engine Emissions (lbs/day)					
						ROG	NOx	CO	SO2	PM10	PM2.5	ROG	NOx	CO	SO2	PM10	PM2.5	ROG	NOx	CO	SO2	PM10	PM2.5
Tug Boats	4	2	2	2	2	24.77	27.70	179.59	0.50	3.65	3.36	1.86	1.90	9.43	0.04	0.51	0.47	26.62	29.61	189.03	0.54	4.16	3.82
Crew and Supply	4	2	2	3	1	11.46	12.54	83.29	0.26	1.69	1.55	0.92	0.94	4.66	0.02	0.25	0.23	12.38	13.48	87.96	0.27	1.94	1.78
Total	**8**	**4**	**4**	**5**	**3**	**36.23**	**40.24**	**262.88**	**0.75**	**5.33**	**4.91**	**2.78**	**2.84**	**14.10**	**0.06**	**0.76**	**0.70**	**39.01**	**43.09**	**276.98**	**0.81**	**6.09**	**5.61**

Note:
Hours per trip estimated to assume that marine vessels would be operating 8 hours per day.
PM2.5 emissions estimated using PM10 emissions and the California Emission Inventory and Reporting System (CEIDARS) particulate matter (PM) speciation profile no. 425 for diesel vehicle exhaust.
"Trips" represent one-day trips and are double the data provided by the engineers.

Table A-145. Annual Mitigated Marine Vessel Emissions by Year

	Annual Emissions - 2021 (tons per year)						Annual Emissions - 2022 (tons per year)					
Vessel Type	**ROG**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**	**ROG**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**
Tug Boats												
Propulsion Engines	3.00	3.36	21.78	0.06	0.44	0.41	1.57	1.76	11.40	0.03	0.23	0.21
Auxiliary Engines	0.23	0.23	1.14	0.01	0.06	0.06	0.12	0.12	0.60	0.00	0.03	0.03
Tug Boats Subtotal	3.23	3.59	22.92	0.07	0.50	0.46	1.69	1.88	12.00	0.03	0.26	0.24
Crew and Supply												
Propulsion Engines	1.39	1.52	10.10	0.03	0.20	0.19	0.73	0.80	5.29	0.02	0.11	0.10
Auxiliary Engines	0.11	0.11	0.57	0.00	0.03	0.03	0.06	0.06	0.30	0.00	0.02	0.01
Crew and Supply Subtotal	1.50	1.63	10.66	0.03	0.23	0.22	0.79	0.86	5.59	0.02	0.12	0.11
Grand Total	**4.73**	**5.22**	**33.58**	**0.10**	**0.74**	**0.68**	**2.48**	**2.74**	**17.59**	**0.05**	**0.39**	**0.36**

Note:
Hours per trip estimated to assume that marine vessels would be operating 8 hours per day.
PM2.5 emissions estimated using PM10 emissions and the California Emission Inventory and Reporting System (CEIDARS) particulate matter (PM) speciation profile no. 425 for diesel vehicle exhaust.
"Trips" represent one-day trips and are double the data provided by the engineers.

ROG, CO, NOx, or PM Emission Estimation Method

$$E = EF_0 \times F \times \left(1 + D \times \frac{A}{UL}\right) \times HP \times LF \times Hr$$

Where:
- E = amount of emissions of a pollutant (PM and NOx) emitted during one period
- EF_0 = the model year, horsepower, and engine use (propulsion or auxiliary) specific zero hour emission factor (when engine is new)
- F = fuel correction factor that accounts for emission reduction benefits from burning cleaner fuel
- D = horsepower and pollutant specific engine deterioration factor, which is the percentage increase of emission factors at the end of the useful life of the engine
- A = age of the engine when the emissions are estimated
- UL = vessel type and engine use specific engine useful life
- HP = rated horsepower of the engine
- LF = vessel type and engine use specific engine load factor
- Hr = number of annual operating hours of the engine

Source: California Air Resources Board. 2010. Staff Report: Initial Statement of Reasons for the Proposed Rulemaking. Amendments to the Regulations to Reduce Emissions from Diesel Engines on Commercial Harbor Craft Operated Within California Waters and 24 Nautical Miles of the California Baseline.
http://www.arb.ca.gov/ports/marinevess/harborcraft/hcdocuments.htm

SOx Emission Estimation Method

$$F_c = HP \times LF \times Hr \times BSFC$$

Where:	Fc	=	fuel consumed per engine per year
	HP	=	rated horsepower of the engine
	Hr	=	number of annual operating hours of the engine
	LF	=	vessel type specific engine load factor
	BSFC	=	brake specific fuel consumption rate; 0.078 gal/kW-hr or 184 g/hp-hr

The sulfur content is assumed to be 15ppm per 13 CCR 2281(a).

Conversion Factors

453.6	grams per pound
2000	pounds per ton

Trips per Project

2021	485
2022	254
Total	739

PMSIZE Profile

0.92 PM2.5:PM10
Profile No. 425, Diesel Vehicle Exhaust

Mitigation Measures

Ships, Propulsion Engines
-Selective Catalytic Reduction with low sulfur fuel 85% NOx reduction

Ships, Auxiliary Engines
-Selective Catalytic Reduction with low sulfur fuel 85% NOx reduction

Tug Boats 61% VOC reduction
Crew and Supply 52% VOC reduction

http://www.aqmd.gov/home/rules-compliance/ceqa/air-quality-analysis-handbook/mitigation-measures-and-control-efficiencies/ocean-going-vessels

Lower San Felipe Intake Alternative - Pipeline Option
Dredge Emissions

Table A-146. Mitigated Emission Factor Equation Variables

Engine Type	Average HP	Average Age	Model Year	Useful Life	Load Factor	Fuel Correction Factor			Deterioration Factor				Zero-Hour Emission Factor (g/bhp-hr)			
						NOx	PM	ROG	NOx	PM	ROG	CO	NOx	PM	ROG	CO
Compressor	353	6	2015	19.5	0.5384	0.948	0.852	0.72	0.21	0.67	0.44	0.25	1.36	0.01	0.0847	0.92
Crane	377	6	2015	9	0.42016	0.948	0.852	0.72	0.21	0.67	0.44	0.25	1.36	0.01	0.0847	0.92
Deck door engine	86	6	2015	16	0.88989	0.948	0.852	0.72	0.14	0.44	0.28	0.16	2.53	0.01	0.1089	3.05
Generator	464	6	2015	22.5	0.74576	0.948	0.852	0.72	0.21	0.67	0.44	0.25	1.36	0.01	0.0847	0.92
Hoist swing winch	379	6	2015	27	0.31182	0.948	0.852	0.72	0.21	0.67	0.44	0.25	1.36	0.01	0.0847	0.92
Other	390	6	2015	16	0.80208	0.948	0.852	0.72	0.21	0.67	0.44	0.25	1.36	0.01	0.0847	0.92
Pump	518	6	2015	21	0.71213	0.948	0.852	0.72	0.21	0.67	0.44	0.25	1.36	0.01	0.0847	0.92

Note:
Model year equal to construction start date (year) minus average age of vessel.
A fuel correction factor of 0.72 for hydrocarbon emissions will be applied to all diesel-powered engines beginning with the 1994 calendar year.

Table A-147. Mitigated Dredging Auxiliary Engine Emission Factors

Engine Type	Aged Emission Factor - 2021 (g/bhp-hr)					Aged Emission Factor - 2022 (g/bhp-hr)				
	NOx	PM10	ROG	CO	SO2	NOx	PM10	ROG	CO	SO2
Compressor	0.74	0.01	0.04	0.53	0.0055	0.75	0.01	0.04	0.54	0.0055
Crane	0.62	0.01	0.03	0.45	0.0055	0.63	0.01	0.03	0.46	0.0055
Deck door engine	2.25	0.01	0.08	2.88	0.0055	2.27	0.01	0.08	2.90	0.0055
Generator	1.02	0.01	0.05	0.73	0.0055	1.02	0.01	0.05	0.74	0.0055
Hoist swing winch	0.42	0.00	0.02	0.30	0.0055	0.42	0.00	0.02	0.31	0.0055
Other	1.12	0.01	0.06	0.81	0.0055	1.13	0.01	0.06	0.82	0.0055
Pump	0.97	0.01	0.05	0.70	0.0055	0.98	0.01	0.05	0.71	0.0055

Note:
Starting in 2007, California required the use of ultra low sulfur diesel fuel (ULSD - 15 ppmw sulfur).
SO2 (g/hp-hr) = (S content in X/1,000,000) x (2 SO2/g S) x BSFC (184 g/hp-hr)

Construction Start Date 2021 (Lay Pipeline)

Table A-148. Mitigated Maximum Daily Emissions

Type	Quantity	Hours/ Day	Daily Emissions (lbs/day)					
			ROG	NOx	CO	SO2	PM10	PM2.5
Compressor	1	20	0.58	11.50	8.30	0.09	0.09	0.08
Crane	1	20	0.55	10.27	7.50	0.09	0.09	0.08
Deck door engine	1	20	0.29	8.52	10.91	0.02	0.03	0.03
Generator	1	20	1.04	20.77	14.97	0.11	0.15	0.14
Hoist swing winch	1	20	0.35	7.03	5.06	0.09	0.05	0.05
Other	1	20	0.98	19.18	13.88	0.09	0.15	0.14
Pump	1	20	1.12	22.23	16.03	0.13	0.17	0.15
		Total	**4.91**	**99.50**	**76.65**	**0.62**	**0.72**	**0.66**

Note: Emissions based on 2021 calendar year because this would represent the worst-case (highest) emissions scenario.

Table A-149. Mitigated Annual Emissions

Type	Trips/ Project	Trips per Year 2021	Trips per Year 2022	Hours/ Day	Annual Emissions - 2021 (tons/year) ROG	NOx	CO	SO2	PM10	PM2.5	Annual Emissions - 2022 (tons/year) ROG	NOx	CO	SO2	PM10	PM2.5
Compressor	12	11	1	20	0.00	0.06	0.05	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Crane	12	11	1	20	0.00	0.06	0.04	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Deck door engine	12	11	1	20	0.00	0.05	0.06	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Generator	12	11	1	20	0.01	0.11	0.08	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
Hoist swing winch	12	11	1	20	0.00	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other	12	11	1	20	0.01	0.11	0.08	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
Pump	12	11	1	20	0.01	0.12	0.09	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
			Total		**0.03**	**0.55**	**0.42**	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**	**0.04**	**0.00**	**0.00**	**0.00**

Conversions
453.6 g/lb
2,000 lbs/ton

PMSIZE Ratio
0.92 PM2.5:PM10
Profile No. 425, Diesel Vehicle Exhaust

Dredge Trips
1 dredge (1 trip per day)
12 trips per project

CVP Enlarged Reservoir Expansion Alternative

Table A-150. Mitigated Onsite Construction Equipment Emissions

Equipment Type	Quantity	OFFROAD Description	HP	Hours per Day	Emission Factors (g/hp-hr or g/mi)						Daily Emissions (lb/day)						Annual Emissions (tons/year)					
					ROG	CO	NOX	SO2	PM10	PM2.5	ROG	CO	NOX	SO2	PM10	PM2.5	ROG	CO	NOX	SO2	PM10	PM2.5
Excavators	3	ConstMin - Excavators	158	20	0.027	1.102	0.020	0.002	0.004	0.003	0.55	23.02	0.42	0.04	0.08	0.07	0.10	4.20	0.08	0.01	0.01	0.01
Bulldozers	4	ConstMin - Rubber Tired Dozers	249	20	0.034	0.400	0.021	0.002	0.004	0.004	1.48	17.57	0.93	0.08	0.17	0.16	0.27	3.21	0.17	0.02	0.03	0.03
Cranes/Lifts	5	ConstMin - Cranes	231	20	0.018	0.278	0.015	0.001	0.003	0.002	0.91	14.14	0.77	0.07	0.13	0.12	0.17	2.58	0.14	0.01	0.02	0.02
Compactors	5	ConstMin - Rollers	80	20	0.030	1.185	0.101	0.002	0.004	0.003	0.53	20.89	1.79	0.03	0.06	0.06	0.10	3.81	0.33	0.01	0.01	0.01
Graders	2	ConstMin - Graders	188	20	0.029	0.400	0.022	0.002	0.004	0.004	0.47	6.63	0.36	0.03	0.06	0.06	0.09	1.21	0.07	0.01	0.01	0.01
Scrapers	2	ConstMin - Scrapers	367	20	0.032	0.465	0.026	0.002	0.004	0.004	1.04	15.04	0.83	0.08	0.14	0.13	0.19	2.75	0.15	0.01	0.03	0.02
Loaders (small)	2	ConstMin - Rubber Tired Loaders	188	20	0.029	0.363	0.019	0.002	0.003	0.003	0.48	6.02	0.32	0.03	0.06	0.05	0.09	1.10	0.06	0.01	0.01	0.01
Loaders (large)	3	ConstMin - Rubber Tired Loaders	541	20	0.034	0.366	0.020	0.002	0.004	0.003	2.40	26.18	1.42	0.13	0.26	0.24	0.44	4.78	0.26	0.02	0.05	0.04
Dump trucks	13	ConstMin - Off-Highway Trucks	403	20	0.040	0.394	0.021	0.002	0.004	0.004	9.20	90.90	4.90	0.43	0.92	0.85	1.68	16.59	0.89	0.08	0.17	0.15
Water Trucks	5		N/A	20	0.068	1.170	0.079	0.004	0.051	0.024	0.22	3.87	0.26	0.01	0.17	0.08	0.04	0.71	0.05	0.00	0.03	0.01
Offroad equipment have units of g/hp-hr; onroad equipment have units of g/mi.										**Total**	**17.29**	**224.28**	**12.00**	**0.94**	**2.06**	**1.82**	3.16	40.93	2.19	0.17	0.38	0.33

Note:
Offroad equipment emission factors from OFFROAD2017 model.
Onroad truck emission factors from EMFAC2014.

Sources:
OFFROAD2017: https://www.arb.ca.gov/orion/
EMFAC2014: http://www.arb.ca.gov/emfac/2014/

Operating Schedule

2 shifts per day
10 hours per shift
365 days per year

Construction Start: 2020

Speed Limit for Onroad Vehicles (Onsite)

15 miles per hour
(speed limit is 35 mph on site, but it is assumed that a water truck will be operating at a lower rate of speed)

Conversions

453.6 grams per pound
2,000 pounds per ton

Mitigation Measures

Diesel oxidation catalyst
80% NOx reduction

CVP Enlarged Reservoir Expansion Alternative
Offsite Construction Emissions

Table A-151. Mitigated Emission Factors (g/mi)

Source	ROG	CO	NOx	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust	PM2.5 Total
Construction workers	0.015	0.753	0.078	0.003	0.002	0.008	0.037	0.100	0.147	0.002	0.002	0.016	0.025	0.045
Haul trucks	0.053	0.311	0.755	0.014	0.003	0.036	0.062	0.100	0.201	0.003	0.009	0.026	0.025	0.064

Table A-152. Mitigated Daily Emissions (pounds per day)

Source	ROG	CO	NOx	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust	PM2.5 Total
Construction workers	0.59	28.83	2.97	0.12	0.07	0.31	1.41	3.84	5.63	0.06	0.08	0.60	0.96	1.71
Haul trucks	2.23	13.15	31.97	0.59	0.14	1.52	2.61	4.25	8.53	0.13	0.38	1.12	1.06	2.70
Total	**2.81**	**41.98**	**34.94**	**0.71**	**0.21**	**1.83**	**4.02**	**8.10**	**14.16**	**0.20**	**0.46**	**1.72**	**2.02**	**4.40**

Table A-153. Mitigated Annual Emissions (tons per year)

Source	ROG	CO	NOx	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust	PM2.5 Total
Construction workers	0.11	5.26	0.54	0.02	0.01	0.06	0.26	0.70	1.03	0.01	0.01	0.11	0.18	0.31
Haul trucks	0.41	2.40	5.83	0.11	0.03	0.28	0.48	0.78	1.56	0.02	0.07	0.20	0.19	0.49
Total	**0.51**	**7.66**	**6.38**	**0.13**	**0.04**	**0.33**	**0.73**	**1.48**	**2.58**	**0.04**	**0.08**	**0.31**	**0.37**	**0.80**

One-way trip distance			Maximum Daily Workers and Trucks		
Workers	40	miles per trip	217	workers per day	(130 day time workers and 87 night time workers)
Trucks	40	miles per trip	240	trucks per day	

Conversions			Operating Schedule		Construction Start Year
453.6	grams per pound		365	days per year	2020
2,000	pounds per ton				

CVP Enlarged Reservoir Expansion Alternative
Fugitive Dust Emissions - Material Handling

Excavated Volume
11,200 cubic yards per shift
8,176,000 cubic yards per year

Equation (AP-42, Chapter 13.2.4):

$$E = k(0.0032)\frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

where:
E = emission factor, pound per ton
k = particle size multiplier
U = mean wind speed, miles per hour
M = material moisture content, %

Average Wind Speed 9.64 mph
Source: MesoWest, Station CF031 (Rt. 152 San Luis), 2015 data. Accessed on: July 27, 2016. Available at: mesowest.utah.edu.

Material Moisture Content: 7.9 %
Source: EPA. 1998. AP-42, Chapter 11-9, Overburden moisture content, bulldozing.

Table A-154. Material Handling Emissions

		EF	Emissions	
Size	k	lb/ton	lbs/day	tpy
PM10	0.35	3.8E-04	8.4	1.5
PM2.5	0.053	5.8E-05	1.3	0.2

Operating Schedule
2 shift per day
7 days per week
365 days per year

Density
1.25 tons per cubic yard
Note: CalEEMod assumes haul trucks can handle 20 tons or 16 cy.

Number of Drops
2 drops per truck *(one drop at borrow site and one drop at dam site)*

Dust Control
61% reduction from watering at least 3 times per day
Source: CalEEMod

CVP Enlarged Reservoir Expansion Alternative
Fugitive Dust Emissions - Grading

Operating Schedule

2	graders
7.1	miles per hour (AP-42, Table 11.9-3)
20	hours per day (total)
142	miles per day
51,830	miles per year *assumes 365 days per year*

Equations (AP-42, Chapter 11.9):

$TSP = 0.040(S)^{2.5}$ and $PM15 = 0.051(S)^{2.0}$

where:
S = mean vehicle speed, miles per hour

Scaling Factors

PM10	0.60	(multiply the 15-micron equation by this fraction to determine emissions)
PM2.5	0.031	(multiply the TSP equation by this fraction to determine emissions)

Table A-155. Grading Emissions

	EF	Emissions	
Size	lb/VMT	lbs/day	tpy
PM10	1.54	85.4	15.6
PM2.5	0.17	9.2	1.7

Dust Control

61% reduction from watering at least 3 times per day

Source: CalEEMod

CVP Enlarged Reservoir Expansion Alternative
Fugitive Dust Emissions - Bulldozing

Operating Schedule

4	bulldozers	
20	hours per day (total)	
7,300	hours per year (total)	*assumes 365 days per year*

Equations (AP-42, Chapter 11.9):

$$TSP = \frac{5.7(s)^{1.2}}{M^{1.3}} \quad \text{and} \quad PM15 = \frac{1.0(s)^{1.5}}{M^{1.4}}$$

where:

s = silt content	6.9 %	(AP-42, Table 11.9-3, Overburden)
M = material moisture content	7.9 %	(AP-42, Table 11.9-3, Overburden)

Scaling Factors

PM10	0.75	(multiply the 15-micron equation by this fraction to determine emissions)
PM2.5	0.105	(multiply the TSP equation by this fraction to determine emissions)

Table A-156. Bulldozing Emissions

	EF	Emissions	
Size	lb/hr	lbs/day	tpy
PM10	0.75	5.9	1.1
PM2.5	0.41	3.2	0.6

Dust Control

61% reduction from watering at least 3 times per day

Source: CalEEMod

CVP Enlarged Reservoir Expansion Alternative
Fugitive Dust Emissions - Paved Road Dust (Haul Roads)

Number of Trucks	13		
Excavated quantity	11,200	cubic yards per shift	
Number of shifts	2	shift per day	
	1,723	cubic yards per truck per day	
	46.75	cubic yards per truck (body capacity)	
	74	trips per day per truck (loaded and unloaded trips)	
Haul Road Length	0.8	miles one-way (paved road; total route is 3.2 miles)	
	770	miles per day	
	280,904	miles per year	*assumes 365 days per year*

Table A-157. Paved Road Dust Emissions

	EF, g/VMT		Emissions	
Size	Uncontrolled	Controlled	lbs/day	tpy
PM10	22.2	21.5	7.5	1.3
PM2.5	5.6	5.4	1.9	0.3

Note: Uncontrolled EF used for daily emissions and controlled EF used for annual emissions.

Dust Control

80% assumes pipe-grid trackout-control device installed

Source: SCAQMD, Mitigation Measures, Fugitive Dust from Paved Roads
http://www.aqmd.gov/home/regulations/ceqa/air-quality-analysis-handbook/mitigation-measures-and-control-efficiencies/fugitive-dust

Conversions

453.6 grams per pound
2,000 pounds per ton

Percentage of haul route paved (estimated from Google Earth) 25%

CVP Enlarged Reservoir Expansion Alternative
Fugitive Dust Emissions - Unpaved Road Dust (Haul Roads)

Number of Trucks	13		
Excavated quantity	11,200	cubic yards per shift	
Number of shifts	2	shift per day	
	1,723	cubic yards per truck per day	
	46.75	cubic yards per truck (body capacity)	
	74	trips per day per truck (loaded and unloaded trips)	
Haul Road Length	2.4	miles one-way (unpaved road; total route is 3.2 miles)	
	2,309	miles per day	
	842,712	miles per year	*assumes 365 days per year*

Equations (AP-42, Chapter 13.2.2):

$$E = k(s/12)^a(W/3)^b$$

$$E_{ext} = E[(365 - P)/365]$$

where:
k, a, and b are empirical constants
E = size-specific emission factor (lb/VMT)
s = surface material silt content (%)
W = mean vehicle weight (tons)
Eext = annual size-specific emission factor extrapolated for natural mitigation
P = number of days in a year with at least 0.254 mm (0.01 in) of precipitation

silt content (construction)	8.5	%	(AP-42, Table 13.2.2-1)
days of precipitation	49		(CalEEMod default)
Unloaded truck weight	50	tons	
Loaded truck weight	126	tons	
Average vehicle weight	88	tons	(estimated from eqiupment specifications)

Table A-158. Mitigated Unpaved Road Dust Emissions

Size	k	a	b	EF, lb/VMT		Emissions	
				Uncontrolled	Controlled	lbs/day	tpy
PM10	1.5	0.9	0.45	5.0	4.4	116.1	18.3
PM2.5	0.15	0.9	0.45	0.5	0.4	11.6	1.8

Source: AP-42, Table 13.2.2-2

Dust Control

61%	reduction from watering at least 3 times per day
99%	paving all unpaved roads (mitigation)

Source: CalEEMod

Percentage of haul route unpaved 75%
(estimated from Google Earth)

Conversions

2,000	pounds per ton

EMFAC2014 Emission Factors
On-Road Motor Vehicles

Table A-159. Mitigated Emission Factors for Construction Worker Commutes

		grams per mile												
Air Basin	Year	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
San Joaquin Valley	2020	0.0153	0.0223	0.0776	0.7533	0.0031	0.0018	0.0080	0.0368	0.0466	0.0017	0.0020	0.0158	0.0194
	2021	0.0137	0.0199	0.0692	0.6917	0.0030	0.0018	0.0080	0.0368	0.0465	0.0017	0.0020	0.0158	0.0194
	2022	0.0123	0.0179	0.0621	0.6401	0.0029	0.0018	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0194
	2023	0.0111	0.0161	0.0560	0.5941	0.0028	0.0017	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0193
	2024	0.0100	0.0146	0.0507	0.5567	0.0026	0.0017	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0193

Note:
Vehicle fleet mix includes gasoline, diesel, and electric automobiles (LDA) and light-duty trucks (LDT1 and LDT2).

Table A-160. Mitigated Emission Factors for Haul and Delivery Trucks

		grams per mile												
Air Basin	Year	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
San Joaquin Valley	2020	0.0526	0.0599	0.7553	0.3107	0.0140	0.0033	0.0360	0.0617	0.1010	0.0031	0.0090	0.0265	0.0386
	2021	0.0534	0.0608	0.7745	0.3155	0.0140	0.0034	0.0360	0.0617	0.1011	0.0032	0.0090	0.0265	0.0387
	2022	0.0544	0.0619	0.7971	0.3211	0.0140	0.0034	0.0360	0.0617	0.1012	0.0033	0.0090	0.0265	0.0388
	2023	0.0562	0.0640	0.8405	0.3318	0.0141	0.0036	0.0360	0.0617	0.1014	0.0035	0.0090	0.0265	0.0389
	2024	0.0568	0.0647	0.8553	0.3355	0.0140	0.0037	0.0360	0.0617	0.1014	0.0035	0.0090	0.0265	0.0390

Table A-161. Mitigated Emission Factors for On-Site Water Trucks (San Joaquin Valley Air Basin)

		grams per mile												
Year	Speed	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
2020	5	0.185	0.211	0.141	3.206	0.004	0.007	0.008	0.037	0.052	0.007	0.002	0.016	0.025
2020	10	0.139	0.158	0.117	2.398	0.004	0.007	0.008	0.037	0.052	0.007	0.002	0.016	0.024
2020	15	0.068	0.077	0.079	1.170	0.004	0.006	0.008	0.037	0.051	0.006	0.002	0.016	0.024
2020	20	0.026	0.030	0.052	0.455	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2020	25	0.016	0.018	0.039	0.273	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2020	30	0.012	0.014	0.033	0.206	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2020	35	0.009	0.011	0.028	0.164	0.004	0.004	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2020	40	0.008	0.009	0.025	0.135	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2020	45	0.007	0.008	0.023	0.115	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2020	50	0.006	0.007	0.021	0.099	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.020
2020	55	0.005	0.006	0.019	0.087	0.004	0.003	0.008	0.037	0.047	0.003	0.002	0.016	0.020
2020	60	0.005	0.005	0.019	0.082	0.004	0.003	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2020	65	0.005	0.005	0.019	0.082	0.004	0.003	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2021	5	0.170	0.194	0.125	3.145	0.004	0.007	0.008	0.037	0.052	0.007	0.002	0.016	0.024
2021	10	0.127	0.145	0.104	2.351	0.004	0.006	0.008	0.037	0.051	0.006	0.002	0.016	0.024
2021	15	0.062	0.071	0.069	1.146	0.004	0.006	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2021	20	0.024	0.028	0.046	0.446	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.022
2021	25	0.014	0.016	0.035	0.268	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2021	30	0.011	0.012	0.029	0.202	0.004	0.004	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2021	35	0.009	0.010	0.025	0.161	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2021	40	0.007	0.008	0.022	0.133	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2021	45	0.006	0.007	0.020	0.112	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.020

Table A-161. Mitigated Emission Factors for On-Site Water Trucks (San Joaquin Valley Air Basin)

		grams per mile												
Year	Speed	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
2021	50	0.005	0.006	0.018	0.097	0.004	0.003	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2021	55	0.005	0.005	0.017	0.085	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2021	60	0.004	0.005	0.016	0.080	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2021	65	0.004	0.005	0.016	0.080	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2022	5	0.158	0.180	0.112	3.103	0.004	0.006	0.008	0.037	0.051	0.006	0.002	0.016	0.024
2022	10	0.118	0.135	0.093	2.319	0.004	0.006	0.008	0.037	0.051	0.006	0.002	0.016	0.023
2022	15	0.058	0.066	0.062	1.130	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2022	20	0.022	0.026	0.041	0.440	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2022	25	0.013	0.015	0.031	0.264	0.004	0.004	0.008	0.037	0.048	0.004	0.002	0.016	0.021
2022	30	0.010	0.012	0.026	0.199	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2022	35	0.008	0.009	0.022	0.159	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2022	40	0.007	0.008	0.020	0.131	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.020
2022	45	0.006	0.006	0.018	0.111	0.004	0.003	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2022	50	0.005	0.006	0.016	0.096	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2022	55	0.004	0.005	0.015	0.084	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2022	60	0.004	0.005	0.015	0.079	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2022	65	0.004	0.005	0.015	0.079	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2023	5	0.150	0.170	0.103	3.085	0.004	0.006	0.008	0.037	0.051	0.006	0.002	0.016	0.023
2023	10	0.112	0.127	0.085	2.304	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2023	15	0.054	0.062	0.057	1.122	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.022
2023	20	0.021	0.024	0.037	0.437	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2023	25	0.013	0.014	0.028	0.262	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2023	30	0.010	0.011	0.024	0.198	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2023	35	0.008	0.009	0.020	0.158	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.020
2023	40	0.006	0.007	0.018	0.130	0.004	0.003	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2023	45	0.005	0.006	0.016	0.110	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2023	50	0.005	0.005	0.015	0.095	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2023	55	0.004	0.005	0.014	0.083	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2023	60	0.004	0.004	0.013	0.079	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2023	65	0.004	0.004	0.013	0.079	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2024	5	0.143	0.162	0.095	3.074	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2024	10	0.106	0.121	0.079	2.295	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2024	15	0.052	0.059	0.052	1.117	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2024	20	0.020	0.023	0.035	0.436	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.021
2024	25	0.012	0.014	0.026	0.261	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2024	30	0.009	0.010	0.022	0.197	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2024	35	0.007	0.008	0.019	0.157	0.004	0.003	0.008	0.037	0.047	0.003	0.002	0.016	0.020
2024	40	0.006	0.007	0.017	0.130	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2024	45	0.005	0.006	0.015	0.110	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2024	50	0.004	0.005	0.014	0.095	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2024	55	0.004	0.004	0.013	0.083	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2024	60	0.004	0.004	0.012	0.079	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2024	65	0.004	0.004	0.012	0.078	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020

Emission Factors
Paved Road Dust Emissions

Equation 1:

$$E = k(sL)^{0.91} \times (W)^{1.02}$$

where: E = particulate emission factor (having units matching the units of k),
k = particle size multiplier for particle size range and units of interest (see below),
sL = road surface silt loading (grams per square meter) (g/m2), and
W = average weight (tons) of the vehicles traveling the road.

Equation 2:

$$E_{ext} = [k(sL)^{0.91} \times (W)^{1.02}](1 - P/4N)$$

where: k, sL, and W are as defined in Equation 1 and
E_{ext} = annual or other long-term average emission factor in the same units as k,
P = number of "wet" days with at least 0.254 mm (0.01 in) of precipitation during the averaging period, and
N = number of days in the averaging period (e.g., 365 for annual, 91 for seasonal, 30 for monthly).

Table A-162. Particle Size Multipliers for Paved Road Equation

Size Range [a]	Ref.	Particle Size Multiplier, k [b]		
		g/VKT	g/VMT	lb/VMT
$PM_{2.5}$	[c]	0.15	0.25	0.00054
PM_{10}		0.62	1.00	0.0022
PM_{15}		0.77	1.23	0.0027
PM_{30}	[d]	3.23	5.24	0.011

Source: USEPA. 2011. Compilation of Air Pollutant Emission Factors (AP-42). Fifth Edition, Volume I. Chapter 13.2.1 Paved Roads. January. Available online at: http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf [Accessed July 17, 2012].

Notes:

[a] Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.

[b] Units shown are grams per vehicle kilometer traveled (g/VKT), grams per vehicle mile traveled (g/VMT), and pounds per vehicle mile traveled (lb/VMT). The multiplier k includes unit conversions to produce emission factors in the units shown for the indicated size range from the mixed units required in Equation 1.

[c] The k-factors for $PM_{2.5}$ were based on the average $PM_{2.5}$:PM_{10} ratio of test runs in Reference 30.

[d] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

Offsite Construction Vehicles

Number precipitation days >0.1 inches
Merced County 49

Road silt loading 0.03 g/m^2 (AP-42, Table 13.2.1-2, ADT > 10,000, ubiquitous baseline)
Average vehicle weight 2.4 tons

Source: CAPCOA. 2013. California Emissions Estimator Model User's Guide, Version 2013.2, Appendix D: Default Data Tables. Prepared by ENVIRON International Corporation and California Air Districts. July. Available online at: http://www.caleemod.com/ [Accessed on July 28, 2016].

Table A-163. Paved Road Dust Emission Factors - Offsite Construction Vehicles

	Emission Factor (g/VMT)			
	Uncontrolled		Controlled	
County	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Merced	0.100	0.025	0.097	0.024

Note:
Controlled emission factor only valid for long-term (annual) emissions; uncontrolled emission factor used for daily emissions.

Haul Road Vehicles

Number precipitation days >0.1 inches			
Merced County	49		
Road silt loading	0.2	g/m^2	(AP-42, Table 13.2.1-2, ADT 500-5,000, ubiquitous baseline)
Unloaded truck weight	50	tons	
	126	tons	
Average vehicle weight	88	tons	(estimated from eqiupment specifications)

Table A-164. Paved Road Dust Emission Factors - Onsite Haul Trucks

	Emission Factor (g/VMT)			
	Uncontrolled		Controlled	
County	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Merced	22.2	5.6	21.5	5.4

Note:
Controlled emission factor only valid for long-term (annual) emissions; uncontrolled emission factor used for daily emissions.

Mitigated Emissions Summary

Table A-165. New Pacheco Alternative - Maximum Daily Mitigated Emissions

Source	Daily Emissions (pounds per day)					
	ROG	NOx	CO	SOx	PM10	PM2.5
			2024			
Off-Road Construction Equipment	2,063.41	2,191.15	2,695.93	2,025.58	2,031.25	2,029.88
On-Road Haul Trucks and Delivery Vehicles	1.27	19.14	7.51	0.30	4.36	1.39
Construction Worker Commuting	0.49	2.51	27.71	0.13	7.77	2.35
Total	**2065.17**	**2212.80**	**2731.14**	**2026.02**	**2043.38**	**2033.62**
			2025			
Off-Road Construction Equipment	2,065.12	2,191.78	2,698.55	2,026.58	2,032.23	2,030.87
On-Road Haul Trucks and Delivery Vehicles	2.25	34.15	13.31	0.53	7.66	2.43
Construction Worker Commuting	0.45	2.30	25.93	0.13	7.77	2.35
Total	**2067.82**	**2228.23**	**2737.79**	**2027.24**	**2047.66**	**2035.65**
			2026			
Off-Road Construction Equipment	2,067.13	2,193.54	2,702.03	2,027.58	2,033.26	2,031.90
On-Road Haul Trucks and Delivery Vehicles	2.28	34.66	13.44	0.53	7.66	2.44
Construction Worker Commuting	0.62	3.19	36.64	0.19	11.65	3.52
Total	**2070.03**	**2231.39**	**2752.12**	**2028.30**	**2052.58**	**2037.86**
			2027			
Off-Road Construction Equipment	2,069.01	2,194.51	2,705.13	2,028.58	2,034.27	2,032.91
On-Road Haul Trucks and Delivery Vehicles	2.30	35.15	13.56	0.53	7.66	2.44
Construction Worker Commuting	0.60	3.12	36.58	0.19	12.29	3.71
Total	**2071.91**	**2232.78**	**2755.28**	**2029.30**	**2054.23**	**2039.05**
			2028			
Off-Road Construction Equipment	2,070.81	2,195.76	2,708.26	2,029.57	2,035.28	2,033.92
On-Road Haul Trucks and Delivery Vehicles	0.16	2.49	0.95	0.04	0.53	0.17
Construction Worker Commuting	0.56	2.90	34.72	0.18	12.28	3.70
Total	**2071.53**	**2201.14**	**2743.93**	**2029.80**	**2048.10**	**2037.79**
			2029			
Off-Road Construction Equipment	2,072.29	2,197.21	2,710.87	2,030.57	2,036.30	2,034.93
On-Road Haul Trucks and Delivery Vehicles	0.16	2.52	0.96	0.04	0.53	0.17
Construction Worker Commuting	0.30	1.57	19.10	0.10	7.11	2.14
Total	**2072.76**	**2201.29**	**2730.94**	**2030.71**	**2043.94**	**2037.24**
Maximum Daily Emissions	**2072.76**	**2232.78**	**2755.28**	**2030.71**	**2054.23**	**2039.05**
BAAQMD Significance Threshold	54	54	n/a	n/a	82	54
Significant?	Yes	Yes	n/a	n/a	Yes	Yes

Source: BAAQMD 2017

Table A-166. New Pacheco Alternative - Annual Mitigated Emissions

Source	Annual Emissions (tons per year)					
	ROG	NOx	CO	SOx	PM10	PM2.5
			2024			
Off-Road Construction Equipment	2,031.19	2,054.50	2,146.63	2,024.29	2,025.32	2,025.07
On-Road Haul Trucks and Delivery Vehicles	0.13	1.88	0.74	0.03	0.43	0.14
Construction Worker Commuting	0.07	0.33	3.68	0.02	1.03	0.31
Total	**2031.38**	**2056.72**	**2151.04**	**2024.34**	**2026.78**	**2025.52**
			2025			
Off-Road Construction Equipment	2,032.32	2,055.44	2,147.92	2,025.29	2,026.32	2,026.07
On-Road Haul Trucks and Delivery Vehicles	0.35	5.25	2.05	0.08	1.18	0.37
Construction Worker Commuting	0.07	0.37	4.15	0.02	1.24	0.38
Total	**2032.74**	**2061.06**	**2154.12**	**2025.39**	**2028.74**	**2026.82**
			2026			
Off-Road Construction Equipment	2,033.51	2,056.58	2,149.38	2,026.29	2,027.33	2,027.08
On-Road Haul Trucks and Delivery Vehicles	0.41	6.31	2.45	0.10	1.39	0.44
Construction Worker Commuting	0.10	0.52	5.93	0.03	1.89	0.57
Total	**2034.02**	**2063.40**	**2157.75**	**2026.41**	**2030.61**	**2028.09**
			2027			
Off-Road Construction Equipment	2,034.67	2,057.57	2,150.76	2,027.29	2,028.33	2,028.08
On-Road Haul Trucks and Delivery Vehicles	0.39	5.90	2.28	0.09	1.29	0.41
Construction Worker Commuting	0.10	0.51	5.96	0.03	2.00	0.60
Total	**2035.15**	**2063.98**	**2158.99**	**2027.41**	**2031.62**	**2029.09**
			2028			
Off-Road Construction Equipment	2,035.81	2,058.62	2,152.15	2,028.29	2,029.33	2,029.08
On-Road Haul Trucks and Delivery Vehicles	0.03	0.45	0.17	0.01	0.10	0.03
Construction Worker Commuting	0.09	0.47	5.65	0.03	2.00	0.60
Total	**2035.93**	**2059.54**	**2157.97**	**2028.32**	**2031.43**	**2029.71**
			2029			
Off-Road Construction Equipment	2,036.90	2,059.70	2,153.44	2,029.29	2,030.33	2,030.08
On-Road Haul Trucks and Delivery Vehicles	0.01	0.19	0.07	0.00	0.04	0.01
Construction Worker Commuting	0.04	0.20	2.48	0.01	0.92	0.28
Total	**2036.95**	**2060.09**	**2155.99**	**2029.30**	**2031.29**	**2030.37**
Maximum Annual Emissions	**2036.95**	**2063.98**	**2158.99**	**2029.30**	**2031.62**	**2030.37**
De Minimis Threshold	100	100	100	100	n/a	100
Significant?	Yes	Yes	Yes	Yes	n/a	Yes

Source: 40 CFR 93.153

Table A-167. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Emission Factors - 2024 (g/hp-hr or g/hr)					
							ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment												
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	53	110	1	g/hp-hr	0.0473	1.2805	0.1321	0.0019	0.0046	0.0043
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	71,036	170	2	g/hp-hr	0.0473	1.2805	0.1321	0.0019	0.0046	0.0043
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	110,098	305	3	g/hp-hr	0.0450	0.4176	0.1121	0.0020	0.0043	0.0039
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	1,867	202	1	g/hp-hr	0.0351	0.3779	0.0989	0.0018	0.0037	0.0034
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	59,824	373	2	g/hp-hr	0.0394	0.3749	0.1007	0.0018	0.0038	0.0035
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	9,507	699	1	g/hp-hr	0.0445	0.3825	0.1021	0.0018	0.0040	0.0037
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	914	193	1	g/hp-hr	0.0315	0.4253	0.1143	0.0021	0.0041	0.0037
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	138	36	1	g/hp-hr	0.0564	1.1974	1.0558	0.0020	0.0039	0.0036
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	70,318	200	2	g/hp-hr	0.0337	0.4133	0.1103	0.0020	0.0040	0.0037
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	914	27	1	g/hp-hr	0.0780	1.3552	1.0746	0.0020	0.0045	0.0041
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	11,600	235	1	g/hp-hr	0.0294	0.3694	0.0986	0.0018	0.0035	0.0033
2.0 CY Excavator	ConstMin - Excavators	Diesel	75	235	1	g/hp-hr	0.0319	0.3879	0.1031	0.0019	0.0037	0.0034
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,063	286	1	g/hp-hr	0.0294	0.3694	0.0986	0.0018	0.0035	0.0033
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	5,755	290	1	g/hp-hr	0.0294	0.3694	0.0986	0.0018	0.0035	0.0033
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	24,968	80	1	g/hp-hr	0.0428	1.2366	0.5148	0.0018	0.0043	0.0040
5 Ton Flatbed Truck	n/a - onroad	Diesel	5,457	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	83	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	5,080	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	256,985	340	6	g/hp-hr	0.0467	0.4056	0.1084	0.0019	0.0042	0.0039
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	43,944	680	2	g/hp-hr	0.0514	0.4139	0.1100	0.0019	0.0043	0.0040
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	12,112	783	1	g/hp-hr	0.0350	0.4688	1.1181	0.0024	0.0094	0.0086
22" Smooth Drum Manual (Bomag 55)	OFF - ConstMin - Rollers	Diesel	2,021	4	1	g/hp-hr	0.3113	1.6476	2.3691	0.0045	0.0906	0.0834
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	50	120	1	g/hp-hr	0.0233	1.0605	0.0983	0.0018	0.0035	0.0032
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	597	145	1	g/hp-hr	0.0233	1.0605	0.0983	0.0018	0.0035	0.0032
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	157	145	1	g/hp-hr	0.0233	1.0605	0.0983	0.0018	0.0035	0.0032
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	5,391	165	1	g/hp-hr	0.0233	1.0605	0.0983	0.0018	0.0035	0.0032
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	55	190	1	g/hp-hr	0.0246	0.3654	0.0991	0.0018	0.0035	0.0032
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	23,482	315	1	g/hp-hr	0.0241	0.3608	0.0993	0.0018	0.0035	0.0032
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	2,210	180	1	g/hp-hr	0.1006	0.8142	0.2089	0.0047	0.0081	0.0074
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	2,210	210	1	g/hp-hr	0.1006	0.8142	0.2089	0.0047	0.0081	0.0074
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	1,105	150	1	g/hp-hr	0.1006	2.3894	0.2089	0.0047	0.0086	0.0079
Concrete Equipment												
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	5,334	10	1	g/hp-hr	0.3080	1.8498	2.3368	0.0048	0.0907	0.0834
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	15,182	220	1	g/hp-hr	0.0248	0.3087	0.0703	0.0015	0.0036	0.0033
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	917	330	1	g/hp-hr	0.0247	0.3015	0.0535	0.0015	0.0037	0.0034
Grout Pump	OFF - Light Commercial - Pumps	Diesel	8,685	18	1	g/hp-hr	0.4110	2.2002	3.1272	0.0060	0.1198	0.1102
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	9,808	100	1	g/hp-hr	0.0262	1.0346	0.3663	0.0015	0.0273	0.0251
Utility Equipment												
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	34,088	13	1	g/hp-hr	2.8518	183.8896	2.2805	0.0080	0.1799	0.1359
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	200	134	1	g/hp-hr	0.0432	1.0349	0.1448	0.0015	0.0049	0.0045
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	20,262	268	1	g/hp-hr	0.0418	0.3492	0.0565	0.0015	0.0039	0.0036
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	2,843	429	1	g/hp-hr	0.0428	0.3339	0.0592	0.0015	0.0042	0.0039
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	483,274	12	12	g/hp-hr	0.4483	2.8454	3.3971	0.0073	0.1327	0.1221
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	200	18	1	g/hp-hr	4.4494	169.4553	3.3243	0.0090	1.8760	1.4174
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	1,060	35	1	g/hp-hr	0.1308	1.8824	1.4386	0.0035	0.0062	0.0057
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	19,943	61	1	g/hp-hr	0.0604	1.0581	0.7930	0.0015	0.0073	0.0067
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	7,171	130	1	g/hp-hr	0.0295	0.9386	0.1430	0.0015	0.0037	0.0034
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	30,483	266	1	g/hp-hr	0.0282	0.3167	0.0722	0.0015	0.0039	0.0036
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	19,230	19	1	g/hp-hr	0.2515	1.2485	1.9166	0.0035	0.0728	0.0670
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	38,711	22	1	g/hp-hr	0.2515	1.2485	1.9166	0.0035	0.0728	0.0670
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	237	24	1	g/hp-hr	0.2515	1.2485	1.9166	0.0035	0.0728	0.0670
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	111	33	1	g/hp-hr	0.1062	1.6505	1.3250	0.0033	0.0054	0.0050
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	19,299	21	1	g/hp-hr	0.1523	0.9557	1.2584	0.0025	0.0486	0.0447
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	12,675	21	1	g/hp-hr	0.1523	0.9557	1.2584	0.0025	0.0486	0.0447

Table A-167. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Emission Factors - 2025 (g/hp-hr or g/hr)						Emission Factors - 2026 (g/hp-hr or g/hr)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment														
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.0473	1.2793	0.1289	0.0019	0.0046	0.0043	0.0483	1.2891	0.1360	0.0019	0.0047	0.0043
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	0.0473	1.2793	0.1289	0.0019	0.0046	0.0043	0.0483	1.2891	0.1360	0.0019	0.0047	0.0043
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	0.0470	0.4208	0.1127	0.0020	0.0043	0.0040	0.0489	0.4245	0.1134	0.0020	0.0044	0.0040
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.0371	0.3827	0.0996	0.0018	0.0037	0.0034	0.0396	0.3890	0.1004	0.0018	0.0038	0.0035
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	0.0401	0.3767	0.1011	0.0018	0.0038	0.0035	0.0412	0.3785	0.1015	0.0018	0.0039	0.0036
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	0.0482	0.3893	0.1035	0.0018	0.0041	0.0038	0.0502	0.3931	0.1043	0.0018	0.0042	0.0038
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.0319	0.4259	0.1144	0.0021	0.0041	0.0037	0.0333	0.4293	0.1148	0.0021	0.0041	0.0038
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.0572	1.2041	1.0577	0.0020	0.0039	0.0036	0.0563	1.1965	1.0554	0.0020	0.0039	0.0035
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	0.0344	0.4147	0.1104	0.0020	0.0040	0.0037	0.0358	0.4180	0.1109	0.0020	0.0040	0.0037
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0819	1.3859	1.0808	0.0020	0.0046	0.0042	0.0856	1.4152	1.0863	0.0020	0.0047	0.0043
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0303	0.3722	0.0990	0.0018	0.0036	0.0033	0.0313	0.3749	0.0994	0.0018	0.0036	0.0033
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.0322	0.3887	0.1032	0.0019	0.0037	0.0034	0.0327	0.3899	0.1034	0.0019	0.0038	0.0035
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0303	0.3722	0.0990	0.0018	0.0036	0.0033	0.0313	0.3749	0.0994	0.0018	0.0036	0.0033
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0303	0.3722	0.0990	0.0018	0.0036	0.0033	0.0313	0.3749	0.0994	0.0018	0.0036	0.0033
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0442	1.2435	0.5162	0.0018	0.0044	0.0041	0.0458	1.2521	0.5181	0.0018	0.0045	0.0042
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	0.0489	0.4100	0.1093	0.0019	0.0043	0.0039	0.0505	0.4132	0.1100	0.0019	0.0043	0.0040
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	0.0498	0.4114	0.1096	0.0019	0.0043	0.0040	0.0531	0.4173	0.1107	0.0019	0.0044	0.0041
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	0.0379	0.4738	1.1261	0.0024	0.0096	0.0089	0.0407	0.4787	1.1336	0.0024	0.0099	0.0091
22" Smooth Drum Manual (Bomag 55)	OFF - ConstMin - Rollers	Diesel	0.3114	1.6467	2.3695	0.0045	0.0906	0.0834	0.3114	1.6464	2.3696	0.0045	0.0906	0.0834
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.0238	1.0643	0.0985	0.0018	0.0035	0.0032	0.0244	1.0687	0.0988	0.0018	0.0035	0.0032
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.0238	1.0643	0.0985	0.0018	0.0035	0.0032	0.0244	1.0687	0.0988	0.0018	0.0035	0.0032
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.0238	1.0643	0.0985	0.0018	0.0035	0.0032	0.0244	1.0687	0.0988	0.0018	0.0035	0.0032
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.0238	1.0643	0.0985	0.0018	0.0035	0.0032	0.0244	1.0687	0.0988	0.0018	0.0035	0.0032
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.0251	0.3665	0.0992	0.0018	0.0035	0.0032	0.0256	0.3674	0.0994	0.0018	0.0035	0.0032
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.0247	0.3615	0.0994	0.0018	0.0035	0.0032	0.0253	0.3616	0.0993	0.0018	0.0035	0.0032
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.1019	0.8170	0.2093	0.0047	0.0081	0.0074	0.1024	0.8182	0.2096	0.0047	0.0081	0.0075
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.1019	0.8170	0.2093	0.0047	0.0081	0.0074	0.1024	0.8182	0.2096	0.0047	0.0081	0.0075
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.1019	2.3976	0.2093	0.0047	0.0087	0.0080	0.1023	2.4006	0.2095	0.0047	0.0087	0.0080
Concrete Equipment														
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.3079	1.8435	2.3366	0.0048	0.0906	0.0834	0.3077	1.8366	2.3355	0.0048	0.0906	0.0833
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.0250	0.3117	0.0474	0.0015	0.0030	0.0028	0.0252	0.3151	0.0473	0.0015	0.0030	0.0028
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.0247	0.3043	0.0495	0.0015	0.0032	0.0029	0.0249	0.3077	0.0523	0.0015	0.0034	0.0031
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.4110	2.2001	3.1270	0.0060	0.1198	0.1102	0.4110	2.2004	3.1274	0.0060	0.1198	0.1102
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.0258	1.0405	0.3221	0.0015	0.0252	0.0231	0.0260	1.0514	0.3244	0.0015	0.0254	0.0233
Utility Equipment														
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	2.8669	183.6809	2.2867	0.0080	0.1821	0.1376	2.8790	183.4791	2.2906	0.0080	0.1840	0.1390
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0442	1.0496	0.1296	0.0015	0.0045	0.0042	0.0446	1.0605	0.1274	0.0015	0.0045	0.0041
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0433	0.3554	0.0489	0.0015	0.0037	0.0034	0.0439	0.3597	0.0514	0.0015	0.0037	0.0034
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0443	0.3394	0.0573	0.0015	0.0039	0.0036	0.0449	0.3433	0.0555	0.0015	0.0041	0.0038
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	0.4483	2.8454	3.3971	0.0073	0.1327	0.1221	0.4483	2.8454	3.3971	0.0073	0.1327	0.1221
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	4.4603	169.0576	3.3256	0.0090	1.8686	1.4118	4.4705	168.6877	3.3263	0.0090	1.8613	1.4063
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.1379	1.9316	1.4487	0.0035	0.0064	0.0059	0.1445	1.9777	1.4581	0.0035	0.0066	0.0061
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0611	1.0696	0.8017	0.0015	0.0073	0.0068	0.0616	1.0807	0.8100	0.0015	0.0074	0.0068
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0294	0.9462	0.1322	0.0015	0.0037	0.0034	0.0297	0.9565	0.1273	0.0015	0.0036	0.0033
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0281	0.3191	0.0675	0.0015	0.0037	0.0034	0.0283	0.3224	0.0674	0.0015	0.0038	0.0035
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2515	1.2486	1.9168	0.0035	0.0728	0.0670	0.2515	1.2486	1.9168	0.0035	0.0728	0.0670
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2515	1.2486	1.9168	0.0035	0.0728	0.0670	0.2515	1.2486	1.9168	0.0035	0.0728	0.0670
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2515	1.2486	1.9168	0.0035	0.0728	0.0670	0.2515	1.2486	1.9168	0.0035	0.0728	0.0670
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.1114	1.6869	1.3326	0.0033	0.0055	0.0051	0.1164	1.7212	1.3396	0.0033	0.0057	0.0052
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.1524	0.9563	1.2592	0.0025	0.0486	0.0447	0.1521	0.9542	1.2564	0.0025	0.0485	0.0446
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.1524	0.9563	1.2592	0.0025	0.0486	0.0447	0.1521	0.9542	1.2564	0.0025	0.0485	0.0446

Table A-167. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Emission Factors - 2027 (g/hp-hr or g/hr)						Emission Factors - 2028 (g/hp-hr or g/hr)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment														
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.0496	1.2969	0.1348	0.0019	0.0047	0.0043	0.0512	1.3078	0.1327	0.0019	0.0048	0.0044
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	0.0496	1.2969	0.1348	0.0019	0.0047	0.0043	0.0512	1.3078	0.1327	0.0019	0.0048	0.0044
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	0.0503	0.4270	0.1139	0.0020	0.0044	0.0041	0.0522	0.4303	0.1146	0.0020	0.0045	0.0041
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.0397	0.3893	0.1006	0.0018	0.0038	0.0035	0.0416	0.3935	0.1012	0.0018	0.0039	0.0036
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	0.0444	0.3843	0.1026	0.0018	0.0040	0.0037	0.0463	0.3873	0.1032	0.0018	0.0040	0.0037
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	0.0498	0.3926	0.1042	0.0018	0.0041	0.0038	0.0534	0.3987	0.1053	0.0018	0.0043	0.0039
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.0350	0.4330	0.1153	0.0021	0.0042	0.0038	0.0360	0.4356	0.1157	0.0021	0.0042	0.0039
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.0563	1.1961	1.0552	0.0020	0.0039	0.0035	0.0570	1.2011	1.0561	0.0020	0.0039	0.0036
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	0.0374	0.4221	0.1113	0.0020	0.0041	0.0038	0.0393	0.4264	0.1119	0.0020	0.0042	0.0038
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0888	1.4396	1.0902	0.0020	0.0048	0.0044	0.0926	1.4702	1.0975	0.0020	0.0049	0.0045
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0329	0.3786	0.1000	0.0018	0.0037	0.0034	0.0336	0.3800	0.1002	0.0018	0.0037	0.0034
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.0334	0.3916	0.1037	0.0019	0.0038	0.0035	0.0342	0.3935	0.1039	0.0019	0.0038	0.0035
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0329	0.3786	0.1000	0.0018	0.0037	0.0034	0.0336	0.3800	0.1002	0.0018	0.0037	0.0034
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0329	0.3786	0.1000	0.0018	0.0037	0.0034	0.0336	0.3800	0.1002	0.0018	0.0037	0.0034
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0473	1.2597	0.5197	0.0018	0.0046	0.0042	0.0487	1.2669	0.5212	0.0018	0.0047	0.0043
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	0.0521	0.4160	0.1105	0.0019	0.0044	0.0040	0.0532	0.4180	0.1109	0.0019	0.0044	0.0041
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	0.0554	0.4218	0.1116	0.0019	0.0045	0.0041	0.0569	0.4243	0.1121	0.0019	0.0045	0.0042
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	0.0434	0.4837	1.1415	0.0024	0.0101	0.0093	0.0460	0.4882	1.1484	0.0024	0.0103	0.0095
22" Smooth Drum Manual (Bomag 55)	OFF - ConstMin - Rollers	Diesel	0.3114	1.6464	2.3696	0.0045	0.0906	0.0834	0.3114	1.6464	2.3696	0.0045	0.0906	0.0834
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.0252	1.0742	0.0990	0.0018	0.0036	0.0033	0.0259	1.0789	0.0993	0.0018	0.0036	0.0033
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.0252	1.0742	0.0990	0.0018	0.0036	0.0033	0.0259	1.0789	0.0993	0.0018	0.0036	0.0033
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.0252	1.0742	0.0990	0.0018	0.0036	0.0033	0.0259	1.0789	0.0993	0.0018	0.0036	0.0033
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.0252	1.0742	0.0990	0.0018	0.0036	0.0033	0.0259	1.0789	0.0993	0.0018	0.0036	0.0033
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.0257	0.3677	0.0994	0.0018	0.0035	0.0032	0.0260	0.3684	0.0995	0.0018	0.0035	0.0032
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.0258	0.3622	0.0994	0.0018	0.0035	0.0032	0.0262	0.3647	0.1000	0.0018	0.0035	0.0032
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.1025	0.8182	0.2095	0.0047	0.0081	0.0075	0.1025	0.8178	0.2094	0.0047	0.0081	0.0075
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.1025	0.8182	0.2095	0.0047	0.0081	0.0075	0.1025	0.8178	0.2094	0.0047	0.0081	0.0075
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.1025	2.4010	0.2095	0.0047	0.0087	0.0080	0.1025	2.4021	0.2096	0.0047	0.0087	0.0080
Concrete Equipment														
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.3080	1.8327	2.3379	0.0048	0.0906	0.0834	0.3082	1.8284	2.3395	0.0048	0.0907	0.0834
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.0252	0.3179	0.0426	0.0015	0.0029	0.0027	0.0255	0.3213	0.0410	0.0016	0.0029	0.0026
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.0248	0.3102	0.0506	0.0015	0.0032	0.0030	0.0250	0.3135	0.0509	0.0016	0.0033	0.0030
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.4110	2.2002	3.1272	0.0060	0.1198	0.1102	0.4110	2.2004	3.1274	0.0060	0.1198	0.1102
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.0258	1.0591	0.2747	0.0015	0.0230	0.0211	0.0260	1.0700	0.2697	0.0016	0.0227	0.0209
Utility Equipment														
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	2.8907	183.2967	2.2946	0.0080	0.1858	0.1404	2.9021	183.1243	2.2986	0.0080	0.1875	0.1417
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0451	1.0720	0.1103	0.0015	0.0044	0.0040	0.0456	1.0842	0.1042	0.0016	0.0038	0.0035
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0452	0.3655	0.0503	0.0015	0.0037	0.0034	0.0456	0.3693	0.0508	0.0016	0.0037	0.0034
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0456	0.3475	0.0540	0.0015	0.0039	0.0036	0.0462	0.3513	0.0499	0.0016	0.0038	0.0035
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	0.4483	2.8454	3.3971	0.0073	0.1327	0.1221	0.4483	2.8455	3.3972	0.0073	0.1327	0.1221
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	4.4798	168.3729	3.3270	0.0090	1.8549	1.4015	4.4849	168.1890	3.3272	0.0090	1.8512	1.3987
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.1507	2.0202	1.4668	0.0035	0.0067	0.0062	0.1567	2.0624	1.4756	0.0035	0.0069	0.0063
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0621	1.0919	0.8185	0.0015	0.0074	0.0068	0.0622	1.1016	0.8207	0.0016	0.0063	0.0058
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0293	0.9618	0.1158	0.0015	0.0036	0.0033	0.0295	0.9715	0.1127	0.0016	0.0033	0.0030
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0283	0.3253	0.0661	0.0015	0.0037	0.0034	0.0284	0.3282	0.0661	0.0016	0.0037	0.0034
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2515	1.2485	1.9167	0.0035	0.0728	0.0670	0.2515	1.2486	1.9169	0.0035	0.0729	0.0670
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2515	1.2485	1.9167	0.0035	0.0728	0.0670	0.2515	1.2486	1.9169	0.0035	0.0729	0.0670
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2515	1.2485	1.9167	0.0035	0.0728	0.0670	0.2515	1.2486	1.9169	0.0035	0.0729	0.0670
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.1209	1.7526	1.3461	0.0033	0.0058	0.0053	0.1254	1.7838	1.3525	0.0033	0.0059	0.0054
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.1517	0.9521	1.2536	0.0025	0.0484	0.0445	0.1520	0.9537	1.2557	0.0025	0.0485	0.0446
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.1517	0.9521	1.2536	0.0025	0.0484	0.0445	0.1520	0.9537	1.2557	0.0025	0.0485	0.0446

Table A-167. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Emission Factors - 2029 (g/hp-hr or g/hr)					
			ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment								
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.0528	1.3191	0.1408	0.0019	0.0049	0.0045
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	0.0528	1.3191	0.1408	0.0019	0.0049	0.0045
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	0.0535	0.4321	0.1149	0.0019	0.0045	0.0042
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.0435	0.3979	0.1018	0.0018	0.0039	0.0036
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	0.0477	0.3893	0.1035	0.0018	0.0041	0.0038
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	0.0555	0.4022	0.1060	0.0018	0.0043	0.0040
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.0374	0.4389	0.1162	0.0021	0.0042	0.0039
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.0563	1.1956	1.0547	0.0020	0.0039	0.0035
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	0.0410	0.4304	0.1125	0.0020	0.0042	0.0039
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0952	1.4912	1.1024	0.0020	0.0050	0.0046
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0354	0.3846	0.1009	0.0018	0.0037	0.0034
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.0350	0.3952	0.1042	0.0019	0.0038	0.0035
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0354	0.3846	0.1009	0.0018	0.0037	0.0034
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0354	0.3846	0.1009	0.0018	0.0037	0.0034
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0498	1.2720	0.5222	0.0018	0.0047	0.0044
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	0.0536	0.4187	0.1110	0.0019	0.0044	0.0041
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	0.0562	0.4227	0.1118	0.0019	0.0045	0.0041
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	0.0479	0.4918	1.1543	0.0024	0.0105	0.0096
22" Smooth Drum Manual (Bomag 55)	OFF - ConstMin - Rollers	Diesel	0.3114	1.6466	2.3698	0.0045	0.0907	0.0834
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.0263	1.0821	0.0994	0.0018	0.0036	0.0033
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.0263	1.0821	0.0994	0.0018	0.0036	0.0033
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.0263	1.0821	0.0994	0.0018	0.0036	0.0033
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.0263	1.0821	0.0994	0.0018	0.0036	0.0033
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.0262	0.3688	0.0996	0.0018	0.0035	0.0032
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.0265	0.3658	0.1003	0.0018	0.0035	0.0033
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.1028	0.8195	0.2098	0.0047	0.0081	0.0075
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.1028	0.8195	0.2098	0.0047	0.0081	0.0075
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.1027	2.4028	0.2096	0.0047	0.0087	0.0080
Concrete Equipment								
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.3080	1.8247	2.3382	0.0048	0.0906	0.0833
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.0258	0.3250	0.0431	0.0016	0.0030	0.0027
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.0251	0.3167	0.0512	0.0016	0.0033	0.0031
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.4111	2.2004	3.1275	0.0060	0.1198	0.1102
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.0261	1.0803	0.2593	0.0016	0.0220	0.0202
Utility Equipment								
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	2.9097	183.0458	2.3031	0.0080	0.1884	0.1423
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0459	1.0947	0.1021	0.0016	0.0038	0.0035
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0458	0.3727	0.0511	0.0016	0.0038	0.0035
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.0467	0.3552	0.0505	0.0016	0.0038	0.0035
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	0.4483	2.8455	3.3971	0.0073	0.1327	0.1221
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	4.4888	168.0628	3.3277	0.0090	1.8487	1.3968
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.1624	2.1017	1.4838	0.0035	0.0070	0.0065
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0621	1.1110	0.8289	0.0016	0.0064	0.0059
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0299	0.9825	0.1162	0.0016	0.0034	0.0031
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.0283	0.3309	0.0622	0.0016	0.0036	0.0033
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2515	1.2486	1.9168	0.0035	0.0728	0.0670
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2515	1.2486	1.9168	0.0035	0.0728	0.0670
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.2515	1.2486	1.9168	0.0035	0.0728	0.0670
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.1297	1.8139	1.3587	0.0033	0.0060	0.0055
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.1524	0.9563	1.2591	0.0025	0.0486	0.0447
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.1524	0.9563	1.2591	0.0025	0.0486	0.0447

Table A-167. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Emission Factors - 2024 (g/hp-hr or g/hr)					
							ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment												
Hoisting Equipment												
20 Ton Truck Crane	ConstMin - Cranes	Diesel	50	123	1	g/hp-hr	0.0214	0.8406	0.0769	0.0014	0.0028	0.0026
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	148	170	1	g/hp-hr	0.0214	0.8406	0.0769	0.0014	0.0028	0.0026
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	26,245	178	1	g/hp-hr	0.0213	0.2861	0.0768	0.0014	0.0027	0.0025
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	14,545	308	1	g/hp-hr	0.0202	0.2787	0.0764	0.0014	0.0027	0.0025
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	6,457	123	1	g/hp-hr	0.0214	0.8406	0.0769	0.0014	0.0028	0.0026
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	300	130	1	g/hp-hr	0.0214	0.8406	0.0769	0.0014	0.0028	0.0026
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	1,050	355	1	g/hp-hr	0.0202	0.2787	0.0764	0.0014	0.0027	0.0025
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	375	63	1	g/hp-hr	0.0229	0.9616	0.4137	0.0015	0.0029	0.0026
Drilling & Tunneling Equipment												
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	54,435	221	2	g/hp-hr	0.0340	0.4884	0.1320	0.0024	0.0046	0.0043
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	4,319	221	1	g/hp-hr	0.0340	0.4884	0.1320	0.0024	0.0046	0.0043
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	338	44	1	g/hp-hr	0.0913	1.7791	1.5051	0.0028	0.0058	0.0053
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	19	63	1	g/hp-hr	0.0229	0.9616	0.4137	0.0015	0.0029	0.0026
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,585	98	1	g/hp-hr	0.0428	1.2366	0.5148	0.0018	0.0043	0.0040
Service & Maintenance Equipment												
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	1,287	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	404,389	n/a	10	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	117,268	n/a	3	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
5 Ton Flat Bed Truck	n/a - onroad	Diesel	22,262	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
10 Ton Flat Bed Truck	n/a - onroad	Diesel	3,158	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
1- Ton Mechanic Truck	n/a - onroad	Diesel	3,250	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
2-Ton Mechanic Truck	n/a - onroad	Diesel	116,578	n/a	3	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
Lube Truck	n/a - onroad	Diesel	76,667	n/a	2	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	38,333	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
1000 Gallon Watertruck	n/a - onroad	Diesel	2,091	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
3000 Gallon Watertruck	n/a - onroad	Diesel	26,605	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
5000 Gallon Watertanker	n/a - onroad	Diesel	597	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	74,735	500	2	g/hp-hr	0.0359	0.4303	0.1172	0.0021	0.0042	0.0039
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	3,803	500	1	g/hp-hr	0.0359	0.4303	0.1172	0.0021	0.0042	0.0039
5 Ton Boomtruck	n/a - onroad	Diesel	212	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
10 Ton Boomtruck	n/a - onroad	Diesel	249	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276
20 Ton Boomtruck	n/a - onroad	Diesel	375	n/a	1	g/hr	0.7511	16.3788	0.7562	0.0577	0.7353	0.3276

Notes:
No logging equipment is available in the OFFROAD2017 database for the San Francisco Bay Area Air Basin. Therefore, equipment from the San Joaquin Valley Air Basin was used to estimate emission factors for skidders.
Emission factors are in units of grams per horsepower-hour (g/hp-hr) for offroad construction equipment and grams per hour (g/hr) for on-road motor vehicles (e.g., flatbed trucks).

Table A-167. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Emission Factors - 2025 (g/hp-hr or g/hr)						Emission Factors - 2026 (g/hp-hr or g/hr)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment														
Hoisting Equipment														
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.0218	0.8438	0.0771	0.0014	0.0028	0.0026	0.0224	0.8474	0.0773	0.0014	0.0029	0.0026
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.0218	0.8438	0.0771	0.0014	0.0028	0.0026	0.0224	0.8474	0.0773	0.0014	0.0029	0.0026
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.0217	0.2869	0.0769	0.0014	0.0027	0.0025	0.0221	0.2876	0.0770	0.0014	0.0028	0.0025
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.0207	0.2798	0.0766	0.0014	0.0027	0.0025	0.0216	0.2812	0.0769	0.0014	0.0027	0.0025
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.0218	0.8438	0.0771	0.0014	0.0028	0.0026	0.0224	0.8474	0.0773	0.0014	0.0029	0.0026
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.0218	0.8438	0.0771	0.0014	0.0028	0.0026	0.0224	0.8474	0.0773	0.0014	0.0029	0.0026
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.0207	0.2798	0.0766	0.0014	0.0027	0.0025	0.0216	0.2812	0.0769	0.0014	0.0027	0.0025
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.0225	0.9595	0.4133	0.0015	0.0028	0.0026	0.0233	0.9639	0.4143	0.0015	0.0029	0.0027
Drilling & Tunneling Equipment														
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	0.0343	0.4897	0.1323	0.0024	0.0047	0.0043	0.0357	0.4928	0.1327	0.0024	0.0047	0.0043
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.0343	0.4897	0.1323	0.0024	0.0047	0.0043	0.0357	0.4928	0.1327	0.0024	0.0047	0.0043
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.0901	1.7739	1.5083	0.0028	0.0058	0.0053	0.0956	1.8307	1.5346	0.0029	0.0060	0.0055
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.0225	0.9595	0.4133	0.0015	0.0028	0.0026	0.0233	0.9639	0.4143	0.0015	0.0029	0.0027
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0442	1.2435	0.5162	0.0018	0.0044	0.0041	0.0458	1.2521	0.5181	0.0018	0.0045	0.0042
Service & Maintenance Equipment														
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
Lube Truck	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
1000 Gallon Watertruck	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
3000 Gallon Watertruck	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
5000 Gallon Watertanker	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	0.0371	0.4325	0.1176	0.0021	0.0043	0.0039	0.0389	0.4357	0.1183	0.0021	0.0043	0.0040
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	0.0371	0.4325	0.1176	0.0021	0.0043	0.0039	0.0389	0.4357	0.1183	0.0021	0.0043	0.0040
5 Ton Boomtruck	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
10 Ton Boomtruck	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197
20 Ton Boomtruck	n/a - onroad	Diesel	0.7167	16.3075	0.7026	0.0558	0.7310	0.3235	0.6875	16.2591	0.6580	0.0542	0.7272	0.3197

Notes:
No logging equipment is available in the OFFROAD2017 database for the San Francisco Bay Area Air Basin. Therefore, equipment from th
Emission factors are in units of grams per horsepower-hour (g/hp-hr) for offroad construction equipment and grams per hour (g/hr) for on-ro

Table A-167. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Emission Factors - 2027 (g/hp-hr or g/hr)						Emission Factors - 2028 (g/hp-hr or g/hr)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment														
Hoisting Equipment														
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.0232	0.8535	0.0775	0.0014	0.0029	0.0027	0.0241	0.8592	0.0778	0.0014	0.0029	0.0027
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.0232	0.8535	0.0775	0.0014	0.0029	0.0027	0.0241	0.8592	0.0778	0.0014	0.0029	0.0027
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.0227	0.2891	0.0772	0.0014	0.0028	0.0025	0.0235	0.2912	0.0776	0.0014	0.0028	0.0026
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.0225	0.2827	0.0772	0.0014	0.0028	0.0025	0.0232	0.2841	0.0775	0.0014	0.0028	0.0026
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.0232	0.8535	0.0775	0.0014	0.0029	0.0027	0.0241	0.8592	0.0778	0.0014	0.0029	0.0027
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.0232	0.8535	0.0775	0.0014	0.0029	0.0027	0.0241	0.8592	0.0778	0.0014	0.0029	0.0027
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.0225	0.2827	0.0772	0.0014	0.0028	0.0025	0.0232	0.2841	0.0775	0.0014	0.0028	0.0026
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.0245	0.9705	0.4157	0.0015	0.0030	0.0027	0.0255	0.9758	0.4169	0.0015	0.0030	0.0028
Drilling & Tunneling Equipment														
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	0.0358	0.4931	0.1328	0.0024	0.0047	0.0043	0.0354	0.4911	0.1324	0.0024	0.0047	0.0043
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.0358	0.4931	0.1328	0.0024	0.0047	0.0043	0.0354	0.4911	0.1324	0.0024	0.0047	0.0043
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.0949	1.8104	1.5146	0.0028	0.0059	0.0054	0.0984	1.8252	1.5036	0.0028	0.0060	0.0055
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.0245	0.9705	0.4157	0.0015	0.0030	0.0027	0.0255	0.9758	0.4169	0.0015	0.0030	0.0028
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0473	1.2597	0.5197	0.0018	0.0046	0.0042	0.0487	1.2669	0.5212	0.0018	0.0047	0.0043
Service & Maintenance Equipment														
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
Lube Truck	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
1000 Gallon Watertruck	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
3000 Gallon Watertruck	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
5000 Gallon Watertanker	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	0.0402	0.4383	0.1188	0.0021	0.0044	0.0040	0.0408	0.4397	0.1191	0.0021	0.0044	0.0040
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	0.0402	0.4383	0.1188	0.0021	0.0044	0.0040	0.0408	0.4397	0.1191	0.0021	0.0044	0.0040
5 Ton Boomtruck	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
10 Ton Boomtruck	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133
20 Ton Boomtruck	n/a - onroad	Diesel	0.6624	16.2224	0.6206	0.0527	0.7237	0.3164	0.6399	16.1870	0.5879	0.0515	0.7204	0.3133

Notes:
No logging equipment is available in the OFFROAD2017 database for the San Francisco Bay Area Air Basin. Therefore, equipment from th
Emission factors are in units of grams per horsepower-hour (g/hp-hr) for offroad construction equipment and grams per hour (g/hr) for on-ro

Table A-167. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Emission Factors - 2029 (g/hp-hr or g/hr)					
			ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment								
Hoisting Equipment								
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.0250	0.8653	0.0781	0.0014	0.0030	0.0027
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.0250	0.8653	0.0781	0.0014	0.0030	0.0027
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.0243	0.2931	0.0778	0.0014	0.0028	0.0026
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.0236	0.2847	0.0776	0.0014	0.0028	0.0026
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.0250	0.8653	0.0781	0.0014	0.0030	0.0027
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.0250	0.8653	0.0781	0.0014	0.0030	0.0027
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.0236	0.2847	0.0776	0.0014	0.0028	0.0026
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.0252	0.9740	0.4165	0.0015	0.0030	0.0028
Drilling & Tunneling Equipment								
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	0.0355	0.4922	0.1326	0.0024	0.0047	0.0043
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.0355	0.4922	0.1326	0.0024	0.0047	0.0043
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.0993	1.8320	1.5044	0.0028	0.0060	0.0055
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.0252	0.9740	0.4165	0.0015	0.0030	0.0028
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.0498	1.2720	0.5222	0.0018	0.0047	0.0044
Service & Maintenance Equipment								
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
Lube Truck	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
1000 Gallon Watertruck	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
3000 Gallon Watertruck	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
5000 Gallon Watertanker	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	0.0409	0.4396	0.1191	0.0021	0.0044	0.0040
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	0.0409	0.4396	0.1191	0.0021	0.0044	0.0040
5 Ton Boomtruck	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
10 Ton Boomtruck	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104
20 Ton Boomtruck	n/a - onroad	Diesel	0.6200	16.1543	0.5597	0.0503	0.7174	0.3104

Notes:
No logging equipment is available in the OFFROAD2017 database for the San Francisco Bay Area Air Basin. Therefore, equipment from th
Emission factors are in units of grams per horsepower-hour (g/hp-hr) for offroad construction equipment and grams per hour (g/hr) for on-ro

Table A-168. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Maximum Daily Emissions - 2024 (pounds per day)					
							ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment												
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	53	110	1	g/hp-hr	0.23	6.21	0.64	0.01	0.02	0.02
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	71,036	170	2	g/hp-hr	0.71	19.20	1.98	0.03	0.07	0.06
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	110,098	305	3	g/hp-hr	1.82	16.85	4.52	0.08	0.17	0.16
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	1,867	202	1	g/hp-hr	0.31	3.37	0.88	0.02	0.03	0.03
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	59,824	373	2	g/hp-hr	1.30	12.33	3.31	0.06	0.13	0.12
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	9,507	699	1	g/hp-hr	1.37	11.79	3.15	0.05	0.12	0.11
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	914	193	1	g/hp-hr	0.27	3.62	0.97	0.02	0.03	0.03
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	138	36	1	g/hp-hr	0.09	1.90	1.68	0.00	0.01	0.01
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	70,318	200	2	g/hp-hr	0.59	7.29	1.95	0.04	0.07	0.06
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	914	27	1	g/hp-hr	0.09	1.61	1.28	0.00	0.01	0.00
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	11,600	235	1	g/hp-hr	0.30	3.83	1.02	0.02	0.04	0.03
2.0 CY Excavator	ConstMin - Excavators	Diesel	75	235	1	g/hp-hr	0.33	4.02	1.07	0.02	0.04	0.04
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,063	286	1	g/hp-hr	0.37	4.66	1.24	0.02	0.04	0.04
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	5,755	290	1	g/hp-hr	0.38	4.72	1.26	0.02	0.05	0.04
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	24,968	80	1	g/hp-hr	0.15	4.36	1.82	0.01	0.02	0.01
5 Ton Flatbed Truck	n/a - onroad	Diesel	5,457	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	83	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	5,080	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	256,985	340	6	g/hp-hr	4.20	36.49	9.75	0.17	0.38	0.35
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	43,944	680	2	g/hp-hr	3.08	24.82	6.60	0.11	0.26	0.24
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	12,112	783	1	g/hp-hr	1.21	16.18	38.60	0.08	0.32	0.30
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	2,021	4	1	g/hp-hr	0.05	0.25	0.37	0.00	0.01	0.01
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	50	120	1	g/hp-hr	0.12	5.61	0.52	0.01	0.02	0.02
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	597	145	1	g/hp-hr	0.15	6.78	0.63	0.01	0.02	0.02
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	157	145	1	g/hp-hr	0.15	6.78	0.63	0.01	0.02	0.02
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	5,391	165	1	g/hp-hr	0.17	7.72	0.72	0.01	0.03	0.02
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	55	190	1	g/hp-hr	0.21	3.06	0.83	0.02	0.03	0.03
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	23,482	315	1	g/hp-hr	0.33	5.01	1.38	0.03	0.05	0.04
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	2,210	180	1	g/hp-hr	0.80	6.46	1.66	0.04	0.06	0.06
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	2,210	210	1	g/hp-hr	0.93	7.54	1.93	0.04	0.07	0.07
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	1,105	150	1	g/hp-hr	0.67	15.80	1.38	0.03	0.06	0.05
Concrete Equipment												
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	5,334	10	1	g/hp-hr	0.14	0.82	1.03	0.00	0.04	0.04
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	15,182	220	1	g/hp-hr	0.24	2.99	0.68	0.01	0.04	0.03
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	917	330	1	g/hp-hr	0.36	4.39	0.78	0.02	0.05	0.05
Grout Pump	OFF - Light Commercial - Pumps	Diesel	8,685	18	1	g/hp-hr	0.33	1.75	2.48	0.00	0.10	0.09
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	9,808	100	1	g/hp-hr	0.12	4.56	1.61	0.01	0.12	0.11
Utility Equipment												
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	34,088	13	1	g/hp-hr	1.63	105.40	1.31	0.00	0.10	0.08
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	200	134	1	g/hp-hr	0.26	6.11	0.86	0.01	0.03	0.03
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	20,262	268	1	g/hp-hr	0.49	4.13	0.67	0.02	0.05	0.04
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	2,843	429	1	g/hp-hr	0.81	6.32	1.12	0.03	0.08	0.07
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	483,274	12	12	g/hp-hr	2.85	18.07	21.57	0.05	0.84	0.78
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	200	18	1	g/hp-hr	3.53	134.49	2.64	0.01	1.49	1.12
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	1,060	35	1	g/hp-hr	0.20	2.90	2.22	0.01	0.01	0.01
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	19,943	61	1	g/hp-hr	0.16	2.85	2.13	0.00	0.02	0.02
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	7,171	130	1	g/hp-hr	0.17	5.38	0.82	0.01	0.02	0.02
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	30,483	266	1	g/hp-hr	0.33	3.71	0.85	0.02	0.05	0.04
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	19,230	19	1	g/hp-hr	0.21	1.05	1.61	0.00	0.06	0.06
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	38,711	22	1	g/hp-hr	0.24	1.21	1.86	0.00	0.07	0.07
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	237	24	1	g/hp-hr	0.27	1.32	2.03	0.00	0.08	0.07
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	111	33	1	g/hp-hr	0.15	2.40	1.93	0.00	0.01	0.01
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	19,299	21	1	g/hp-hr	0.14	0.88	1.17	0.00	0.05	0.04
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	12,675	21	1	g/hp-hr	0.14	0.88	1.17	0.00	0.05	0.04

Table A-168. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Maximum Daily Emissions - 2025 (pounds per day)						Maximum Daily Emissions - 2026 (pounds per day)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment														
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.23	6.20	0.63	0.01	0.02	0.02	0.23	6.25	0.66	0.01	0.02	0.02
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	0.71	19.18	1.93	0.03	0.07	0.06	0.72	19.33	2.04	0.03	0.07	0.06
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	1.90	16.98	4.55	0.08	0.17	0.16	1.97	17.12	4.58	0.08	0.18	0.16
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.33	3.41	0.89	0.02	0.03	0.03	0.35	3.46	0.89	0.02	0.03	0.03
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	1.32	12.39	3.33	0.06	0.13	0.12	1.36	12.45	3.34	0.06	0.13	0.12
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	1.49	12.00	3.19	0.05	0.13	0.12	1.55	12.12	3.21	0.05	0.13	0.12
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.27	3.62	0.97	0.02	0.03	0.03	0.28	3.65	0.98	0.02	0.03	0.03
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.09	1.91	1.68	0.00	0.01	0.01	0.09	1.90	1.68	0.00	0.01	0.01
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	0.61	7.31	1.95	0.04	0.07	0.07	0.63	7.37	1.96	0.04	0.07	0.07
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.10	1.65	1.29	0.00	0.01	0.01	0.10	1.68	1.29	0.00	0.01	0.01
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.31	3.86	1.03	0.02	0.04	0.03	0.32	3.88	1.03	0.02	0.04	0.03
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.33	4.03	1.07	0.02	0.04	0.04	0.34	4.04	1.07	0.02	0.04	0.04
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.38	4.69	1.25	0.02	0.05	0.04	0.39	4.73	1.25	0.02	0.05	0.04
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.39	4.76	1.27	0.02	0.05	0.04	0.40	4.79	1.27	0.02	0.05	0.04
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.16	4.39	1.82	0.01	0.02	0.01	0.16	4.42	1.83	0.01	0.02	0.01
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	4.39	36.88	9.83	0.17	0.38	0.35	4.54	37.17	9.89	0.17	0.39	0.36
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	2.99	24.67	6.57	0.11	0.26	0.24	3.18	25.02	6.64	0.11	0.26	0.24
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	1.31	16.36	38.88	0.08	0.33	0.31	1.40	16.53	39.14	0.08	0.34	0.31
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	0.05	0.25	0.37	0.00	0.01	0.01	0.05	0.25	0.37	0.00	0.01	0.01
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.13	5.63	0.52	0.01	0.02	0.02	0.13	5.65	0.52	0.01	0.02	0.02
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.15	6.80	0.63	0.01	0.02	0.02	0.16	6.83	0.63	0.01	0.02	0.02
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.15	6.80	0.63	0.01	0.02	0.02	0.16	6.83	0.63	0.01	0.02	0.02
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.17	7.74	0.72	0.01	0.03	0.02	0.18	7.77	0.72	0.01	0.03	0.02
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.21	3.07	0.83	0.02	0.03	0.03	0.21	3.08	0.83	0.02	0.03	0.03
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.34	5.02	1.38	0.03	0.05	0.04	0.35	5.02	1.38	0.03	0.05	0.04
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.81	6.48	1.66	0.04	0.06	0.06	0.81	6.49	1.66	0.04	0.06	0.06
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.94	7.56	1.94	0.04	0.07	0.07	0.95	7.58	1.94	0.04	0.08	0.07
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.67	15.86	1.38	0.03	0.06	0.05	0.68	15.88	1.39	0.03	0.06	0.05
Concrete Equipment														
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.14	0.81	1.03	0.00	0.04	0.04	0.14	0.81	1.03	0.00	0.04	0.04
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.24	3.02	0.46	0.01	0.03	0.03	0.24	3.06	0.46	0.01	0.03	0.03
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.36	4.43	0.72	0.02	0.05	0.04	0.36	4.48	0.76	0.02	0.05	0.04
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.33	1.75	2.48	0.00	0.10	0.09	0.33	1.75	2.48	0.00	0.10	0.09
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.11	4.59	1.42	0.01	0.11	0.10	0.11	4.64	1.43	0.01	0.11	0.10
Utility Equipment														
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	1.64	105.28	1.31	0.00	0.10	0.08	1.65	105.17	1.31	0.00	0.11	0.08
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.26	6.20	0.77	0.01	0.03	0.02	0.26	6.27	0.75	0.01	0.03	0.02
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.51	4.20	0.58	0.02	0.04	0.04	0.52	4.25	0.61	0.02	0.04	0.04
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.84	6.42	1.08	0.03	0.07	0.07	0.85	6.49	1.05	0.03	0.08	0.07
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	2.85	18.07	21.57	0.05	0.84	0.78	2.85	18.07	21.57	0.05	0.84	0.78
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	3.54	134.17	2.64	0.01	1.48	1.12	3.55	133.88	2.64	0.01	1.48	1.12
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.21	2.98	2.24	0.01	0.01	0.01	0.22	3.05	2.25	0.01	0.01	0.01
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.16	2.88	2.16	0.00	0.02	0.02	0.17	2.91	2.18	0.00	0.02	0.02
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.17	5.42	0.76	0.01	0.02	0.02	0.17	5.48	0.73	0.01	0.02	0.02
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.33	3.74	0.79	0.02	0.04	0.04	0.33	3.78	0.79	0.02	0.04	0.04
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.21	1.05	1.61	0.00	0.06	0.06	0.21	1.05	1.61	0.00	0.06	0.06
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.24	1.21	1.86	0.00	0.07	0.07	0.24	1.21	1.86	0.00	0.07	0.07
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.27	1.32	2.03	0.00	0.08	0.07	0.27	1.32	2.03	0.00	0.08	0.07
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.16	2.45	1.94	0.00	0.01	0.01	0.17	2.50	1.95	0.00	0.01	0.01
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.14	0.89	1.17	0.00	0.05	0.04	0.14	0.88	1.16	0.00	0.04	0.04
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.14	0.89	1.17	0.00	0.05	0.04	0.14	0.88	1.16	0.00	0.04	0.04

Table A-168. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Maximum Daily Emissions - 2027 (pounds per day)						Maximum Daily Emissions - 2028 (pounds per day)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment														
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.24	6.29	0.65	0.01	0.02	0.02	0.25	6.34	0.64	0.01	0.02	0.02
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	0.74	19.44	2.02	0.03	0.07	0.07	0.77	19.61	1.99	0.03	0.07	0.07
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	2.03	17.23	4.60	0.08	0.18	0.16	2.11	17.36	4.62	0.08	0.18	0.17
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.35	3.47	0.90	0.02	0.03	0.03	0.37	3.50	0.90	0.02	0.03	0.03
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	1.46	12.64	3.38	0.06	0.13	0.12	1.52	12.74	3.39	0.06	0.13	0.12
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	1.53	12.10	3.21	0.05	0.13	0.12	1.65	12.29	3.25	0.05	0.13	0.12
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.30	3.68	0.98	0.02	0.04	0.03	0.31	3.71	0.98	0.02	0.04	0.03
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.09	1.90	1.67	0.00	0.01	0.01	0.09	1.91	1.68	0.00	0.01	0.01
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	0.66	7.44	1.96	0.04	0.07	0.07	0.69	7.52	1.97	0.04	0.07	0.07
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.11	1.71	1.30	0.00	0.01	0.01	0.11	1.75	1.31	0.00	0.01	0.01
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.34	3.92	1.04	0.02	0.04	0.03	0.35	3.94	1.04	0.02	0.04	0.04
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.35	4.06	1.07	0.02	0.04	0.04	0.35	4.08	1.08	0.02	0.04	0.04
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.41	4.77	1.26	0.02	0.05	0.04	0.42	4.79	1.26	0.02	0.05	0.04
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.42	4.84	1.28	0.02	0.05	0.04	0.43	4.86	1.28	0.02	0.05	0.04
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.17	4.44	1.83	0.01	0.02	0.01	0.17	4.47	1.84	0.01	0.02	0.02
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	4.69	37.41	9.94	0.17	0.39	0.36	4.79	37.60	9.97	0.17	0.40	0.37
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	3.32	25.29	6.69	0.11	0.27	0.25	3.41	25.44	6.72	0.11	0.27	0.25
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	1.50	16.70	39.41	0.08	0.35	0.32	1.59	16.85	39.65	0.08	0.36	0.33
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	0.05	0.25	0.37	0.00	0.01	0.01	0.05	0.25	0.37	0.00	0.01	0.01
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.13	5.68	0.52	0.01	0.02	0.02	0.14	5.71	0.53	0.01	0.02	0.02
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.16	6.87	0.63	0.01	0.02	0.02	0.17	6.90	0.63	0.01	0.02	0.02
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.16	6.87	0.63	0.01	0.02	0.02	0.17	6.90	0.63	0.01	0.02	0.02
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.18	7.82	0.72	0.01	0.03	0.02	0.19	7.85	0.72	0.01	0.03	0.02
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.22	3.08	0.83	0.02	0.03	0.03	0.22	3.09	0.83	0.02	0.03	0.03
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.36	5.03	1.38	0.03	0.05	0.04	0.36	5.06	1.39	0.03	0.05	0.04
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.81	6.49	1.66	0.04	0.06	0.06	0.81	6.49	1.66	0.04	0.06	0.06
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.95	7.58	1.94	0.04	0.08	0.07	0.95	7.57	1.94	0.04	0.08	0.07
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.68	15.88	1.39	0.03	0.06	0.05	0.68	15.89	1.39	0.03	0.06	0.05
Concrete Equipment														
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.14	0.81	1.03	0.00	0.04	0.04	0.14	0.81	1.03	0.00	0.04	0.04
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.24	3.08	0.41	0.01	0.03	0.03	0.25	3.12	0.40	0.02	0.03	0.03
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.36	4.51	0.74	0.02	0.05	0.04	0.36	4.56	0.74	0.02	0.05	0.04
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.33	1.75	2.48	0.00	0.10	0.09	0.33	1.75	2.48	0.00	0.10	0.09
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.11	4.67	1.21	0.01	0.10	0.09	0.11	4.72	1.19	0.01	0.10	0.09
Utility Equipment														
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	1.66	105.06	1.32	0.00	0.11	0.08	1.66	104.97	1.32	0.00	0.11	0.08
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.27	6.33	0.65	0.01	0.03	0.02	0.27	6.41	0.62	0.01	0.02	0.02
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.53	4.32	0.59	0.02	0.04	0.04	0.54	4.36	0.60	0.02	0.04	0.04
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.86	6.57	1.02	0.03	0.07	0.07	0.87	6.65	0.94	0.03	0.07	0.07
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	2.85	18.07	21.57	0.05	0.84	0.78	2.85	18.07	21.57	0.05	0.84	0.78
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	3.56	133.63	2.64	0.01	1.47	1.11	3.56	133.48	2.64	0.01	1.47	1.11
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.23	3.12	2.26	0.01	0.01	0.01	0.24	3.18	2.28	0.01	0.01	0.01
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.17	2.94	2.20	0.00	0.02	0.02	0.17	2.96	2.21	0.00	0.02	0.02
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.17	5.51	0.66	0.01	0.02	0.02	0.17	5.57	0.65	0.01	0.02	0.02
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.33	3.82	0.78	0.02	0.04	0.04	0.33	3.85	0.78	0.02	0.04	0.04
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.21	1.05	1.61	0.00	0.06	0.06	0.21	1.05	1.61	0.00	0.06	0.06
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.24	1.21	1.86	0.00	0.07	0.07	0.24	1.21	1.86	0.00	0.07	0.07
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.27	1.32	2.03	0.00	0.08	0.07	0.27	1.32	2.03	0.00	0.08	0.07
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.18	2.55	1.96	0.00	0.01	0.01	0.18	2.60	1.97	0.00	0.01	0.01
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.14	0.88	1.16	0.00	0.04	0.04	0.14	0.88	1.16	0.00	0.04	0.04
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.14	0.88	1.16	0.00	0.04	0.04	0.14	0.88	1.16	0.00	0.04	0.04

Table A-168. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Maximum Daily Emissions - 2029 (pounds per day)					
			ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment								
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.26	6.40	0.68	0.01	0.02	0.02
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	0.79	19.77	2.11	0.03	0.07	0.07
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	2.16	17.43	4.63	0.08	0.18	0.17
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.39	3.54	0.91	0.02	0.04	0.03
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	1.57	12.80	3.40	0.06	0.13	0.12
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	1.71	12.40	3.27	0.05	0.13	0.12
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.32	3.73	0.99	0.02	0.04	0.03
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.09	1.90	1.67	0.00	0.01	0.01
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	0.72	7.59	1.98	0.04	0.07	0.07
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.11	1.78	1.31	0.00	0.01	0.01
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.37	3.98	1.05	0.02	0.04	0.04
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.36	4.09	1.08	0.02	0.04	0.04
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.45	4.85	1.27	0.02	0.05	0.04
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.45	4.92	1.29	0.02	0.05	0.04
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.18	4.49	1.84	0.01	0.02	0.02
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	4.82	37.66	9.99	0.17	0.40	0.37
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	3.37	25.35	6.70	0.11	0.27	0.25
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	1.65	16.98	39.85	0.08	0.36	0.33
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	0.05	0.25	0.37	0.00	0.01	0.01
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.14	5.73	0.53	0.01	0.02	0.02
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.17	6.92	0.64	0.01	0.02	0.02
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.17	6.92	0.64	0.01	0.02	0.02
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.19	7.87	0.72	0.01	0.03	0.02
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.22	3.09	0.83	0.02	0.03	0.03
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.37	5.08	1.39	0.03	0.05	0.05
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.82	6.50	1.67	0.04	0.06	0.06
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.95	7.59	1.94	0.04	0.08	0.07
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.68	15.89	1.39	0.03	0.06	0.05
Concrete Equipment								
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.14	0.80	1.03	0.00	0.04	0.04
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.25	3.15	0.42	0.02	0.03	0.03
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.37	4.61	0.74	0.02	0.05	0.04
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.33	1.75	2.48	0.00	0.10	0.09
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.12	4.76	1.14	0.01	0.10	0.09
Utility Equipment								
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	1.67	104.92	1.32	0.00	0.11	0.08
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.27	6.47	0.60	0.01	0.02	0.02
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.54	4.40	0.60	0.02	0.04	0.04
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.88	6.72	0.96	0.03	0.07	0.07
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	2.85	18.07	21.57	0.05	0.84	0.78
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	3.56	133.38	2.64	0.01	1.47	1.11
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.25	3.24	2.29	0.01	0.01	0.01
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.17	2.99	2.23	0.00	0.02	0.02
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.17	5.63	0.67	0.01	0.02	0.02
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.33	3.88	0.73	0.02	0.04	0.04
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.21	1.05	1.61	0.00	0.06	0.06
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.24	1.21	1.86	0.00	0.07	0.07
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.27	1.32	2.03	0.00	0.08	0.07
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.19	2.64	1.98	0.00	0.01	0.01
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.14	0.89	1.17	0.00	0.05	0.04
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.14	0.89	1.17	0.00	0.05	0.04

Table A-168. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Maximum Daily Emissions - 2024 (pounds per day)					
							ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment												
20 Ton Truck Crane	ConstMin - Cranes	Diesel	50	123	1	g/hp-hr	0.12	4.56	0.42	0.01	0.02	0.01
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	148	170	1	g/hp-hr	0.16	6.30	0.58	0.01	0.02	0.02
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	26,245	178	1	g/hp-hr	0.17	2.25	0.60	0.01	0.02	0.02
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	14,545	308	1	g/hp-hr	0.27	3.79	1.04	0.02	0.04	0.03
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	6,457	123	1	g/hp-hr	0.12	4.56	0.42	0.01	0.02	0.01
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	300	130	1	g/hp-hr	0.12	4.82	0.44	0.01	0.02	0.01
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	1,050	355	1	g/hp-hr	0.32	4.36	1.20	0.02	0.04	0.04
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	375	63	1	g/hp-hr	0.06	2.67	1.15	0.00	0.01	0.01
Drilling & Tunneling Equipment												
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	54,435	221	2	g/hp-hr	0.66	9.52	2.57	0.05	0.09	0.08
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	4,319	221	1	g/hp-hr	0.33	4.76	1.29	0.02	0.05	0.04
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	338	44	1	g/hp-hr	0.18	3.45	2.92	0.01	0.01	0.01
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	19	63	1	g/hp-hr	0.06	2.67	1.15	0.00	0.01	0.01
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,585	98	1	g/hp-hr	0.19	5.34	2.22	0.01	0.02	0.02
Service & Maintenance Equipment												
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	1,287	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	404,389	n/a	10	g/hr	0.33	7.22	0.33	0.03	0.32	0.14
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	117,268	n/a	3	g/hr	0.10	2.17	0.10	0.01	0.10	0.04
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
5 Ton Flat Bed Truck	n/a - onroad	Diesel	22,262	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
10 Ton Flat Bed Truck	n/a - onroad	Diesel	3,158	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
1- Ton Mechanic Truck	n/a - onroad	Diesel	3,250	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
2-Ton Mechanic Truck	n/a - onroad	Diesel	116,578	n/a	3	g/hr	0.10	2.17	0.10	0.01	0.10	0.04
Lube Truck	n/a - onroad	Diesel	76,667	n/a	2	g/hr	0.07	1.44	0.07	0.01	0.06	0.03
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	38,333	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
1000 Gallon Watertruck	n/a - onroad	Diesel	2,091	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
3000 Gallon Watertruck	n/a - onroad	Diesel	26,605	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
5000 Gallon Watertanker	n/a - onroad	Diesel	597	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	74,735	500	2	g/hp-hr	1.58	18.97	5.17	0.09	0.19	0.17
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	3,803	500	1	g/hp-hr	0.79	9.49	2.58	0.05	0.09	0.09
5 Ton Boomtruck	n/a - onroad	Diesel	212	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
10 Ton Boomtruck	n/a - onroad	Diesel	249	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
20 Ton Boomtruck	n/a - onroad	Diesel	375	n/a	1	g/hr	0.03	0.72	0.03	0.00	0.03	0.01
		Total	**2,461,102**	**n/a**	**n/a**	**n/a**	**2,063.41**	**2,695.93**	**2,191.15**	**2,025.58**	**2,031.25**	**2,029.88**

Table A-168. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Maximum Daily Emissions - 2025 (pounds per day)						Maximum Daily Emissions - 2026 (pounds per day)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment														
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.12	4.58	0.42	0.01	0.02	0.01	0.12	4.60	0.42	0.01	0.02	0.01
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.16	6.32	0.58	0.01	0.02	0.02	0.17	6.35	0.58	0.01	0.02	0.02
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.17	2.25	0.60	0.01	0.02	0.02	0.17	2.26	0.60	0.01	0.02	0.02
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.28	3.80	1.04	0.02	0.04	0.03	0.29	3.82	1.04	0.02	0.04	0.03
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.12	4.58	0.42	0.01	0.02	0.01	0.12	4.60	0.42	0.01	0.02	0.01
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.13	4.84	0.44	0.01	0.02	0.02	0.13	4.86	0.44	0.01	0.02	0.02
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.32	4.38	1.20	0.02	0.04	0.04	0.34	4.40	1.20	0.02	0.04	0.04
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.06	2.67	1.15	0.00	0.01	0.01	0.06	2.68	1.15	0.00	0.01	0.01
Drilling & Tunneling Equipment														
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	0.67	9.54	2.58	0.05	0.09	0.08	0.70	9.60	2.59	0.05	0.09	0.08
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.33	4.77	1.29	0.02	0.05	0.04	0.35	4.80	1.29	0.02	0.05	0.04
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.17	3.44	2.93	0.01	0.01	0.01	0.19	3.55	2.98	0.01	0.01	0.01
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.06	2.67	1.15	0.00	0.01	0.01	0.06	2.68	1.15	0.00	0.01	0.01
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.19	5.37	2.23	0.01	0.02	0.02	0.20	5.41	2.24	0.01	0.02	0.02
Service & Maintenance Equipment														
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.32	7.19	0.31	0.02	0.32	0.14	0.30	7.17	0.29	0.02	0.32	0.14
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.09	2.16	0.09	0.01	0.10	0.04	0.09	2.15	0.09	0.01	0.10	0.04
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.09	2.16	0.09	0.01	0.10	0.04	0.09	2.15	0.09	0.01	0.10	0.04
Lube Truck	n/a - onroad	Diesel	0.06	1.44	0.06	0.00	0.06	0.03	0.06	1.43	0.06	0.00	0.06	0.03
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
1000 Gallon Watertruck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
3000 Gallon Watertruck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
5000 Gallon Watertanker	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	1.64	19.07	5.19	0.09	0.19	0.17	1.71	19.21	5.22	0.09	0.19	0.18
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	0.82	9.54	2.59	0.05	0.09	0.09	0.86	9.61	2.61	0.05	0.10	0.09
5 Ton Boomtruck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
10 Ton Boomtruck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
20 Ton Boomtruck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.72	0.03	0.00	0.03	0.01
		Total	**2,065.12**	**2,698.55**	**2,191.78**	**2,026.58**	**2,032.23**	**2,030.87**	**2,067.13**	**2,702.03**	**2,193.54**	**2,027.58**	**2,033.26**	**2,031.90**

Table A-168. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Maximum Daily Emissions - 2027 (pounds per day)						Maximum Daily Emissions - 2028 (pounds per day)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment														
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.13	4.63	0.42	0.01	0.02	0.01	0.13	4.66	0.42	0.01	0.02	0.01
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.17	6.40	0.58	0.01	0.02	0.02	0.18	6.44	0.58	0.01	0.02	0.02
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.18	2.27	0.61	0.01	0.02	0.02	0.18	2.29	0.61	0.01	0.02	0.02
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.30	3.84	1.05	0.02	0.04	0.03	0.31	3.86	1.05	0.02	0.04	0.03
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.13	4.63	0.42	0.01	0.02	0.01	0.13	4.66	0.42	0.01	0.02	0.01
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.13	4.89	0.44	0.01	0.02	0.02	0.14	4.92	0.45	0.01	0.02	0.02
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.35	4.43	1.21	0.02	0.04	0.04	0.36	4.45	1.21	0.02	0.04	0.04
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.07	2.70	1.15	0.00	0.01	0.01	0.07	2.71	1.16	0.00	0.01	0.01
Drilling & Tunneling Equipment														
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	0.70	9.61	2.59	0.05	0.09	0.08	0.69	9.57	2.58	0.05	0.09	0.08
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.35	4.80	1.29	0.02	0.05	0.04	0.34	4.79	1.29	0.02	0.05	0.04
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.18	3.51	2.94	0.01	0.01	0.01	0.19	3.54	2.92	0.01	0.01	0.01
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.07	2.70	1.15	0.00	0.01	0.01	0.07	2.71	1.16	0.00	0.01	0.01
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.20	5.44	2.25	0.01	0.02	0.02	0.21	5.47	2.25	0.01	0.02	0.02
Service & Maintenance Equipment														
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.29	7.15	0.27	0.02	0.32	0.14	0.28	7.14	0.26	0.02	0.32	0.14
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.09	2.15	0.08	0.01	0.10	0.04	0.08	2.14	0.08	0.01	0.10	0.04
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.09	2.15	0.08	0.01	0.10	0.04	0.08	2.14	0.08	0.01	0.10	0.04
Lube Truck	n/a - onroad	Diesel	0.06	1.43	0.05	0.00	0.06	0.03	0.06	1.43	0.05	0.00	0.06	0.03
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
1000 Gallon Watertruck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
3000 Gallon Watertruck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
5000 Gallon Watertanker	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	1.77	19.33	5.24	0.09	0.19	0.18	1.80	19.39	5.25	0.09	0.19	0.18
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	0.89	9.66	2.62	0.05	0.10	0.09	0.90	9.69	2.63	0.05	0.10	0.09
5 Ton Boomtruck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
10 Ton Boomtruck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
20 Ton Boomtruck	n/a - onroad	Diesel	0.03	0.72	0.03	0.00	0.03	0.01	0.03	0.71	0.03	0.00	0.03	0.01
		Total	**2,069.01**	**2,705.13**	**2,194.51**	**2,028.58**	**2,034.27**	**2,032.91**	**2,070.81**	**2,708.26**	**2,195.76**	**2,029.57**	**2,035.28**	**2,033.92**

Table A-168. Maximum Daily Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Maximum Daily Emissions - 2029 (pounds per day)					
			ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment								
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.14	4.69	0.42	0.01	0.02	0.01
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.19	6.49	0.59	0.01	0.02	0.02
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.19	2.30	0.61	0.01	0.02	0.02
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.32	3.87	1.05	0.02	0.04	0.03
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.14	4.69	0.42	0.01	0.02	0.01
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.14	4.96	0.45	0.01	0.02	0.02
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.37	4.46	1.21	0.02	0.04	0.04
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.07	2.71	1.16	0.00	0.01	0.01
Drilling & Tunneling Equipment								
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	0.69	9.59	2.58	0.05	0.09	0.08
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.35	4.80	1.29	0.02	0.05	0.04
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.19	3.55	2.92	0.01	0.01	0.01
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.07	2.71	1.16	0.00	0.01	0.01
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.22	5.50	2.26	0.01	0.02	0.02
Service & Maintenance Equipment								
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.27	7.12	0.25	0.02	0.32	0.14
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.08	2.14	0.07	0.01	0.09	0.04
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.08	2.14	0.07	0.01	0.09	0.04
Lube Truck	n/a - onroad	Diesel	0.05	1.42	0.05	0.00	0.06	0.03
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
1000 Gallon Watertruck	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
3000 Gallon Watertruck	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
5000 Gallon Watertanker	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	1.80	19.38	5.25	0.09	0.19	0.18
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	0.90	9.69	2.62	0.05	0.10	0.09
5 Ton Boomtruck	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
10 Ton Boomtruck	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
20 Ton Boomtruck	n/a - onroad	Diesel	0.03	0.71	0.02	0.00	0.03	0.01
		Total	**2,072.29**	**2,710.87**	**2,197.21**	**2,030.57**	**2,036.30**	**2,034.93**

Table A-169. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Annual Emissions - 2024 (tons per year)					
							ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment												
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	53	110	1	g/hp-hr	0.04	1.13	0.12	0.00	0.00	0.00
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	71,036	170	2	g/hp-hr	0.13	3.50	0.36	0.01	0.01	0.01
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	110,098	305	3	g/hp-hr	0.33	3.07	0.83	0.01	0.03	0.03
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	1,867	202	1	g/hp-hr	0.06	0.61	0.16	0.00	0.01	0.01
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	59,824	373	2	g/hp-hr	0.24	2.25	0.60	0.01	0.02	0.02
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	9,507	699	1	g/hp-hr	0.25	2.15	0.57	0.01	0.02	0.02
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	914	193	1	g/hp-hr	0.05	0.66	0.18	0.00	0.01	0.01
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	138	36	1	g/hp-hr	0.02	0.35	0.31	0.00	0.00	0.00
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	70,318	200	2	g/hp-hr	0.11	1.33	0.36	0.01	0.01	0.01
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	914	27	1	g/hp-hr	0.02	0.29	0.23	0.00	0.00	0.00
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	11,600	235	1	g/hp-hr	0.06	0.70	0.19	0.00	0.01	0.01
2.0 CY Excavator	ConstMin - Excavators	Diesel	75	235	1	g/hp-hr	0.06	0.73	0.20	0.00	0.01	0.01
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,063	286	1	g/hp-hr	0.07	0.85	0.23	0.00	0.01	0.01
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	5,755	290	1	g/hp-hr	0.07	0.86	0.23	0.00	0.01	0.01
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	24,968	80	1	g/hp-hr	0.03	0.80	0.33	0.00	0.00	0.00
5 Ton Flatbed Truck	n/a - onroad	Diesel	5,457	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	83	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	5,080	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	256,985	340	6	g/hp-hr	0.77	6.66	1.78	0.03	0.07	0.06
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	43,944	680	2	g/hp-hr	0.56	4.53	1.20	0.02	0.05	0.04
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	12,112	783	1	g/hp-hr	0.22	2.95	7.04	0.01	0.06	0.05
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	2,021	4	1	g/hp-hr	0.01	0.05	0.07	0.00	0.00	0.00
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	50	120	1	g/hp-hr	0.02	1.02	0.09	0.00	0.00	0.00
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	597	145	1	g/hp-hr	0.03	1.24	0.11	0.00	0.00	0.00
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	157	145	1	g/hp-hr	0.03	1.24	0.11	0.00	0.00	0.00
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	5,391	165	1	g/hp-hr	0.03	1.41	0.13	0.00	0.00	0.00
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	55	190	1	g/hp-hr	0.04	0.56	0.15	0.00	0.01	0.00
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	23,482	315	1	g/hp-hr	0.06	0.91	0.25	0.00	0.01	0.01
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	2,210	180	1	g/hp-hr	0.15	1.18	0.30	0.01	0.01	0.01
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	2,210	210	1	g/hp-hr	0.17	1.38	0.35	0.01	0.01	0.01
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	1,105	150	1	g/hp-hr	0.12	2.88	0.25	0.01	0.01	0.01
Concrete Equipment												
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	5,334	10	1	g/hp-hr	0.02	0.15	0.19	0.00	0.01	0.01
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	15,182	220	1	g/hp-hr	0.04	0.55	0.12	0.00	0.01	0.01
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	917	330	1	g/hp-hr	0.07	0.80	0.14	0.00	0.01	0.01
Grout Pump	OFF - Light Commercial - Pumps	Diesel	8,685	18	1	g/hp-hr	0.06	0.32	0.45	0.00	0.02	0.02
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	9,808	100	1	g/hp-hr	0.02	0.83	0.29	0.00	0.02	0.02
Utility Equipment												
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	34,088	13	1	g/hp-hr	0.30	19.24	0.24	0.00	0.02	0.01
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	200	134	1	g/hp-hr	0.05	1.12	0.16	0.00	0.01	0.00
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	20,262	268	1	g/hp-hr	0.09	0.75	0.12	0.00	0.01	0.01
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	2,843	429	1	g/hp-hr	0.15	1.15	0.20	0.01	0.01	0.01
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	483,274	12	12	g/hp-hr	0.52	3.30	3.94	0.01	0.15	0.14
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	200	18	1	g/hp-hr	0.64	24.54	0.48	0.00	0.27	0.21
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	1,060	35	1	g/hp-hr	0.04	0.53	0.41	0.00	0.00	0.00
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	19,943	61	1	g/hp-hr	0.03	0.52	0.39	0.00	0.00	0.00
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	7,171	130	1	g/hp-hr	0.03	0.98	0.15	0.00	0.00	0.00
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	30,483	266	1	g/hp-hr	0.06	0.68	0.15	0.00	0.01	0.01
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	19,230	19	1	g/hp-hr	0.04	0.19	0.29	0.00	0.01	0.01
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	38,711	22	1	g/hp-hr	0.04	0.22	0.34	0.00	0.01	0.01
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	237	24	1	g/hp-hr	0.05	0.24	0.37	0.00	0.01	0.01
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	111	33	1	g/hp-hr	0.03	0.44	0.35	0.00	0.00	0.00
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	19,299	21	1	g/hp-hr	0.03	0.16	0.21	0.00	0.01	0.01
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	12,675	21	1	g/hp-hr	0.03	0.16	0.21	0.00	0.01	0.01

Table A-169. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Annual Emissions - 2025 (tons per year)						Annual Emissions - 2026 (tons per year)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment														
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.04	1.13	0.11	0.00	0.00	0.00	0.04	1.14	0.12	0.00	0.00	0.00
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	0.13	3.50	0.35	0.01	0.01	0.01	0.13	3.53	0.37	0.01	0.01	0.01
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	0.35	3.10	0.83	0.01	0.03	0.03	0.36	3.13	0.84	0.01	0.03	0.03
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.06	0.62	0.16	0.00	0.01	0.01	0.06	0.63	0.16	0.00	0.01	0.01
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	0.24	2.26	0.61	0.01	0.02	0.02	0.25	2.27	0.61	0.01	0.02	0.02
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	0.27	2.19	0.58	0.01	0.02	0.02	0.28	2.21	0.59	0.01	0.02	0.02
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.05	0.66	0.18	0.00	0.01	0.01	0.05	0.67	0.18	0.00	0.01	0.01
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.02	0.35	0.31	0.00	0.00	0.00	0.02	0.35	0.31	0.00	0.00	0.00
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	0.11	1.33	0.36	0.01	0.01	0.01	0.12	1.35	0.36	0.01	0.01	0.01
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.02	0.30	0.23	0.00	0.00	0.00	0.02	0.31	0.24	0.00	0.00	0.00
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.06	0.70	0.19	0.00	0.01	0.01	0.06	0.71	0.19	0.00	0.01	0.01
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.06	0.73	0.20	0.00	0.01	0.01	0.06	0.74	0.20	0.00	0.01	0.01
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.07	0.86	0.23	0.00	0.01	0.01	0.07	0.86	0.23	0.00	0.01	0.01
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.07	0.87	0.23	0.00	0.01	0.01	0.07	0.87	0.23	0.00	0.01	0.01
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.03	0.80	0.33	0.00	0.00	0.00	0.03	0.81	0.33	0.00	0.00	0.00
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	0.80	6.73	1.79	0.03	0.07	0.06	0.83	6.78	1.81	0.03	0.07	0.07
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	0.55	4.50	1.20	0.02	0.05	0.04	0.58	4.57	1.21	0.02	0.05	0.04
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	0.24	2.99	7.09	0.01	0.06	0.06	0.26	3.02	7.14	0.01	0.06	0.06
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	0.01	0.05	0.07	0.00	0.00	0.00	0.01	0.05	0.07	0.00	0.00	0.00
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.02	1.03	0.10	0.00	0.00	0.00	0.02	1.03	0.10	0.00	0.00	0.00
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.03	1.24	0.11	0.00	0.00	0.00	0.03	1.25	0.12	0.00	0.00	0.00
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.03	1.24	0.11	0.00	0.00	0.00	0.03	1.25	0.12	0.00	0.00	0.00
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.03	1.41	0.13	0.00	0.00	0.00	0.03	1.42	0.13	0.00	0.00	0.00
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.04	0.56	0.15	0.00	0.01	0.00	0.04	0.56	0.15	0.00	0.01	0.00
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.06	0.92	0.25	0.00	0.01	0.01	0.06	0.92	0.25	0.00	0.01	0.01
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.15	1.18	0.30	0.01	0.01	0.01	0.15	1.19	0.30	0.01	0.01	0.01
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.17	1.38	0.35	0.01	0.01	0.01	0.17	1.38	0.35	0.01	0.01	0.01
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.12	2.89	0.25	0.01	0.01	0.01	0.12	2.90	0.25	0.01	0.01	0.01
Concrete Equipment														
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.02	0.15	0.19	0.00	0.01	0.01	0.02	0.15	0.19	0.00	0.01	0.01
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.04	0.55	0.08	0.00	0.01	0.00	0.04	0.56	0.08	0.00	0.01	0.00
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.07	0.81	0.13	0.00	0.01	0.01	0.07	0.82	0.14	0.00	0.01	0.01
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.06	0.32	0.45	0.00	0.02	0.02	0.06	0.32	0.45	0.00	0.02	0.02
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.02	0.84	0.26	0.00	0.02	0.02	0.02	0.85	0.26	0.00	0.02	0.02
Utility Equipment														
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	0.30	19.21	0.24	0.00	0.02	0.01	0.30	19.19	0.24	0.00	0.02	0.01
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.05	1.13	0.14	0.00	0.00	0.00	0.05	1.14	0.14	0.00	0.00	0.00
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.09	0.77	0.11	0.00	0.01	0.01	0.09	0.78	0.11	0.00	0.01	0.01
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.15	1.17	0.20	0.01	0.01	0.01	0.15	1.18	0.19	0.01	0.01	0.01
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	0.52	3.30	3.94	0.01	0.15	0.14	0.52	3.30	3.94	0.01	0.15	0.14
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	0.65	24.49	0.48	0.00	0.27	0.20	0.65	24.43	0.48	0.00	0.27	0.20
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.04	0.54	0.41	0.00	0.00	0.00	0.04	0.56	0.41	0.00	0.00	0.00
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.03	0.53	0.39	0.00	0.00	0.00	0.03	0.53	0.40	0.00	0.00	0.00
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.03	0.99	0.14	0.00	0.00	0.00	0.03	1.00	0.13	0.00	0.00	0.00
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.06	0.68	0.14	0.00	0.01	0.01	0.06	0.69	0.14	0.00	0.01	0.01
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.04	0.19	0.29	0.00	0.01	0.01	0.04	0.19	0.29	0.00	0.01	0.01
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.04	0.22	0.34	0.00	0.01	0.01	0.04	0.22	0.34	0.00	0.01	0.01
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.05	0.24	0.37	0.00	0.01	0.01	0.05	0.24	0.37	0.00	0.01	0.01
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.03	0.45	0.35	0.00	0.00	0.00	0.03	0.46	0.36	0.00	0.00	0.00
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.03	0.16	0.21	0.00	0.01	0.01	0.03	0.16	0.21	0.00	0.01	0.01
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.03	0.16	0.21	0.00	0.01	0.01	0.03	0.16	0.21	0.00	0.01	0.01

Table A-169. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Annual Emissions - 2027 (tons per year)						Annual Emissions - 2028 (tons per year)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment														
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.04	1.15	0.12	0.00	0.00	0.00	0.05	1.16	0.12	0.00	0.00	0.00
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	0.14	3.55	0.37	0.01	0.01	0.01	0.14	3.58	0.36	0.01	0.01	0.01
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	0.37	3.14	0.84	0.01	0.03	0.03	0.38	3.17	0.84	0.01	0.03	0.03
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.06	0.63	0.16	0.00	0.01	0.01	0.07	0.64	0.16	0.00	0.01	0.01
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	0.27	2.31	0.62	0.01	0.02	0.02	0.28	2.32	0.62	0.01	0.02	0.02
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	0.28	2.21	0.59	0.01	0.02	0.02	0.30	2.24	0.59	0.01	0.02	0.02
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.05	0.67	0.18	0.00	0.01	0.01	0.06	0.68	0.18	0.00	0.01	0.01
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.02	0.35	0.31	0.00	0.00	0.00	0.02	0.35	0.31	0.00	0.00	0.00
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	0.12	1.36	0.36	0.01	0.01	0.01	0.13	1.37	0.36	0.01	0.01	0.01
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.02	0.31	0.24	0.00	0.00	0.00	0.02	0.32	0.24	0.00	0.00	0.00
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.06	0.72	0.19	0.00	0.01	0.01	0.06	0.72	0.19	0.00	0.01	0.01
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.06	0.74	0.20	0.00	0.01	0.01	0.06	0.74	0.20	0.00	0.01	0.01
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.08	0.87	0.23	0.00	0.01	0.01	0.08	0.87	0.23	0.00	0.01	0.01
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.08	0.88	0.23	0.00	0.01	0.01	0.08	0.89	0.23	0.00	0.01	0.01
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.03	0.81	0.33	0.00	0.00	0.00	0.03	0.82	0.34	0.00	0.00	0.00
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	0.86	6.83	1.81	0.03	0.07	0.07	0.87	6.86	1.82	0.03	0.07	0.07
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	0.61	4.62	1.22	0.02	0.05	0.05	0.62	4.64	1.23	0.02	0.05	0.05
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	0.27	3.05	7.19	0.01	0.06	0.06	0.29	3.08	7.24	0.01	0.06	0.06
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	0.01	0.05	0.07	0.00	0.00	0.00	0.01	0.05	0.07	0.00	0.00	0.00
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.02	1.04	0.10	0.00	0.00	0.00	0.03	1.04	0.10	0.00	0.00	0.00
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.03	1.25	0.12	0.00	0.00	0.00	0.03	1.26	0.12	0.00	0.00	0.00
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.03	1.25	0.12	0.00	0.00	0.00	0.03	1.26	0.12	0.00	0.00	0.00
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.03	1.43	0.13	0.00	0.00	0.00	0.03	1.43	0.13	0.00	0.00	0.00
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.04	0.56	0.15	0.00	0.01	0.00	0.04	0.56	0.15	0.00	0.01	0.00
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.07	0.92	0.25	0.00	0.01	0.01	0.07	0.92	0.25	0.00	0.01	0.01
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.15	1.19	0.30	0.01	0.01	0.01	0.15	1.18	0.30	0.01	0.01	0.01
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.17	1.38	0.35	0.01	0.01	0.01	0.17	1.38	0.35	0.01	0.01	0.01
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.12	2.90	0.25	0.01	0.01	0.01	0.12	2.90	0.25	0.01	0.01	0.01
Concrete Equipment														
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.02	0.15	0.19	0.00	0.01	0.01	0.02	0.15	0.19	0.00	0.01	0.01
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.04	0.56	0.08	0.00	0.01	0.00	0.05	0.57	0.07	0.00	0.01	0.00
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.07	0.82	0.13	0.00	0.01	0.01	0.07	0.83	0.14	0.00	0.01	0.01
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.06	0.32	0.45	0.00	0.02	0.02	0.06	0.32	0.45	0.00	0.02	0.02
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.02	0.85	0.22	0.00	0.02	0.02	0.02	0.86	0.22	0.00	0.02	0.02
Utility Equipment														
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	0.30	19.17	0.24	0.00	0.02	0.01	0.30	19.16	0.24	0.00	0.02	0.01
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.05	1.16	0.12	0.00	0.00	0.00	0.05	1.17	0.11	0.00	0.00	0.00
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.10	0.79	0.11	0.00	0.01	0.01	0.10	0.80	0.11	0.00	0.01	0.01
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.16	1.20	0.19	0.01	0.01	0.01	0.16	1.21	0.17	0.01	0.01	0.01
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	0.52	3.30	3.94	0.01	0.15	0.14	0.52	3.30	3.94	0.01	0.15	0.14
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	0.65	24.39	0.48	0.00	0.27	0.20	0.65	24.36	0.48	0.00	0.27	0.20
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.04	0.57	0.41	0.00	0.00	0.00	0.04	0.58	0.42	0.00	0.00	0.00
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.03	0.54	0.40	0.00	0.00	0.00	0.03	0.54	0.40	0.00	0.00	0.00
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.03	1.01	0.12	0.00	0.00	0.00	0.03	1.02	0.12	0.00	0.00	0.00
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.06	0.70	0.14	0.00	0.01	0.01	0.06	0.70	0.14	0.00	0.01	0.01
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.04	0.19	0.29	0.00	0.01	0.01	0.04	0.19	0.29	0.00	0.01	0.01
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.04	0.22	0.34	0.00	0.01	0.01	0.04	0.22	0.34	0.00	0.01	0.01
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.05	0.24	0.37	0.00	0.01	0.01	0.05	0.24	0.37	0.00	0.01	0.01
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.03	0.47	0.36	0.00	0.00	0.00	0.03	0.47	0.36	0.00	0.00	0.00
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.03	0.16	0.21	0.00	0.01	0.01	0.03	0.16	0.21	0.00	0.01	0.01
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.03	0.16	0.21	0.00	0.01	0.01	0.03	0.16	0.21	0.00	0.01	0.01

Table A-169. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Annual Emissions - 2029 (tons per year)					
			ROG	CO	NOx	SOx	PM10	PM2.5
Earthmoving Equipment								
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	0.05	1.17	0.12	0.00	0.00	0.00
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	0.14	3.61	0.39	0.01	0.01	0.01
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	0.39	3.18	0.85	0.01	0.03	0.03
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	0.07	0.65	0.17	0.00	0.01	0.01
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	0.29	2.34	0.62	0.01	0.02	0.02
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	0.31	2.26	0.60	0.01	0.02	0.02
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	0.06	0.68	0.18	0.00	0.01	0.01
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	0.02	0.35	0.31	0.00	0.00	0.00
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	0.13	1.39	0.36	0.01	0.01	0.01
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.02	0.32	0.24	0.00	0.00	0.00
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.07	0.73	0.19	0.00	0.01	0.01
2.0 CY Excavator	ConstMin - Excavators	Diesel	0.07	0.75	0.20	0.00	0.01	0.01
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.08	0.89	0.23	0.00	0.01	0.01
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.08	0.90	0.24	0.00	0.01	0.01
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.03	0.82	0.34	0.00	0.00	0.00
5 Ton Flatbed Truck	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	0.88	6.87	1.82	0.03	0.07	0.07
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	0.61	4.63	1.22	0.02	0.05	0.05
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	0.30	3.10	7.27	0.01	0.07	0.06
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	0.01	0.05	0.07	0.00	0.00	0.00
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	0.03	1.04	0.10	0.00	0.00	0.00
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	0.03	1.26	0.12	0.00	0.00	0.00
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	0.03	1.26	0.12	0.00	0.00	0.00
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	0.03	1.44	0.13	0.00	0.00	0.00
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	0.04	0.56	0.15	0.00	0.01	0.00
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	0.07	0.93	0.25	0.00	0.01	0.01
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	0.15	1.19	0.30	0.01	0.01	0.01
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	0.17	1.38	0.35	0.01	0.01	0.01
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	0.12	2.90	0.25	0.01	0.01	0.01
Concrete Equipment								
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	0.02	0.15	0.19	0.00	0.01	0.01
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.05	0.58	0.08	0.00	0.01	0.00
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	0.07	0.84	0.14	0.00	0.01	0.01
Grout Pump	OFF - Light Commercial - Pumps	Diesel	0.06	0.32	0.45	0.00	0.02	0.02
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	0.02	0.87	0.21	0.00	0.02	0.02
Utility Equipment								
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	0.30	19.15	0.24	0.00	0.02	0.01
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.05	1.18	0.11	0.00	0.00	0.00
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.10	0.80	0.11	0.00	0.01	0.01
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	0.16	1.23	0.17	0.01	0.01	0.01
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	0.52	3.30	3.94	0.01	0.15	0.14
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	0.65	24.34	0.48	0.00	0.27	0.20
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	0.05	0.59	0.42	0.00	0.00	0.00
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.03	0.55	0.41	0.00	0.00	0.00
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.03	1.03	0.12	0.00	0.00	0.00
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	0.06	0.71	0.13	0.00	0.01	0.01
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.04	0.19	0.29	0.00	0.01	0.01
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.04	0.22	0.34	0.00	0.01	0.01
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	0.05	0.24	0.37	0.00	0.01	0.01
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	0.03	0.48	0.36	0.00	0.00	0.00
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.03	0.16	0.21	0.00	0.01	0.01
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	0.03	0.16	0.21	0.00	0.01	0.01

Table A-169. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Annual Emissions - 2024 (tons per year)					
							ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment												
20 Ton Truck Crane	ConstMin - Cranes	Diesel	50	123	1	g/hp-hr	0.02	0.83	0.08	0.00	0.00	0.00
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	148	170	1	g/hp-hr	0.03	1.15	0.11	0.00	0.00	0.00
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	26,245	178	1	g/hp-hr	0.03	0.41	0.11	0.00	0.00	0.00
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	14,545	308	1	g/hp-hr	0.05	0.69	0.19	0.00	0.01	0.01
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	6,457	123	1	g/hp-hr	0.02	0.83	0.08	0.00	0.00	0.00
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	300	130	1	g/hp-hr	0.02	0.88	0.08	0.00	0.00	0.00
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	1,050	355	1	g/hp-hr	0.06	0.80	0.22	0.00	0.01	0.01
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	375	63	1	g/hp-hr	0.01	0.49	0.21	0.00	0.00	0.00
Drilling & Tunneling Equipment												
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	54,435	221	2	g/hp-hr	0.12	1.74	0.47	0.01	0.02	0.02
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	4,319	221	1	g/hp-hr	0.06	0.87	0.23	0.00	0.01	0.01
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	338	44	1	g/hp-hr	0.03	0.63	0.53	0.00	0.00	0.00
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	19	63	1	g/hp-hr	0.01	0.49	0.21	0.00	0.00	0.00
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,585	98	1	g/hp-hr	0.03	0.98	0.41	0.00	0.00	0.00
Service & Maintenance Equipment												
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	1,287	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	404,389	n/a	10	g/hr	0.06	1.32	0.06	0.00	0.06	0.03
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	117,268	n/a	3	g/hr	0.02	0.40	0.02	0.00	0.02	0.01
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
5 Ton Flat Bed Truck	n/a - onroad	Diesel	22,262	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
10 Ton Flat Bed Truck	n/a - onroad	Diesel	3,158	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
1- Ton Mechanic Truck	n/a - onroad	Diesel	3,250	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
2-Ton Mechanic Truck	n/a - onroad	Diesel	116,578	n/a	3	g/hr	0.02	0.40	0.02	0.00	0.02	0.01
Lube Truck	n/a - onroad	Diesel	76,667	n/a	2	g/hr	0.01	0.26	0.01	0.00	0.01	0.01
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	38,333	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
1000 Gallon Watertruck	n/a - onroad	Diesel	2,091	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
3000 Gallon Watertruck	n/a - onroad	Diesel	26,605	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
5000 Gallon Watertanker	n/a - onroad	Diesel	597	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	74,735	500	2	g/hp-hr	0.29	3.46	0.94	0.02	0.03	0.03
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	3,803	500	1	g/hp-hr	0.14	1.73	0.47	0.01	0.02	0.02
5 Ton Boomtruck	n/a - onroad	Diesel	212	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
10 Ton Boomtruck	n/a - onroad	Diesel	249	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
20 Ton Boomtruck	n/a - onroad	Diesel	375	n/a	1	g/hr	0.01	0.13	0.01	0.00	0.01	0.00
		Total	**2,461,102**	**n/a**	**n/a**	**n/a**	**2,031.19**	**2,146.63**	**2,054.50**	**2,024.29**	**2,025.32**	**2,025.07**

Table A-169. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Annual Emissions - 2025 (tons per year)						Annual Emissions - 2026 (tons per year)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment														
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.02	0.84	0.08	0.00	0.00	0.00	0.02	0.84	0.08	0.00	0.00	0.00
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.03	1.15	0.11	0.00	0.00	0.00	0.03	1.16	0.11	0.00	0.00	0.00
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.03	0.41	0.11	0.00	0.00	0.00	0.03	0.41	0.11	0.00	0.00	0.00
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.05	0.69	0.19	0.00	0.01	0.01	0.05	0.70	0.19	0.00	0.01	0.01
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.02	0.84	0.08	0.00	0.00	0.00	0.02	0.84	0.08	0.00	0.00	0.00
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.02	0.88	0.08	0.00	0.00	0.00	0.02	0.89	0.08	0.00	0.00	0.00
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.06	0.80	0.22	0.00	0.01	0.01	0.06	0.80	0.22	0.00	0.01	0.01
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.01	0.49	0.21	0.00	0.00	0.00	0.01	0.49	0.21	0.00	0.00	0.00
Drilling & Tunneling Equipment														
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	0.12	1.74	0.47	0.01	0.02	0.02	0.13	1.75	0.47	0.01	0.02	0.02
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.06	0.87	0.24	0.00	0.01	0.01	0.06	0.88	0.24	0.00	0.01	0.01
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.03	0.63	0.53	0.00	0.00	0.00	0.03	0.65	0.54	0.00	0.00	0.00
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.01	0.49	0.21	0.00	0.00	0.00	0.01	0.49	0.21	0.00	0.00	0.00
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.03	0.98	0.41	0.00	0.00	0.00	0.04	0.99	0.41	0.00	0.00	0.00
Service & Maintenance Equipment														
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.06	1.31	0.06	0.00	0.06	0.03	0.06	1.31	0.05	0.00	0.06	0.03
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.02	0.39	0.02	0.00	0.02	0.01	0.02	0.39	0.02	0.00	0.02	0.01
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.02	0.39	0.02	0.00	0.02	0.01	0.02	0.39	0.02	0.00	0.02	0.01
Lube Truck	n/a - onroad	Diesel	0.01	0.26	0.01	0.00	0.01	0.01	0.01	0.26	0.01	0.00	0.01	0.01
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
1000 Gallon Watertruck	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
3000 Gallon Watertruck	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
5000 Gallon Watertanker	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	0.30	3.48	0.95	0.02	0.03	0.03	0.31	3.51	0.95	0.02	0.03	0.03
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	0.15	1.74	0.47	0.01	0.02	0.02	0.16	1.75	0.48	0.01	0.02	0.02
5 Ton Boomtruck	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
10 Ton Boomtruck	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
20 Ton Boomtruck	n/a - onroad	Diesel	0.01	0.13	0.01	0.00	0.01	0.00	0.01	0.13	0.01	0.00	0.01	0.00
		Total	**2,032.32**	**2,147.92**	**2,055.44**	**2,025.29**	**2,026.32**	**2,026.07**	**2,033.51**	**2,149.38**	**2,056.58**	**2,026.29**	**2,027.33**	**2,027.08**

Table A-169. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Annual Emissions - 2027 (tons per year)						Annual Emissions - 2028 (tons per year)					
			ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment														
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.02	0.84	0.08	0.00	0.00	0.00	0.02	0.85	0.08	0.00	0.00	0.00
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.03	1.17	0.11	0.00	0.00	0.00	0.03	1.18	0.11	0.00	0.00	0.00
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.03	0.41	0.11	0.00	0.00	0.00	0.03	0.42	0.11	0.00	0.00	0.00
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.06	0.70	0.19	0.00	0.01	0.01	0.06	0.70	0.19	0.00	0.01	0.01
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.02	0.84	0.08	0.00	0.00	0.00	0.02	0.85	0.08	0.00	0.00	0.00
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.02	0.89	0.08	0.00	0.00	0.00	0.03	0.90	0.08	0.00	0.00	0.00
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.06	0.81	0.22	0.00	0.01	0.01	0.07	0.81	0.22	0.00	0.01	0.01
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.01	0.49	0.21	0.00	0.00	0.00	0.01	0.49	0.21	0.00	0.00	0.00
Drilling & Tunneling Equipment														
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	0.13	1.75	0.47	0.01	0.02	0.02	0.13	1.75	0.47	0.01	0.02	0.02
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.06	0.88	0.24	0.00	0.01	0.01	0.06	0.87	0.24	0.00	0.01	0.01
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.03	0.64	0.54	0.00	0.00	0.00	0.03	0.65	0.53	0.00	0.00	0.00
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.01	0.49	0.21	0.00	0.00	0.00	0.01	0.49	0.21	0.00	0.00	0.00
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.04	0.99	0.41	0.00	0.00	0.00	0.04	1.00	0.41	0.00	0.00	0.00
Service & Maintenance Equipment														
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.05	1.31	0.05	0.00	0.06	0.03	0.05	1.30	0.05	0.00	0.06	0.03
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.02	0.39	0.01	0.00	0.02	0.01	0.02	0.39	0.01	0.00	0.02	0.01
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.02	0.39	0.01	0.00	0.02	0.01	0.02	0.39	0.01	0.00	0.02	0.01
Lube Truck	n/a - onroad	Diesel	0.01	0.26	0.01	0.00	0.01	0.01	0.01	0.26	0.01	0.00	0.01	0.01
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
1000 Gallon Watertruck	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
3000 Gallon Watertruck	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
5000 Gallon Watertanker	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	0.32	3.53	0.96	0.02	0.04	0.03	0.33	3.54	0.96	0.02	0.04	0.03
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	0.16	1.76	0.48	0.01	0.02	0.02	0.16	1.77	0.48	0.01	0.02	0.02
5 Ton Boomtruck	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
10 Ton Boomtruck	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
20 Ton Boomtruck	n/a - onroad	Diesel	0.01	0.13	0.00	0.00	0.01	0.00	0.01	0.13	0.00	0.00	0.01	0.00
		Total	**2,034.67**	**2,150.76**	**2,057.57**	**2,027.29**	**2,028.33**	**2,028.08**	**2,035.81**	**2,152.15**	**2,058.62**	**2,028.29**	**2,029.33**	**2,029.08**

Table A-169. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Annual Emissions - 2029 (tons per year)					
			ROG	CO	NOx	SOx	PM10	PM2.5
Hoisting Equipment								
20 Ton Truck Crane	ConstMin - Cranes	Diesel	0.02	0.86	0.08	0.00	0.00	0.00
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	0.03	1.18	0.11	0.00	0.00	0.00
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	0.03	0.42	0.11	0.00	0.00	0.00
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	0.06	0.71	0.19	0.00	0.01	0.01
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	0.02	0.86	0.08	0.00	0.00	0.00
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	0.03	0.91	0.08	0.00	0.00	0.00
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	0.07	0.81	0.22	0.00	0.01	0.01
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	0.01	0.49	0.21	0.00	0.00	0.00
Drilling & Tunneling Equipment								
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	0.13	1.75	0.47	0.01	0.02	0.02
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	0.06	0.88	0.24	0.00	0.01	0.01
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	0.04	0.65	0.53	0.00	0.00	0.00
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	0.01	0.49	0.21	0.00	0.00	0.00
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	0.04	1.00	0.41	0.00	0.00	0.00
Service & Maintenance Equipment								
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	0.05	1.30	0.05	0.00	0.06	0.02
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	0.01	0.39	0.01	0.00	0.02	0.01
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
5 Ton Flat Bed Truck	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
10 Ton Flat Bed Truck	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
1- Ton Mechanic Truck	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
2-Ton Mechanic Truck	n/a - onroad	Diesel	0.01	0.39	0.01	0.00	0.02	0.01
Lube Truck	n/a - onroad	Diesel	0.01	0.26	0.01	0.00	0.01	0.00
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
1000 Gallon Watertruck	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
3000 Gallon Watertruck	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
5000 Gallon Watertanker	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	0.33	3.54	0.96	0.02	0.04	0.03
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	0.16	1.77	0.48	0.01	0.02	0.02
5 Ton Boomtruck	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
10 Ton Boomtruck	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
20 Ton Boomtruck	n/a - onroad	Diesel	0.00	0.13	0.00	0.00	0.01	0.00
		Total	**2,036.90**	**2,153.44**	**2,059.70**	**2,029.29**	**2,030.33**	**2,030.08**

Pacheco Reservoir Expansion Alternative
Offsite Construction Emissions

Table A-170. Construction Worker Commuting Emissions

Year	Maximum Daily Trips	Annual Trips	Emission Factors, grams per mile						Maximum Daily Emissions, pounds per day						Annual Emissions, tons per year					
			ROG	NOx	CO	SOx	PM10	PM2.5	ROG	NOx	CO	SOx	PM10	PM2.5	ROG	NOx	CO	SOx	PM10	PM2.5
2024	600	159,250	0.0093	0.0475	0.5237	0.0025	0.1469	0.0444	0.49	2.51	27.71	0.13	7.77	2.35	0.07	0.33	3.68	0.02	1.03	0.31
2025	600	191,889	0.0085	0.0435	0.4900	0.0024	0.1469	0.0444	0.45	2.30	25.93	0.13	7.77	2.35	0.07	0.37	4.15	0.02	1.24	0.38
2026	900	291,261	0.0078	0.0402	0.4617	0.0023	0.1468	0.0444	0.62	3.19	36.64	0.19	11.65	3.52	0.10	0.52	5.93	0.03	1.89	0.57
2027	950	309,400	0.0072	0.0372	0.4367	0.0023	0.1468	0.0443	0.60	3.12	36.58	0.19	12.29	3.71	0.10	0.51	5.96	0.03	2.00	0.60
2028	950	309,400	0.0066	0.0346	0.4144	0.0022	0.1466	0.0442	0.56	2.90	34.72	0.18	12.28	3.70	0.09	0.47	5.65	0.03	2.00	0.60
2029	550	142,567	0.0062	0.0323	0.3939	0.0021	0.1465	0.0441	0.30	1.57	19.10	0.10	7.11	2.14	0.04	0.20	2.48	0.01	0.92	0.28
								Maximum	**0.62**	**3.19**	**36.64**	**0.19**	**12.29**	**3.71**	**0.10**	**0.52**	**5.96**	**0.03**	**2.00**	**0.60**

Note: Particulate matter (PM10 and PM2.5) emissions contain exhaust, tire wear, brake wear, and paved road dust.

Table A-171. Mitigated Haul Trucks Emissions

Year	Maximum Daily Trips	Annual Trips	Emission Factors, grams per mile						Maximum Daily Emissions, pounds per day						Annual Emissions, tons per year					
			ROG	NOx	CO	SOx	PM10	PM2.5	ROG	NOx	CO	SOx	PM10	PM2.5	ROG	NOx	CO	SOx	PM10	PM2.5
2024	245	48,230	0.0589	0.8860	0.3475	0.0141	0.2019	0.0641	1.27	19.14	7.51	0.30	4.36	1.39	0.13	1.88	0.74	0.03	0.43	0.14
2025	430	132,253	0.0595	0.9006	0.3511	0.0141	0.2020	0.0642	2.25	34.15	13.31	0.53	7.66	2.43	0.35	5.25	2.05	0.08	1.18	0.37
2026	430	156,520	0.0600	0.9141	0.3545	0.0141	0.2020	0.0642	2.28	34.66	13.44	0.53	7.66	2.44	0.41	6.31	2.45	0.10	1.39	0.44
2027	430	144,387	0.0606	0.9270	0.3577	0.0141	0.2021	0.0643	2.30	35.15	13.56	0.53	7.66	2.44	0.39	5.90	2.28	0.09	1.29	0.41
2028	30	10,920	0.0611	0.9397	0.3608	0.0141	0.2021	0.0643	0.16	2.49	0.95	0.04	0.53	0.17	0.03	0.45	0.17	0.01	0.10	0.03
2029	30	4,550	0.0616	0.9510	0.3636	0.0140	0.2022	0.0644	0.16	2.52	0.96	0.04	0.53	0.17	0.01	0.19	0.07	0.00	0.04	0.01
								Maximum	**2.30**	**35.15**	**13.56**	**0.53**	**7.66**	**2.44**	**0.41**	**6.31**	**2.45**	**0.10**	**1.39**	**0.44**

Note: Particulate matter (PM10 and PM2.5) emissions contain exhaust, tire wear, brake wear, and paved road dust.

One-way trip distance
Workers 40 miles
Trucks 40 miles

Conversions
453.6 grams per pound
2,000 pounds per ton

Emission Factors
Paved Road Dust Emissions

Equation 1:

$$E = k(sL)^{0.91} \times (W)^{1.02}$$

where: E = particulate emission factor (having units matching the units of k),
k = particle size multiplier for particle size range and units of interest (see below),
sL = road surface silt loading (grams per square meter) (g/m2), and
W = average weight (tons) of the vehicles traveling the road.

Equation 2:

$$E_{ext} = [k(sL)^{0.91} \times (W)^{1.02}](1 - P/4N)$$

where: k, sL, and W are as defined in Equation 1 and
E_{ext} = annual or other long-term average emission factor in the same units as k,
P = number of "wet" days with at least 0.254 mm (0.01 in) of precipitation during the averaging period, and
N = number of days in the averaging period (e.g., 365 for annual, 91 for seasonal, 30 for monthly).

Table A-172. Particle Size Multipliers for Paved Road Equation

Size Range [a]	Ref.	Particle Size Multiplier, k [b]		
		g/VKT	g/VMT	lb/VMT
$PM_{2.5}$	[c]	0.15	0.25	0.00054
PM_{10}		0.62	1.00	0.0022
PM_{15}		0.77	1.23	0.0027
PM_{30}	[d]	3.23	5.24	0.011

Source: USEPA. 2011. Compilation of Air Pollutant Emission Factors (AP-42). Fifth Edition, Volume I. Chapter 13.2.1 Paved Roads. January. Available online at: http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf [Accessed July 17, 2012].

Notes:

[a] Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.

[b] Units shown are grams per vehicle kilometer traveled (g/VKT), grams per vehicle mile traveled (g/VMT), and pounds per vehicle mile traveled (lb/VMT). The multiplier k includes unit conversions to produce emission factors in the units shown for the indicated size range from the mixed units required in Equation 1.

[c] The k-factors for $PM_{2.5}$ were based on the average $PM_{2.5}$:PM_{10} ratio of test runs in Reference 30.

[d] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

Offsite Construction Vehicles

Number precipitation days >0.1 inches
Santa Clara County 58

Road silt loading 0.03 g/m^2 (AP-42, Table 13.2.1-2, ADT > 10,000, ubiquitous baseline)
Average vehicle weight 2.4 tons

Source: CAPCOA. 2017. California Emissions Estimator Model User's Guide, Version 2016.3.2, Appendix D: Default Data Tables. Prepared by BREEZE Software, A Division of Trinity Consultants. October. Available online at: http://www.caleemod.com/ [Accessed on November 9, 2018].

Table A-173. Paved Road Dust Emission Factors - Offsite Construction Vehicles

County	Emission Factor (g/VMT)			
	Uncontrolled		Controlled	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Merced	0.100	0.025	0.096	0.024

Note:
Controlled emission factor only valid for long-term (annual) emissions; uncontrolled emission factor used for daily emissions.

EMFAC2014 Emission Factors
On-Road Motor Vehicles

Table A-174. Emission Factors for Construction Worker Commutes

		grams per mile												
Air Basin	Year	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
San Francisco Bay Area	2024	0.0093	0.0135	0.0475	0.5237	0.0025	0.0017	0.0080	0.0368	0.0465	0.0016	0.0020	0.0158	0.0193
	2025	0.0085	0.0123	0.0435	0.4900	0.0024	0.0017	0.0080	0.0368	0.0464	0.0016	0.0020	0.0158	0.0193
	2026	0.0078	0.0113	0.0402	0.4617	0.0023	0.0016	0.0080	0.0368	0.0464	0.0015	0.0020	0.0158	0.0193
	2027	0.0072	0.0104	0.0372	0.4367	0.0023	0.0015	0.0080	0.0368	0.0463	0.0014	0.0020	0.0158	0.0192
	2028	0.0066	0.0097	0.0346	0.4144	0.0022	0.0014	0.0080	0.0368	0.0462	0.0013	0.0020	0.0158	0.0191
	2029	0.0062	0.0090	0.0323	0.3939	0.0021	0.0013	0.0080	0.0368	0.0461	0.0012	0.0020	0.0158	0.0190

Note:
Vehicle fleet mix includes gasoline, diesel, and electric automobiles (LDA) and light-duty trucks (LDT1 and LDT2).

Table A-175. Mitigated Emission Factors for Haul and Delivery Trucks

		grams per mile												
Air Basin	Year	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
San Francisco Bay Area	2024	0.059	0.067	0.886	0.348	0.014	0.004	0.036	0.062	0.101	0.004	0.009	0.026	0.039
	2025	0.059	0.068	0.901	0.351	0.014	0.004	0.036	0.062	0.102	0.004	0.009	0.026	0.039
	2026	0.060	0.068	0.914	0.354	0.014	0.004	0.036	0.062	0.102	0.004	0.009	0.026	0.039
	2027	0.061	0.069	0.927	0.358	0.014	0.004	0.036	0.062	0.102	0.004	0.009	0.026	0.039
	2028	0.061	0.070	0.940	0.361	0.014	0.004	0.036	0.062	0.102	0.004	0.009	0.026	0.039
	2029	0.062	0.070	0.951	0.364	0.014	0.004	0.036	0.062	0.102	0.004	0.009	0.026	0.039

Note: Mitigation requires model year 2015 or later engines.

Table A-176. Mitigated Emission Factors for On-Site Heavy-Duty Vehicles (San Francisco Bay Area Air Basin)

		grams per mile												
Year	Speed	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
2024	5	0.138	0.157	0.091	3.002	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.023
2024	10	0.103	0.117	0.075	2.238	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.022
2024	15	0.050	0.057	0.050	1.092	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2024	20	0.019	0.022	0.033	0.425	0.004	0.004	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2024	25	0.012	0.013	0.025	0.255	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2024	30	0.009	0.010	0.021	0.193	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.020
2024	35	0.007	0.008	0.018	0.153	0.004	0.003	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2024	40	0.006	0.007	0.016	0.126	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2024	45	0.005	0.006	0.015	0.107	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2024	50	0.004	0.005	0.013	0.092	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2024	55	0.004	0.004	0.012	0.081	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2024	60	0.004	0.004	0.012	0.077	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2024	65	0.003	0.004	0.012	0.076	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.019
2025	5	0.132	0.150	0.085	2.990	0.004	0.005	0.008	0.037	0.050	0.005	0.002	0.016	0.022
2025	10	0.098	0.112	0.070	2.228	0.004	0.005	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2025	15	0.048	0.054	0.047	1.087	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2025	20	0.019	0.021	0.031	0.423	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2025	25	0.011	0.013	0.023	0.254	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2025	30	0.008	0.010	0.019	0.192	0.004	0.003	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2025	35	0.007	0.008	0.017	0.152	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2025	40	0.006	0.006	0.015	0.126	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2025	45	0.005	0.005	0.014	0.107	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020

Table A-176. Mitigated Emission Factors for On-Site Heavy-Duty Vehicles (San Francisco Bay Area Air Basin)

		grams per mile												
Year	Speed	ROG	TOG	NOx	CO	SOx	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Total
2025	50	0.004	0.005	0.012	0.092	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2025	55	0.004	0.004	0.012	0.081	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.019
2025	60	0.003	0.004	0.011	0.076	0.004	0.002	0.008	0.037	0.046	0.002	0.002	0.016	0.019
2025	65	0.003	0.004	0.011	0.076	0.004	0.002	0.008	0.037	0.046	0.002	0.002	0.016	0.019
2026	5	0.126	0.144	0.079	2.982	0.004	0.005	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2026	10	0.094	0.107	0.066	2.222	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2026	15	0.046	0.052	0.044	1.084	0.004	0.004	0.008	0.037	0.048	0.004	0.002	0.016	0.021
2026	20	0.018	0.020	0.029	0.422	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2026	25	0.011	0.012	0.022	0.253	0.004	0.003	0.008	0.037	0.047	0.003	0.002	0.016	0.020
2026	30	0.008	0.009	0.018	0.192	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2026	35	0.006	0.007	0.016	0.152	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2026	40	0.005	0.006	0.014	0.125	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2026	45	0.005	0.005	0.013	0.107	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2026	50	0.004	0.004	0.012	0.092	0.004	0.002	0.008	0.037	0.046	0.002	0.002	0.016	0.019
2026	55	0.003	0.004	0.011	0.081	0.004	0.002	0.008	0.037	0.046	0.002	0.002	0.016	0.019
2026	60	0.003	0.004	0.010	0.076	0.004	0.002	0.008	0.037	0.046	0.002	0.002	0.016	0.019
2026	65	0.003	0.004	0.010	0.076	0.004	0.002	0.008	0.037	0.046	0.002	0.002	0.016	0.019
2027	5	0.122	0.139	0.075	2.977	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2027	10	0.091	0.103	0.062	2.217	0.004	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2027	15	0.044	0.050	0.041	1.081	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2027	20	0.017	0.020	0.027	0.421	0.004	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2027	25	0.010	0.012	0.021	0.253	0.004	0.003	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2027	30	0.008	0.009	0.017	0.191	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2027	35	0.006	0.007	0.015	0.152	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2027	40	0.005	0.006	0.013	0.125	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2027	45	0.004	0.005	0.012	0.107	0.004	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.019
2027	50	0.004	0.004	0.011	0.092	0.004	0.002	0.008	0.037	0.046	0.002	0.002	0.016	0.019
2027	55	0.003	0.004	0.010	0.081	0.004	0.002	0.008	0.037	0.046	0.001	0.002	0.016	0.019
2027	60	0.003	0.004	0.010	0.076	0.004	0.002	0.008	0.037	0.046	0.001	0.002	0.016	0.019
2027	65	0.003	0.004	0.010	0.075	0.004	0.001	0.008	0.037	0.046	0.001	0.002	0.016	0.019
2028	5	0.118	0.134	0.071	2.971	0.003	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.022
2028	10	0.087	0.100	0.059	2.212	0.003	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.021
2028	15	0.043	0.049	0.039	1.079	0.003	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2028	20	0.017	0.019	0.026	0.420	0.003	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.020
2028	25	0.010	0.011	0.020	0.252	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2028	30	0.008	0.009	0.016	0.191	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2028	35	0.006	0.007	0.014	0.151	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2028	40	0.005	0.006	0.012	0.125	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.019
2028	45	0.004	0.005	0.011	0.106	0.003	0.002	0.008	0.037	0.046	0.002	0.002	0.016	0.019
2028	50	0.004	0.004	0.010	0.091	0.003	0.002	0.008	0.037	0.046	0.001	0.002	0.016	0.019
2028	55	0.003	0.004	0.010	0.080	0.003	0.001	0.008	0.037	0.046	0.001	0.002	0.016	0.019
2028	60	0.003	0.003	0.009	0.076	0.003	0.001	0.008	0.037	0.046	0.001	0.002	0.016	0.019
2028	65	0.003	0.003	0.009	0.075	0.003	0.001	0.008	0.037	0.046	0.001	0.002	0.016	0.019
2029	5	0.114	0.130	0.068	2.966	0.003	0.004	0.008	0.037	0.049	0.004	0.002	0.016	0.021
2029	10	0.085	0.097	0.056	2.208	0.003	0.004	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2029	15	0.041	0.047	0.037	1.077	0.003	0.003	0.008	0.037	0.048	0.003	0.002	0.016	0.021
2029	20	0.016	0.018	0.025	0.419	0.003	0.003	0.008	0.037	0.047	0.003	0.002	0.016	0.020
2029	25	0.010	0.011	0.019	0.252	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2029	30	0.007	0.008	0.016	0.190	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.020
2029	35	0.006	0.007	0.013	0.151	0.003	0.002	0.008	0.037	0.047	0.002	0.002	0.016	0.019
2029	40	0.005	0.005	0.012	0.125	0.003	0.002	0.008	0.037	0.046	0.002	0.002	0.016	0.019
2029	45	0.004	0.005	0.011	0.106	0.003	0.002	0.008	0.037	0.046	0.001	0.002	0.016	0.019
2029	50	0.004	0.004	0.010	0.091	0.003	0.001	0.008	0.037	0.046	0.001	0.002	0.016	0.019
2029	55	0.003	0.004	0.009	0.080	0.003	0.001	0.008	0.037	0.046	0.001	0.002	0.016	0.019
2029	60	0.003	0.003	0.009	0.076	0.003	0.001	0.008	0.037	0.046	0.001	0.002	0.016	0.019
2029	65	0.003	0.003	0.009	0.075	0.003	0.001	0.008	0.037	0.046	0.001	0.002	0.016	0.019

Note: Mitigation requires model year 2015 or later engines.

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Appendix P: Detailed Greenhouse Gas Emissions Calculations

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Appendix P
Detailed Greenhouse Gas Emissions Calculations

P.1 Assessment Methods

P.1.1 Greenhouse Gas Emissions

Construction emissions are described as temporary or "short term" in duration. These temporary and short-term emissions have the potential to represent a significant impact to greenhouse gas (GHG) emissions and climate change. GHG emissions are caused by on- and off-road vehicle exhaust.

The emissions estimation method (i.e., specific emission calculation equations) was based on the California Emission Estimator Model (CalEEMod), Version 2016.3.2 (California Air Pollution Control Officers Association [CAPCOA] 2017), although the calculations were performed outside of the model for flexibility. The CalEEMod is "inflexible" because it is difficult to analyze projects with multiple phases or alternatives because nuanced assumptions cannot always be included in the calculations. Construction-related emissions were estimated using multiple sources as described below.

- OFFROAD2017 Off-Road Emissions Inventory Model (California Air Resources Board [CARB] 2017a)
- EMFAC2014 Web Database (CARB 2014)
- The Climate Registry 2018 Default Emission Factors (The Climate Registry 2018)
- CalEEMod User's Guide, Appendix D: Default Data Tables (CAPCOA 2017)
- Rulemaking documentation related to diesel engines on commercial harbor craft (CARB 2004 and CARB 2007)

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

This analysis uses the GWP from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (Forster et al. 2007) for a 100-year time period to estimate CO_2e. This approach is consistent with the federal GHG Reporting Rule (40 Code of Federal Regulations [CFR] 98), as effective on January 1, 2014 (78 FR 71904) and California's 2000-2015 GHG Inventory Report (CARB 2017b). The GWPs used in this analysis are 25 for methane (CH_4) and 298 for nitrous oxide (N_2O).

The following sections provide additional discussion of emission estimation methodologies used for each source group. Detailed emission calculations are provided in Attachment A.

P.1.1.1 On-Site Construction Equipment Engine Emissions

Emission factors were developed using CARB's OFFROAD2017 model. Emission factors were developed for Merced and Santa Clara Counties for calendar years 2020 to 2026. The OFFROAD2017 model does not estimate emissions of CH_4 and N_2O; therefore, it was necessary to estimate these emissions separately. The Climate Registry's 2018 Default Emission Factors were used to estimate emissions. Emission factors for "Construction/Mining Equipment" were used to estimate CH_4 and N_2O emissions for all off-road construction equipment.

The average power rating (horsepower [hp]) for the equipment was weighted from the equipment population and hp bins contained in the models. The average hp is consistent with those developed for Chapter 10, Air Quality.

The emission factors that were developed for each piece of equipment are multiplied by the number of pieces of each equipment type that would be used during each phase of construction for each alternative. Annual emissions were calculated based on the emission factors and data provided by the design engineers. Table P-1 summarizes the maximum daily equipment counts for each alternative. The maximum daily equipment count was assumed to operate continually during each construction phase.

The construction schedule is based on a 10-hour workday for the Lower San Felipe Intake Alternative, the San Luis Reservoir Enlargement Alternative, and the Pacheco Reservoir Expansion Alternative; the latter two alternatives will operate for two shifts per day. For the Lower San Felipe Intake Alternative, it was assumed that tunneling operations would assume 24 hours per day; therefore, 12 employees would work in the tunnel each day (assumes four workers per 8-hour shift). The construction schedule for the Treatment Alternative is based on an 8-hour workday (one shift).

Table P-1. Off-Road Engine Equipment Counts

Equipment Type	Lower San Felipe Intake Alternative – Tunneling Option	Lower San Felipe Intake Alternative – Pipeline Option	Treatment Alternative[1]	San Luis Reservoir Enlargement Alternative	Pacheco Reservoir Expansion Alternative
Aerial Lifts	0	0	0	0	2
Air compressor	0	0	0	1	4
Boom Truck	0	0	0	1	3
Bulldozer	2	2	1	3	6
Cement and Mortar Mixers	0	0	0	0	1
Chipper	0	0	0	0	0
Concrete Pumpers	2	1	2	0	0
Concrete Saw Cutters	0	0	2	2	0
Cranes	4	3	2	4	7
Drill Rig	1	0	0	0	0
Dump Truck	0	0	0	3	10
Excavator	1	1	1	2	1
Flatbed Trucks (on site)	3	3	4	2	3
Forklift	0	0	0	1	0
Fuel and Lube Truck	0	0	0	1	3
Grader	2	2	0	2	2
Loaders	2	2	1	2	12
Mechanic Truck	0	0	0	1	4
Pickup Truck	0	0	0	6	16
Portable Diesel Generators	7	4	0	3	4
Pressure Washers	0	0	0	0	2
Pump	0	0	0	2	5
Roller	0	0	0	0	7
Scraper	1	1	0	2	1
Signal Boards	0	0	0	0	12
Skidders	0	0	0	0	3
Tractor	0	0	0	2	0
Truck Mounted Drill Rig (Wells)	0	0	0	0	4
Vibrating Plate	0	0	0	1	0
Vibratory Soil Compactors	0	0	0	4	0
Water Truck	2	2	2	3	6
Welders	0	0	0	0	4
Wheel Trencher	0	0	2	0	0
Total	**27**	**21**	**17**	**48**	**122**

Notes:

[1] Equipment counts for Treatment Alternative are based on the dissolved air flotation technology and are assumed to be equivalent to the ozonation technology currently proposed for this alternative. Construction assumptions will be confirmed when feasibility level design is completed in July 2018.

P.1.1.2 Off-Site Haul/Delivery Truck and Construction Worker Engine Emissions

Engine exhaust emissions would occur from several on-road vehicles including dump trucks, concrete trucks, delivery trucks, gravel/paving trucks, and soil hauling trucks. Water trucks and flatbed trucks could also operate onsite during construction activities. Furthermore, emissions would also occur from construction workers commuting to the various construction sites. Off-site vehicle trip assumptions are consistent with those used in Chapter 14, Traffic and Transportation.

Haul and delivery truck emission factors were estimated using EMFAC2014 for heavy-duty diesel engines while the water and flatbed trucks were assumed to be medium-duty vehicles. Construction worker commuting emissions were estimated from the specific county's fleet mix for passenger automobiles and light-duty trucks. Both gasoline and diesel engines were assumed to be used by the construction workers.

For the haul/delivery trucks and construction workers, emission factors were estimated from the combined speeds in the various counties (i.e., a "burden" model run), rather than a specific speed. The onsite trucks were assumed to operate at 40 miles per hour.

The EMFAC2014 model does not estimate emissions of CH_4 and N_2O; therefore, it was necessary to estimate these emissions separately. The Climate Registry's 2018 Default Emission Factors were used to estimate emissions. Emission factors for "Diesel Medium and Heavy-Duty Vehicles (Trucks and Busses)" were used to estimate CH_4 and N_2O emissions for all haul and delivery trucks. Construction worker emission factors were estimated based on the county-specific fleet mix of "Gasoline Passenger Cars," "Gasoline Light Trucks (Vans, Pickup Trucks, Sport Utility Vehicles)," "Diesel Passenger Cars," and "Diesel Light Trucks."

P.1.1.3 Marine Emissions (Tugboats, Barges, and Dredges)

Marine emissions would occur from vessels used during construction of either a tunnel or pipeline in the Lower San Felipe Intake Alternative. The tugboats used to move the barges and dredges within the San Luis Reservoir and the crew and supply boats would use both propulsion and auxiliary engines. Emission factors for transport fuels were obtained from The Climate Registry's 2018 Default Emission Factors.

Data on the average number of engines per vessel, the average annual operating hours per vessel type, and the useful life of each vessel were obtained from CARB's *Emissions Estimation Methodology for Commercial Harbor Craft Operating in California* (2007). Information on the quantity and average hp of auxiliary and propulsion engines and the vessel age were estimated from CARB's *Statewide Commercial Harbor Craft Survey* (2004).

Dredges would also operate in the Lower San Felipe Intake Alternative during construction of the pipeline; dredges would not be used during tunnel construction. Emission factors for the auxiliary engines operating on the dredges were obtained from the OFFROAD2017 model.

P.1.2 Climate Change Analysis

The climate change impact assessment characterizes the sensitivity of environmental effects evaluated in this Environmental Impact Statement/Report (EIS/EIR) to uncertainties in potential future socioeconomic and climatic conditions. As previously discussed, Section 15126.2(a) of the California Environmental Quality Act (CEQA) Guidelines require Lead Agencies to consider the effects of placing projects in locations susceptible to hazardous conditions. Because climate change can affect hazards like flooding and wildfire, this section thereby requires the effects of climate change to be analyzed under CEQA.

Appendix Q, Climate Change Analysis, presents the significance determinations made in Chapters 4 through 25, and evaluates how those significance determinations could be changed under future climate change scenarios. This analysis does not identify new impacts that were not already analyzed in the other chapters; it instead describes how those impacts might change with future climate change.

P.2 Significance Criteria

The significance criteria described below were developed consistent with the CEQA Guidelines to determine the significance of potential impacts on air quality. Impacts on GHG emissions would be considered potentially significant if the proposed project or alternatives would:

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

In addition to the general criteria provided above, individual air districts may also establish significance criteria that would also be applicable. Additional significance criteria by air district are provided below.

P.2.1 San Joaquin Valley Air Pollution Control District (SJVAPCD)

The SJVAPCD publishes a *Guidance for Assessing and Mitigating Air Quality Impacts* (GAMAQI) (SJVAPCD 2015) to assist Lead Agencies with uniform procedures for addressing GHG impacts in environmental documentation. The SJVAPCD does not establish a specific quantitative level of GHG emissions increase above which a project would have a significant impact on the

environment. As a result, the SJVAPCD uses a tiered approach for assessing the significance of a project based on the following criteria (SJVAPCD 2009):

- Projects determined to be exempt from the requirements of CEQA would be determined to have a less than significant individual and cumulative impact for GHG emissions and would not require further environmental review, including analysis of project specific GHG emissions.

- Projects complying with an approved GHG emission reduction plan or GHG mitigation program that avoids or substantially reduces GHG emissions within the geographic area in which the project is located would be determined to have a less than significant individual and cumulative impact for GHG emissions.

- Projects implementing best performance standards (BPS) would not require quantification of project specific emissions. Such projects would be determined to have a less than significant individual and cumulative impact for GHG emissions.

- Projects not implementing BPS would require quantification of project specific GHG emissions and demonstration that project specific GHG emissions would be reduced or mitigated by at least 29 percent compared to business as usual (BAU).

- Notwithstanding any of the above provisions, projects requiring preparation of an EIR for any other reason would require quantification of project specific GHG emissions. Projects implementing BPS or achieving at least a 29 percent GHG emission reduction compared to BAU would be determined to have a less than significant individual and cumulative impact for GHG.

The alternatives do not include the installation of any stationary sources that would be subject to the SJVAPCD's BPS provisions. The BPS classes are generally geared towards stationary source fossil fuel-combustion equipment like boilers, engines, and heaters. In addition, the action alternatives do not consist of "traditional" land use development projects like proposed residential, commercial, industrial, or governmental operations that primarily increase GHG emissions through energy consumption and vehicle miles traveled.

P.2.2 BAAQMD

To evaluate the significance of GHG emissions in the SJVAPCD from non-stationary sources, the quantitative thresholds proposed by the Bay Area Air Quality Management District (BAAQMD) in its CEQA Air Quality Guidelines (2017a) were used. The BAAQMD thresholds are adequate to measure GHG emissions increases above which could hinder implementation of the State's GHG reduction goals, including AB 32.

The BAAQMD publishes CEQA Air Quality Guidelines to assist Lead Agencies with complying with CEQA's requirements. These guidelines were updated in May 2017 to include new and updated significance thresholds.

The 2017 BAAQMD Air Quality CEQA Guidelines do not provide a threshold for construction projects, but they include multiple thresholds for operational emissions, including 1,100 metric tons carbon dioxide equivalent per year ($MTCO_2e$/year) for projects other than stationary sources and 10,000 $MTCO_2e$/year for stationary sources. For construction impacts, the BAAQMD recommends quantifying and disclosing GHG emissions that would occur during construction and to then make a determination of significance in relation to meeting AB 32 reduction goals. Additionally, best management practices should be incorporated to reduce GHG impacts.

P.2.3 Sacramento Metropolitan Air Quality Management District (SMAQMD)

Although the project is not located within the boundaries of the SMAQMD, the significance criteria used by other air districts was evaluated. The SMAQMD uses a significance threshold of 1,100 $MTCO_2e$/year for the construction phase of a proposed project (2015). Because the air quality in the Sacramento Valley is similar to the air quality in the Bay Area and the San Joaquin Valley, and because the threshold is a conservative assessment of GHG impacts for construction-related activities, the threshold was used in this analysis.

P.2.4 Plan Consistency

The action alternatives were compared to various plans, policies, and regulations that were enacted to reduce GHG emissions. If an alternative is found to be consistent with the applicable plans, then impacts associated with construction and operation would be less than significant for the second criterion related to GHG impacts.

P.2.4.1 Initial Scoping Plan

The action alternatives were compared to the Assembly Bill (AB) 32 Initial Scoping Plan (CARB 2008) for consistency. The initial scoping plan contains a variety of strategies that were designed to reduce the State's GHG emissions. Table P-1 summarizes the 18 strategies contained in the initial scoping plan and the alternatives were evaluated for consistency. As shown in the table, emission reduction measures would either not be applicable or the alternatives would be constructed in such a way that they would be compliant.

Table P-1. Initial Scoping Plan Measures Consistency Analysis

Emission Reduction Measure	Project Consistency
1. California Cap-and-Trade Program Linked to Western Climate Initiative Partner Jurisdictions. Implement a broad-based California cap-and-trade program to provide a firm limit on emissions. Link the California cap–and-trade program with other Western Climate Initiative Partner programs to create a regional market system to achieve greater environmental and economic benefits for California. Ensure California's program meets all applicable AB 32 requirements for market-based mechanisms.	**Not Applicable.** The project is a part of an industry that is required to comply with the cap-and-trade regulations.
2. California Light-Duty Vehicle GHG Standards. Implement adopted Pavley standards and planned second phase of the program. Align zero-emission vehicle, alternative and renewable fuel and vehicle technology programs with long-term climate change goals.	**Not Applicable.** This is a statewide measure that is not implemented by a project proponent.
3. Energy Efficiency. Maximize energy efficiency building and appliance standards, and pursue additional efficiency efforts including new technologies, and new policy and implementation mechanisms. Pursue comparable investment in energy efficiency from all retail providers of electricity in California (including both investor-owned and publicly-owned utilities).	**Consistent.** Any new buildings built as part of an action alternative (e.g., new pump station buildings) would be constructed in compliance with the State's energy efficiency regulations for buildings.
4. Renewables Portfolio Standard. Achieve 33 percent renewable energy mix statewide.	**Not Applicable.** This is a statewide measure that is not implemented by a project proponent.
5. Low Carbon Fuel Standard. Develop and adopt the Low Carbon Fuel Standard.	**Not Applicable.** This is a statewide measure that is not implemented by a project proponent.
6. Regional Transportation-Related GHG Targets. Develop regional GHG emissions reduction targets for passenger vehicles.	**Not Applicable.** The regional transportation plans developed for the Bay Area contain provisions required under Senate Bill 375 to reduce GHG emissions from vehicle miles traveled. The regional transportation plans do not have any requirements that apply to the action alternatives.
7. Vehicle Efficiency Measures. Implement light-duty vehicle efficiency measures.	**Not Applicable.** This is a statewide measure that is not implemented by a project proponent.
8. Goods Movement. Implement adopted regulations for the use of shore power for ships at berth. Improve efficiency in goods movement activities.	**Not Applicable.** The project does not propose any changes to goods movement from trucks, ports, and other related facilities.
9. Million Solar Roofs Program. Install 3,000 megawatts of solar-electric capacity under California's existing solar programs.	**Not Applicable.** The project does not impede the ability of the State to install additional solar roofs.
10. Medium/Heavy-Duty Vehicles. Adopt medium and heavy-duty vehicle efficiency measures.	**Not Applicable.** This is a statewide measure that is not implemented by a project proponent.
11. Industrial Emissions. Require assessment of large industrial sources to determine whether individual sources within a facility can cost-effectively reduce GHG emissions and provide other pollution reduction co-benefits. Reduce GHG emissions from fugitive emissions from oil and gas extraction and gas transmission. Adopt and implement regulations to control fugitive methane emissions and reduce flaring at refineries.	**Not Applicable.** This measure only applies to major industrial facilities emitting more than 500,000 $MTCO_2e$ per year.
12. High Speed Rail. Support implementation of a high-speed rail system.	**Not Applicable.** This is a statewide measure that is not implemented by a project proponent.
13. Green Building Strategy. Expand the use of green building practices to reduce the carbon footprint of California's new and existing inventory of buildings.	**Consistent.** Any new buildings built as part of an action alternative (e.g., new pump station buildings) would use green building strategies to the extent possible.

Emission Reduction Measure	Project Consistency
14. High Global Warming Potential Gases. Adopt measure to reduce high global warming potential gases.	**Not Applicable.** This project does not include air conditioning or refrigeration.
15. Recycling and Waste. Reduce methane emissions at landfills. Increase waste diversion, composting and other beneficial uses of organic materials, and mandate commercial recycling. Move toward zero-waste.	**Not Applicable.** Project operations would not result in the generation of waste.
16. Sustainable Forests. Preserve forest sequestration and encourage the use of forest biomass for sustainable energy generation.	**Not Applicable.** None of the alternatives under consideration would be in forested areas or areas zoned as forestland.
17. Water. Continue efficiency programs and use cleaner energy sources to move and treat water.	Consistent. Additional electricity use would be required to pump or treat water depending on the alternative. Increasing energy efficiency to move, treat, and use water is a would reduce GHG emissions.
18. Agriculture. In the near-term, encourage investment in manure digesters and at the five-year Scoping Plan update determine if the program should be made mandatory by 2020.	**Not Applicable.** The project site is not designated or in use for agricultural purposes.

Source: CARB 2008
Key:
AB = Assembly Bill; GHG = greenhouse gas; $MTCO_2e$ = metric tons carbon dioxide equivalent

P.2.4.2 2017 Climate Change Scoping Plan Update

California's 2017 Climate Change Scoping Plan (CARB 2017c) contains various emission reduction strategies to help the State to meet the goals of Executive Order B-30-15 and Senate Bill (SB) 32 to achieve a 2030 goal of reducing GHG emissions 40 percent below 2020 levels. The updated scoping plan contains various emission reduction measures that are specific to the water sector. Table P-2 summarizes the various measures and evaluates if the action alternatives would be consistent.

Table P-2. 2017 Updated Scoping Plan Measures Consistency Analysis

Emission Reduction Measure	Project Consistency
1. As directed by Governor Brown's Executive Order B-37-16, DWR and SWRCB will develop and implement new water use targets to generate more statewide water conservation than existing targets (the existing State law requires a 20 percent reduction in urban per capita water use by 2020 [SBx7-7, Steinberg, Chapter 4, Statutes of 2009]). The new water use targets will be based on strengthened standards for indoor use, outdoor irrigation, commercial, industrial, and institutional water use.	**Not Applicable.** The proposed project would not impede DWR's and SWRCB's ability to implement statewide water conservation targets.
2. SWRCB will develop long-term water conservation regulation, and permanently prohibit practices that waste potable water.	**Not Applicable.** The proposed project would not impede SWRCB's ability to implement its recommendations to use water more wisely.
3. DWR and SWRCB will develop and implement actions to minimize water system leaks, and to set performance standards for water loss, as required by SB 555 (Wolk, Chapter 679, Statutes of 2015).	**Not Applicable.** The measure is only applicable to urban retail water suppliers.
4. DWR and CDFA will update existing requirements for agricultural water management plans to increase water system efficiency.	**Not Applicable.** The project site is not designated or in use for agricultural purposes.

Emission Reduction Measure	Project Consistency
5. CEC will certify innovative technologies for water conservation and water loss detection and control.	**Not Applicable.** The measure is only applicable at utility, household, and appliance levels.
6. CEC will continue to update the State's Appliance Efficiency Regulations (California Code of Regulations, Title 20, Sections 1601–1608) for appliances offered for sale in California to establish standards that reduce energy consumption for devices that use electricity, gas, and/or water.	**Not Applicable.** The proposed project would not operation any appliances subject to the emission reduction measure.
7. CalEPA will oversee development of a voluntary registry for GHG emissions resulting from the water-energy nexus, as required by SB 1425 (Pavley, Chapter 596, Statutes of 2016).	**Not Applicable.** The proposed project would not impede the State's ability to develop a GHG emission registry.
8. The SWP has entered long-term contracts to procure renewable electricity from 140 MW solar installations in California.	**Not Applicable.** The proposed project would not interfere with the ability of the SWP to procure renewable electricity.
9. As described in its Climate Action Plan, DWR will continue to increase the use of renewable energy to operate the SWP.	**Not Applicable.** The proposed project would not interfere with the ability of DWR to increase its renewable energy use.

Source: CARB 2017c
Key:
CalEPA = California Environmental Protection Agency; CDFA = California Department of Food and Agriculture; CEC = California Energy Commission; DWR = Department of Water Resources; GHG = greenhouse gas; MW = megawatt; SB = Senate Bill; SWP = State Water Project; SWRCB = State Water Resources Control Board

P.2.4.3 BAAQMD 2017 Clean Air Plan

The 2017 Clean Air Plan, *Spare the Air, Cool the Climate*, contains various control measures to protect public health and to protect the climate. The 2017 Plan identifies methods to reduce Bay Area GHG emissions 40 percent below 1990 levels by 2030 and 80 percent below 1990 levels by 2050 (BAAQMD 2017b). The goals and objectives focus on the following economic sectors: stationary sources, transportation, energy, buildings, agriculture, natural and working lands, waste management, water, and super-GHG pollutants. Table P-3 summarizes the control measures designed to reduce GHG emissions from the water sector.

Table P-3. 2017 Clean Air Plan Consistency Analysis

Number	Name	Description	Consistency Evaluation
WR1	Limit GHGs from POTWs	Initiate a process to better understand and quantify GHG emissions at POTWs. Explore rulemaking to reduce GHGs emitted directly within POTWs. Promote the use of biogas recovery systems at POTWs.	**Not Applicable.** The proposed project would not interfere with the Bay Area's ability to reduce GHGs emitted within POTWs.
WR2	Support water conservation	Develop a list of best practices that reduce water consumption and increase on-site water recycling in new and existing buildings; incorporate into local planning guidance.	**Not Applicable.** No buildings would be built for the proposed project that would increase water usage.

Source: BAAQMD 2017b
Key:
GHG = greenhouse gas; POTWs = publicly owned treatment works

P.3 References

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Appendix P: Attachment A, Detailed Greenhouse Gas Emissions Calculations Tables

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Operation & Maintenance Emissions

Table A-1. Lower San Felipe Intake Alternative (Tunnel Option) - Annual Operational Emissions

Source	Annual Emissions (MTCO2e/year)			
	CO2	CH4	N2O	CO2e
Additional Pumping at Pacheco	229	1	1	231
Air Compressor Operation	48	0	0	48
LOX Delivery Trucks	7	0	0	7
Subtotal with Air Compressor Operation	277	1	1	279
Subtotal with LOX Delivery Trucks	236	1	1	238
Maximum Operational Emissions	**277**	**1**	**1**	**279**
Significance Threshold	n/a	n/a	n/a	10,000
Significant?	n/a	n/a	n/a	No

Table A-2. Lower San Felipe Intake Alternative (Pipeline Option) - Annual Operational Emissions

Source	Annual Emissions (MTCO2e/year)			
	CO2	CH4	N2O	CO2e
Additional Pumping at Pacheco	229	1	1	231
Air Compressor Operation	48	0	0	48
LOX Delivery Trucks	7	0	0	7
Subtotal with Air Compressor Operation	277	1	1	279
Subtotal with LOX Delivery Trucks	236	1	1	238
Maximum Operational Emissions	**277**	**1**	**1**	**279**
Significance Threshold	n/a	n/a	n/a	10,000
Significant?	n/a	n/a	n/a	No

Table A-3. Treatment Alternative - Annual Operational Emissions

Source	Annual Emissions (MTCO2e/year)			
	CO2	CH4	N2O	CO2e
Workers	2	0	0	2
Solid Waste Disposal	1	0	0	1
Total Operational Emissions	**3**	**0**	**0**	**3**
Significance Threshold	n/a	n/a	n/a	10,000
Significant?	n/a	n/a	n/a	No

Table A-4. Enlarged Reservoir and Treatment Retrofit Alternative - Annual Operational Emissions

Source	Annual Emissions (MTCO2e/year)			
	CO2	CH4	N2O	CO2e
Additional Pumping at Gianelli	5,715	16	23	5,754
Additional Pumping at Pacheco	754	2	3	759
Workers	2	0	0	2
Solid Waste Disposal	1	0	0	1
Total Operational Emissions	**6,471**	**18**	**26**	**6,516**
Significance Threshold	n/a	n/a	n/a	10,000
Significant?	n/a	n/a	n/a	No

Lower San Felipe Intake Alternative

Air Compressor Operation	92	days per year	(Assumes 200 HP operating 25% of year)
Air Flow Rate	1,200	scfm	(Mattei Air Compressor, Model MAXIMA 160 X, 200 hp)
	1,728,000	scf per day	
	158,976,000	scf per year	
Delivery Truck Capacity	20	tons per truck	http://www.uigi.com/delivery.html
	483,200	scf/truck	
Equivalent LOX Truck Trips	4	trucks per day	
	330	trucks per year	

Table A-5. LOX Delivery Truck Emissions

Source	CO2	CH4	N2O	Total
Emission Factor (g/mi)	1,589.77	0.01	0.005	n/a
Emissions (metric tons per year)	6.93	0.00002	0.00002	n/a
Emissions (MTCO2e/year)	6.93	0.001	0.01	6.93

Trip Length 6.6 miles

CAPCOA. 2017. CalEEMod User's Guide, Version 2016.3.2, Appendix D: Default Data Tables, Table 4.2, Merced County, Rural C-NW (Commercial-Nonwork)

CalEEMod User's Guide states that C-NW trips include trips made by delivery vehicles of goods associated with the land use.

Table A-6. Purchased Electricity Emissions

Source	Electricity (kWh/year)	Annual Emissions (MT/year)			Annual Emissions (MTCO2e/year)			
		CO2	CH4	N2O	CO2	CH4	N2O	CO2e
Emission Factors (lbs/MWh)	n/a	293.67	0.033	0.004	n/a	n/a	n/a	n/a
Aeration System (Air Compressor)	357,700	47.65	0.01	0.001	47.65	0.13	0.19	47.98
Additional Pumping at Pacheco	1,722,800	229.49	0.03	0.003	229.49	0.64	0.93	231.07

CO2 Emission Factor Source: The Climate Registry. 2018. Utility-Specific Emission Rates, 2016 Emission Rates, Pacific Gas & Electric. Available online at https://www.theclimateregistry.org/our-members/cris-public-reports/ [Accessed on October 23, 2018].

CH4 and N2O Emission Factor Source: The Climate Registry. 2018. 2018 Default Emission Factors, Table 14.1 U.S. Default Factors for Calculating Emissions from Grid Electricity by eGRID Subregion; CAMX. Available online at https://www.theclimateregistry.org/wp-content/uploads/2018/06/The-Climate-Registry-2018-Default-Emission-Factor-Document.pdf [Accesssed on October 23, 2018].

Conversions

60	minutes per hour	
24	hours per day	
24,160	scf per ton	(http://www.uigi.com/o2_conv.html)
1,000,000	grams per metric ton	
1,000	kW per MW	
453.6	grams per pound	

GWP

CO2	1
CH4	25
N2O	298

Source: The Climate Registery. 2018. Default Emission Factors. Table B.1, AR4.

Treatment Alternative

Table A-7. Worker Trips

Source	CO2	CH4	N2O	Total
Emission Factor (g/mi)	287.63	0.18	0.02	n/a
Emissions (metric tons per year)	2.27	0.001	0.0002	n/a
Emissions (MTCO2e/year)	2.27	0.04	0.05	2.35

Trip Length Sources:

CAPCOA. 2017. CalEEMod User's Guide, Version 2016.3.2, Appendix D: Default Data Tables, Table 4.2, Santa Clara County, Urban H-W (Home-Work)

Key: FTE = Full Time Equivalent Employees

Full Time Equivalent Employees	1
Trip Length (miles)	10.8

Maintenance Trips

Treatment

Solids Disposal	10%	increase in solids disposal
Santa Teresa	935	additional pounds per day
	171	additional tons per year

Truck Trips	9	trucks per year

Table A-8. Solid Waste Disposal Truck Trips

Source	CO2	CH4	N2O	Total
Emission Factor (g/mi)	4,060.91	0.0051	0.0048	n/a
Emissions (metric tons per year)	0.53	0.000001	0.000001	n/a
Emissions (MTCO2e/year)	0.53	0.00002	0.0002	0.53

Trip Length 7.3 miles

CAPCOA. 2017. CalEEMod User's Guide, Version 2016.3.2, Appendix D: Default Data Tables, Table 4.2, Santa Clara County, Urban C-NW (Commercial-Nonwork).

CalEEMod User's Guide states that C-NW trips include trips made by delivery vehicles of goods associated with the land use.

Conversions

20	tons per truck (CalEEMod User's Guide, Version 2016.3.2
365	days per year
453.6	grams per pound
1,000,000	grams per metric ton
2,000	pounds per ton

GWP

CO2	1
CH4	25
N2O	298

Source: The Climate Registery. 2018. Default Emission Factors. Table B.1, AR4.

Enlarged Reservoir Alternative

Table A-9. Purchased Electricity Emissions

Source	Electricity (kWh/year)	Annual Emissions (MT/year)			Annual Emissions (MTCO2e/year)			
		CO2	CH4	N2O	CO2	CH4	N2O	CO2e
Emission Factors (lbs/MWh)	n/a	293.67	0.033	0.004	n/a	n/a	n/a	n/a
Additional Pumping at Gianelli	42,899,932	5,714.64	0.64	0.078	5,714.64	16.05	23.20	5,753.89
Additional Pumping at Pacheco	5,657,134	753.58	0.08	0.010	753.58	2.12	3.06	758.76

CO2 Emission Factor Source: The Climate Registry. 2018. Utility-Specific Emission Rates, 2016 Emission Rates, Pacific Gas & Electric. Available online at https://www.theclimateregistry.org/our-members/cris-public-reports/ [Accessed on October 23, 2018].

CH4 and N2O Emission Factor Source: The Climate Registry. 2018. 2018 Default Emission Factors, Table 14.1 U.S. Default Factors for Calculating Emissions from Grid Electricity by eGRID Subregion; CAMX. Available online at https://www.theclimateregistry.org/wp-content/uploads/2018/06/The-Climate-Registry-2018-Default-Emission-Factor-Document.pdf [Accesssed on October 23, 2018].

Conversions

60	minutes per hour	
24	hours per day	
24,160	scf per ton	(http://www.uigi.com/o2_conv.html)
1,000,000	grams per metric ton	
1,000	kW per MW	
453.6	grams per pound	

GWP

CO2	1
CH4	25
N2O	298

Source: The Climate Registery. 2018. Default Emission Factors. Table B.1, AR4.

Gianelli

13	months of additional pumping over 82 year model record
0.16	annual average months per year
114	hours per year

Gianelli Pumping Plant Capacity

Number of Pumps	8	
Rating per Pump	63,000	hp
Total Power Rating	504,000	hp
	375,833	kW

Pacheco

36	months of additional pumping over 82 year model record
0.44	annual average months per year
316	hours per year

Pacheco Pumping Plant Capacity

Number of Pumps	12	
Rating per Pump	2,000	hp
Total Power Rating	24,000	hp
	17,897	kW

Pacheco Reservoir Expansion Alternative

Table A-10. Purchased Electricity Emissions

Source	Electricity (kWh/year)	Annual Emissions (MT/year)			Annual Emissions (MTCO2e/year)			
		CO2	CH4	N2O	CO2	CH4	N2O	CO2e
Emission Factors (lbs/MWh)	n/a	293.67	0.033	0.004	n/a	n/a	n/a	n/a
Additional Pumping at Pacheco	1,960,404	261.14	0.03	0.004	261.14	0.73	1.06	262.94

CO2 Emission Factor Source: The Climate Registry. 2018. Utility-Specific Emission Rates, 2016 Emission Rates, Pacific Gas & Electric. Available online at https://www.theclimateregistry.org/our-members/cris-public-reports/ [Accessed on October 23, 2018].

CH4 and N2O Emission Factor Source: The Climate Registry. 2018. 2018 Default Emission Factors, Table 14.1 U.S. Default Factors for Calculating Emissions from Grid Electricity by eGRID Subregion; CAMX. Available online at https://www.theclimateregistry.org/wp-content/uploads/2018/06/The-Climate-Registry-2018-Default-Emission-Factor-Document.pdf [Accesssed on October 23, 2018].

Conversions

60	minutes per hour	
24	hours per day	
24,160	scf per ton	(http://www.uigi.com/o2_conv.html)
1,000,000	grams per metric ton	
1,000	kW per MW	
453.6	grams per pound	
325,851	gallons per acre-foot	
7.48	gallons per cubic foot	

GWP

CO2	1
CH4	25
N2O	298

Source: The Climate Registery. 2018. Default Emission Factors. Table B.1, AR4.

Pacheco Pumping Plant Capacity

Number of Pumps	11	
Rating per Pump	1,250	hp
Total Power Rating	13,750	hp
	10,253	kW

Pump Station Capacity

490	cfs	*(SCVWD Initial Study and Notice of Preparation)*
219,912	gpm	

Average Annual Pump Rate

7,742	acre-feet	(based on 82-year model record)
191	hours per year	

Onroad Motor Vehicle Emission Factors
EMFAC2014

Table A-10. Running Emission Factors (San Francisco Bay Area)

Year	Vehicle Type	(grams per mile)		
		CO2	CH4	N2O
2021	Workers	287.6285	0.1789	0.0197
	Solid Waste Collection Truck	4060.9074	0.0051	0.0048
	Haul Truck	1598.9822	0.0051	0.0048
2022	Workers	276.5057	0.1775	0.0195
	Solid Waste Collection Truck	3998.4441	0.0051	0.0048
	Haul Truck	1577.9571	0.0051	0.0048

Onroad Motor Vehicle Emission Factors
EMFAC2014

Table A-11. Running Emission Factors (San Joaquin Valley)

Year	Vehicle Type	(grams per mile)		
		CO2	CH4	N2O
2021	Workers	297.3278	0.1790	0.0197
	Solid Waste Collection Truck	4319.5118	0.0051	0.0048
	Haul Truck	1589.7741	0.0051	0.0048
2022	Workers	285.9653	0.1776	0.0196
	Solid Waste Collection Truck	4279.4235	0.0051	0.0048
	Haul Truck	1568.9545	0.0051	0.0048

Greenhouse Gas Construction Emissions Summary

Table A-12. Lower San Felipe Intake Alternative (Tunnel Option) - Annual Emissions

Source	Annual Emissions (tons per year)			
	CO2	CH4	N2O	CO2e
	2020			
Off-Road Construction Equipment	8,593	1	0	8,613
On-Road Haul Trucks and Delivery Vehicles	385	0	0	385
Construction Worker Commuting	276	0	0	301
Marine Emissions (Tugboats and Crew/Supply Vessels)	-	-	-	-
Dredge (Auxiliary Engines)	-	-	-	-
2020 Total Emissions	**9,254**	**1**	**0**	**9,299**
	2021			
Off-Road Construction Equipment	12,135	1	0	12,161
On-Road Haul Trucks and Delivery Vehicles	381	0	0	381
Construction Worker Commuting	266	0	0	290
Marine Emissions (Tugboats and Crew/Supply Vessels)	909	0	0	921
Dredge (Auxiliary Engines)	-	-	-	-
2021 Total Emissions	**13,690**	**1**	**0**	**13,753**
	2022			
Off-Road Construction Equipment	9,487	1	0	9,506
On-Road Haul Trucks and Delivery Vehicles	377	0	0	377
Construction Worker Commuting	256	0	0	280
Marine Emissions (Tugboats and Crew/Supply Vessels)	1,558	0	0	1,579
Dredge (Auxiliary Engines)	-	-	-	-
2022 Total Emissions	**11,677**	**1**	**0**	**11,742**
	2023			
Off-Road Construction Equipment	7,719	1	0	7,734
On-Road Haul Trucks and Delivery Vehicles	334	0	0	334
Construction Worker Commuting	246	0	0	270
Marine Emissions (Tugboats and Crew/Supply Vessels)	130	0	0	132
Dredge (Auxiliary Engines)	-	-	-	-
2023 Total Emissions	**8,429**	**1**	**0**	**8,470**
Maximum Annual Emissions	**13,690**	**1**	**0**	**13,753**
Annual Significance Threshold	n/a	n/a	n/a	12,500
Significant?	n/a	n/a	n/a	Yes
Grand Total Emissions	**43,051**	**3**	**0**	**43,265**
Project Significance Threshold	n/a	n/a	n/a	25,000
Significant?	n/a	n/a	n/a	Yes

Table A-13. Lower San Felipe Intake Alternative (Pipeline Option) - Annual Emissions

Source	Annual Emissions (tons per year)			
	CO2	CH4	N2O	CO2e
	2020			
Off-Road Construction Equipment	7,225	1	0	7,243
On-Road Haul Trucks and Delivery Vehicles	133	0	0	134
Construction Worker Commuting	135	0	0	147
Marine Emissions (Tugboats and Crew/Supply Vessels)	-	-	-	-
Dredge (Auxiliary Engines)	-	-	-	-
2020 Total Emissions	**7,493**	**1**	**0**	**7,523**

Source	Annual Emissions (tons per year)			
	CO2	CH4	N2O	CO2e
	2021			
Off-Road Construction Equipment	9,909	1	0	9,932
On-Road Haul Trucks and Delivery Vehicles	132	0	0	132
Construction Worker Commuting	130	0	0	142
Marine Emissions (Tugboats and Crew/Supply Vessels)	13,030	0	1	13,203
Dredge (Auxiliary Engines)	130	0	0	132
2021 Total Emissions	**23,331**	**1**	**1**	**23,541**
	2022			
Off-Road Construction Equipment	2,433	0	0	2,439
On-Road Haul Trucks and Delivery Vehicles	98	0	0	98
Construction Worker Commuting	94	0	0	103
Marine Emissions (Tugboats and Crew/Supply Vessels)	1,185	0	0	1,200
Dredge (Auxiliary Engines)	12	0	0	12
2022 Total Emissions	**3,821**	**0**	**0**	**3,852**
Maximum Annual Emissions	**23,331**	**1**	**1**	**23,541**
Annual Significance Threshold	n/a	n/a	n/a	12,500
Significant?	n/a	n/a	n/a	Yes
Grand Total Emissions	**34,645**	**2**	**1**	**34,916**
Project Significance Threshold	n/a	n/a	n/a	25,000
Significant?	n/a	n/a	n/a	Yes

Table A-14. Treatment Alternative - Annual Emissions

Source	Annual Emissions (tons per year)			
	CO2	CH4	N2O	CO2e
	2020			
Off-Road Construction Equipment	715	0	0	717
On-Road Haul Trucks and Delivery Vehicles	26	0	0	26
Construction Worker Commuting	99	0	0	108
2020 Total Emissions	**840**	**0**	**0**	**851**
	2021			
Off-Road Construction Equipment	640	0	0	642
On-Road Haul Trucks and Delivery Vehicles	26	0	0	26
Construction Worker Commuting	95	0	0	104
2021 Total Emissions	**762**	**0**	**0**	**772**
	2022			
Off-Road Construction Equipment	528	0	0	529
On-Road Haul Trucks and Delivery Vehicles	26	0	0	26
Construction Worker Commuting	91	0	0	100
2022 Total Emissions	**645**	**0**	**0**	**656**
Maximum Annual Emissions	**840**	**0**	**0**	**851**
Annual Significance Threshold	n/a	n/a	n/a	12,500
Significant?	n/a	n/a	n/a	No
Grand Total Emissions	**2,247**	**0**	**0**	**2,279**
Project Significance Threshold	n/a	n/a	n/a	25,000
Significant?	n/a	n/a	n/a	No

Source	Annual Emissions (tons per year)			
	CO2	CH4	N2O	CO2e

Table A-15. CVP Resevoir Expansion Alternative - Annual Emissions

Source	Annual Emissions (tons per year)			
	CO2	CH4	N2O	CO2e
	2020			
Off-Road Construction Equipment	16,972	1	0	17,135
On-Road Haul Trucks and Delivery Vehicles	11,411	0	0	11,422
Construction Worker Commuting	1,958	1	0	2,131
2020 Total Emissions	**30,341**	**3**	**1**	**30,688**
	2021			
Off-Road Construction Equipment	16,973	1	0	17,135
On-Road Haul Trucks and Delivery Vehicles	11,291	0	0	11,302
Construction Worker Commuting	1,884	1	0	2,057
2021 Total Emissions	**30,148**	**3**	**1**	**30,494**
	2022			
Off-Road Construction Equipment	16,968	1	0	17,127
On-Road Haul Trucks and Delivery Vehicles	11,166	0	0	11,177
Construction Worker Commuting	1,812	1	0	1,985
2022 Total Emissions	**29,946**	**3**	**1**	**30,289**
	2023			
Off-Road Construction Equipment	16,961	1	0	17,119
On-Road Haul Trucks and Delivery Vehicles	10,785	0	0	10,796
Construction Worker Commuting	1,741	1	0	1,914
2023 Total Emissions	**29,486**	**2**	**1**	**29,828**
	2024			
Off-Road Construction Equipment	16,928	1	0	17,085
On-Road Haul Trucks and Delivery Vehicles	10,737	0	0	10,748
Construction Worker Commuting	1,671	1	0	1,844
2024 Total Emissions	**29,337**	**2**	**1**	**29,677**
	2025			
Off-Road Construction Equipment	16,931	1	0	17,087
On-Road Haul Trucks and Delivery Vehicles	10,698	0	0	10,709
Construction Worker Commuting	1,603	1	0	1,776
2025 Total Emissions	**29,232**	**2**	**1**	**29,571**
	2026			
Off-Road Construction Equipment	16,925	1	0	17,079
On-Road Haul Trucks and Delivery Vehicles	10,662	0	0	10,673
Construction Worker Commuting	1,545	1	0	1,718
2026 Total Emissions	**29,131**	**2**	**1**	**29,470**
	2027			
Off-Road Construction Equipment	16,911	1	0	17,064
On-Road Haul Trucks and Delivery Vehicles	10,625	0	0	10,636
Construction Worker Commuting	1,491	1	0	1,664
2027 Total Emissions	**29,027**	**2**	**1**	**29,365**
	2028			
Off-Road Construction Equipment	16,901	1	0	17,054
On-Road Haul Trucks and Delivery Vehicles	10,594	0	0	10,605
Construction Worker Commuting	1,444	1	0	1,617
2028 Total Emissions	**28,939**	**2**	**1**	**29,275**
	2029			
Off-Road Construction Equipment	16,890	1	0	17,042
On-Road Haul Trucks and Delivery Vehicles	10,564	0	0	10,575
Construction Worker Commuting	1,402	1	0	1,576
2029 Total Emissions	**28,856**	**2**	**1**	**29,192**

Source	Annual Emissions (tons per year) CO2	CH4	N2O	CO2e
No Shear Key Option				
Maximum Annual Emissions	**30,341**	**3**	**1**	**30,688**
Annual Significance Threshold	n/a	n/a	n/a	12,500
Significant?	n/a	n/a	n/a	Yes
Grand Total Emissions	**236,648**	**20**	**8**	**239,382**
Project Significance Threshold	n/a	n/a	n/a	25,000
Significant?	n/a	n/a	n/a	Yes
Shear Key Option				
Maximum Annual Emissions	**30,341**	**3**	**1**	**30,688**
Annual Significance Threshold	n/a	n/a	n/a	12,500
Significant?	n/a	n/a	n/a	Yes
Grand Total Emissions	**294,443**	**24**	**9**	**297,850**
Project Significance Threshold	n/a	n/a	n/a	25,000
Significant?	n/a	n/a	n/a	Yes

Table A-16. New Pacheco Alternative - Annual Unmitigated Emissions

	6	7	8	9
Source	**Annual Emissions (metric tons per year) CO2**	**CH4**	**N2O**	**CO2e**
	2024			
Off-Road Construction Equipment	21,057	1	0	21,104
On-Road Haul Trucks and Delivery Vehicles	1,621	1	0	1,796
Construction Worker Commuting	2,970	0	0	2,973
Total	**25,648**	**3**	**1**	**25,872**
	2025			
Off-Road Construction Equipment	16,871	1	0	16,910
On-Road Haul Trucks and Delivery Vehicles	1,871	1	1	2,081
Construction Worker Commuting	8,115	0	0	8,123
Total	**26,857**	**3**	**1**	**27,114**
	2026			
Off-Road Construction Equipment	14,624	1	0	14,658
On-Road Haul Trucks and Delivery Vehicles	2,732	2	1	3,051
Construction Worker Commuting	9,571	0	0	9,581
Total	**26,927**	**3**	**1**	**27,290**
	2027			
Off-Road Construction Equipment	11,414	1	0	11,443
On-Road Haul Trucks and Delivery Vehicles	2,801	2	1	3,140
Construction Worker Commuting	8,799	0	0	8,808
Total	**23,014**	**3**	**1**	**23,391**
	2028			
Off-Road Construction Equipment	9,035	1	0	9,057
On-Road Haul Trucks and Delivery Vehicles	2,712	2	1	3,052
Construction Worker Commuting	663	0	0	664
Total	**12,411**	**3**	**1**	**12,773**
	2029			
Off-Road Construction Equipment	3,649	0	0	3,655
On-Road Haul Trucks and Delivery Vehicles	1,214	1	0	1,371
Construction Worker Commuting	276	0	0	276
Total	**5,139**	**1**	**0**	**5,302**
Maximum Annual Emissions	**26,927**	**3**	**1**	**27,290**
Annual Significance Threshold	n/a	n/a	n/a	12,500
Significant?	n/a	n/a	n/a	Yes
Grand Total Emissions	**119,995**	**16**	**5**	**121,742**
Project Significance Threshold	n/a	n/a	n/a	25,000
Significant?	n/a	n/a	n/a	Yes

GHG Emissions Summary
Off-Road Construction Equipment

Table A-17. Summary of Annual Emissions by Alternative

Alternative	Annual Emissions (metric tons per year)			
	CO2	CH4	N2O	CO2e
	2020			
Lower San Felipe Intake Alternative				
Tunnel Option	8,593	0.72	0.01	8,613
Pipeline Option	7,225	0.60	0.01	7,243
Treatment Alternative	715	0.06	0.00	717
	2021			
Lower San Felipe Intake Alternative				
Tunnel Option	12,135	0.91	0.01	12,161
Pipeline Option	9,909	0.79	0.01	9,932
Treatment Alternative	640	0.05	0.00	642
	2022			
Lower San Felipe Intake Alternative				
Tunnel Option	9,487	0.67	0.01	9,506
Pipeline Option	2,433	0.19	0.00	2,439
Treatment Alternative	528	0.04	0.00	529
	2023			
Lower San Felipe Intake Alternative				
Tunnel Option	7,719	0.51	0.01	7,734
Pipeline Option	-	-	-	-
Treatment Alternative	-	-	-	-
	Annual Maximum (metric tons per year)			
Lower San Felipe Intake Alternative				
Tunnel Option	12,135	0.91	0.01	12,161
Pipeline Option	9,909	0.79	0.01	9,932
Treatment Alternative	715	0.06	0.00	717
	Grand Total (metric tons per project)			
Lower San Felipe Intake Alternative				
Tunnel Option	37,934	2.81	0.04	38,014
Pipeline Option	19,567	1.58	0.02	19,614
Treatment Alternative	1,883	0.16	0.00	1,888

Lower San Felipe Intake Alternative - Tunnel Option

Table A-18. Equipment List

Equipment	Quantity	Mobilization	Site Improvements	Construct Vertical Shaft	Set up TBM	Tunneling and Spreading of Soils	Cofferdam and TBM Out	Connect to Existing Intake	Fabricate Inlet	Set Inlet and Flood Tunnel	Construct Aeration Facility	Fab and Set Air Tubing	Final Work and Testing	Demobilization
Bulldozer	2	X	X											
Concrete Pumpers	2			X				X	X		X			
Cranes	4			X	X		X		X	X	X			
Drill Rig	1			X										
Excavator	1		X	X							X			
Flatbed Trucks (on site)	3	X	X	X	X	X	X	X	X	X	X	X	X	X
Grader	2		X			X					X			X
Loaders	2	X	X								X			
Portable Diesel Generators	7	X	X	X	X	X	X	X	X	X	X	X	X	X
Scraper	1		X			X					X			
Water Truck	2	X	X			X					X			X

Source: Equipment Tables_08012012.docx; EngineeringDataNeeds_July30_2012.xlsx

Table A-19. Annual Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Months	Annual Emissions - 2020 (MT/year)				Annual Emissions - 2021 (MT/year)			
								CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e
Mobilization	Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	2020	6	376.23	0.05	-	377.49	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231			-	-	-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221			-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			171.12	0.00	0.00	171.79	-	-	-	-
	Grader	ConstMin - Graders	-	20	188			-	-	-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202			276.21	0.02	-	276.78	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559			2,177.64	0.18	-	2,182.26	-	-	-	-
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	2	20	n/a			114.08	0.00	0.00	114.53	-	-	-	-
Mobilization Subtotal								**3,115.28**	**0.26**	**0.00**	**3,122.85**	**-**	**-**	**-**	**-**
Site Improvements	Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	2020	6	376.23	0.05	-	377.49	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231			-	-	-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221			-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	1	20	158			114.74	0.01	-	115.01	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			171.12	0.00	0.00	171.79	-	-	-	-
	Grader	ConstMin - Graders	2	20	188			293.50	0.02	-	294.12	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202			276.21	0.02	-	276.78	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559			2,177.64	0.18	-	2,182.26	-	-	-	-
	Scraper	ConstMin - Scrapers	1	20	367			338.02	0.03	-	338.86	-	-	-	-
	Water Truck	N/A - Onroad engine	2	20	n/a			114.08	0.00	0.00	114.53	-	-	-	-
Site Improvements Subtotal								**3,861.54**	**0.33**	**0.00**	**3,870.83**	**-**	**-**	**-**	**-**
Construct Vertical Shaft	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2020	6	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	20	18			27.25	0.00	-	27.33	27.26	0.00	-	27.34
	Cranes	ConstMin - Cranes	4	20	231			252.41	0.02	-	252.99	252.51	0.02	-	253.05
	Drill Rig	ConstMin - Bore/Drill Rigs	1	20	221			104.48	0.00	-	104.58	104.34	0.00	-	104.43
	Excavator	ConstMin - Excavators	1	20	158			57.37	0.01	-	57.50	57.37	0.00	-	57.50
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			85.56	0.00	0.00	85.90	83.40	0.00	0.00	83.74
	Grader	ConstMin - Graders	-	20	188			-	-	-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559			1,088.82	0.09	-	1,091.13	1,100.69	0.09	-	1,102.83
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a			-	-	-	-	-	-	-	-
Construct Vertical Shaft Subtotal								**1,615.89**	**0.13**	**0.00**	**1,619.43**	**1,625.57**	**0.12**	**0.00**	**1,628.89**
Set Up TBM	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	2	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-	-	-	-	-
	Cranes	ConstMin - Cranes	4	20	231			-	-	-	-	168.34	0.01	-	168.70
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221			-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-	55.60	0.00	0.00	55.83
	Grader	ConstMin - Graders	-	20	188			-	-	-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559			-	-	-	-	733.79	0.06	-	735.22
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a			-	-	-	-	-	-	-	-
Set Up TBM Subtotal								**-**	**-**	**-**	**-**	**957.73**	**0.07**	**0.00**	**959.75**

Lower San Felipe Intake Alternative - Tunnel Option

Table A-18. Equipment List

Equipment	Quantity
Bulldozer	2
Concrete Pumpers	2
Cranes	4
Drill Rig	1
Excavator	1
Flatbed Trucks (on site)	3
Grader	2
Loaders	2
Portable Diesel Generators	7
Scraper	1
Water Truck	2

Source: Equipment Tables_08012012.docx; EngineeringDataNeeds_July30_2012.

Table A-19. Annual Emissions from Construction Equipment

Phase	Equipment	Annual Emissions - 2022 (MT/year)				Annual Emissions - 2023 (MT/year)				Grand Total
		CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e	(MTCO2e/project)
Mobilization	Bulldozer	-	-	-	-	-	-	-	-	377.49
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	-	-	-	-	-	-	-	-	-
	Drill Rig	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	-	-	-	-	-	-	-	-	171.79
	Grader	-	-	-	-	-	-	-	-	-
	Loaders	-	-	-	-	-	-	-	-	276.78
	Portable Diesel Generators	-	-	-	-	-	-	-	-	2,182.26
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	114.53
		-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3,122.85**
Site Improvements	Bulldozer	-	-	-	-	-	-	-	-	377.49
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	-	-	-	-	-	-	-	-	-
	Drill Rig	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	115.01
	Flatbed Trucks (on site)	-	-	-	-	-	-	-	-	171.79
	Grader	-	-	-	-	-	-	-	-	294.12
	Loaders	-	-	-	-	-	-	-	-	276.78
	Portable Diesel Generators	-	-	-	-	-	-	-	-	2,182.26
	Scraper	-	-	-	-	-	-	-	-	338.86
	Water Truck	-	-	-	-	-	-	-	-	114.53
		-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3,870.83**
Construct Vertical Shaft	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	-	-	-	-	54.67
	Cranes	-	-	-	-	-	-	-	-	506.04
	Drill Rig	-	-	-	-	-	-	-	-	209.01
	Excavator	-	-	-	-	-	-	-	-	115.00
	Flatbed Trucks (on site)	-	-	-	-	-	-	-	-	169.64
	Grader	-	-	-	-	-	-	-	-	-
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	-	-	-	-	-	-	-	-	2,193.95
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	-
		-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3,248.31**
Set Up TBM	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	-	-	-	-	-	-	-	-	168.70
	Drill Rig	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	-	-	-	-	-	-	-	-	55.83
	Grader	-	-	-	-	-	-	-	-	-
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	-	-	-	-	-	-	-	-	735.22
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	-
		-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**959.75**

Table A-19. Annual Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Months	Annual Emissions - 2020 (MT/year)				Annual Emissions - 2021 (MT/year)			
								CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e
Tunneling and Spreading of Soils	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	20	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231			-	-	-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221			-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-	194.60	0.00	0.00	195.39
	Grader	ConstMin - Graders	2	20	188			-	-	-	-	342.01	0.03	-	342.69
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559			-	-	-	-	2,568.28	0.20	-	2,573.26
	Scraper	ConstMin - Scrapers	1	20	367			-	-	-	-	394.47	0.04	-	395.40
	Water Truck	N/A - Onroad engine	2	20	n/a			-	-	-	-	129.74	0.00	0.00	130.26
Tunneling and Spreading of Soils Subtotal								**-**	**-**	**-**	**-**	**3,629.10**	**0.27**	**0.00**	**3,637.01**
Cofferdam and TBM Out	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	3	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-	-	-	-	-
	Cranes	ConstMin - Cranes	4	20	231			-	-	-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221			-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-	-	-	-	-
	Grader	ConstMin - Graders	-	20	188			-	-	-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559			-	-	-	-	-	-	-	-
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a			-	-	-	-	-	-	-	-
Cofferdam and TBM Out Subtotal								**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Connect to Existing Intake	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	3	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	20	18			-	-	-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231			-	-	-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221			-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-	-	-	-	-
	Grader	ConstMin - Graders	-	20	188			-	-	-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559			-	-	-	-	-	-	-	-
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a			-	-	-	-	-	-	-	-
Connect to Existing Intake Subtotal								**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Fabricate Inlet	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	3	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	20	18			-	-	-	-	-	-	-	-
	Cranes	ConstMin - Cranes	4	20	231			-	-	-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221			-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-	-	-	-	-
	Grader	ConstMin - Graders	-	20	188			-	-	-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559			-	-	-	-	-	-	-	-
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a			-	-	-	-	-	-	-	-
Fabricate Inlet Subtotal								**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Table A-19. Annual Emissions from Construction Equipment

Phase	Equipment	Annual Emissions - 2022 (MT/year)				Annual Emissions - 2023 (MT/year)				Grand Total
		CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e	(MTCO2e/project)
Tunneling and Spreading of Soils	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	-	-	-	-	-	-	-	-	-
	Drill Rig	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	324.63	0.00	0.00	325.97	26.28	0.00	0.00	26.39	547.75
	Grader	586.24	0.04	-	587.35	48.54	0.00	-	48.62	978.66
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	4,450.76	0.32	-	4,458.86	374.94	0.03	-	375.58	7,407.70
	Scraper	675.87	0.06	-	677.39	56.32	0.00	-	56.44	1,129.23
	Water Truck	216.42	0.00	0.00	217.32	17.52	0.00	0.00	17.59	365.17
		6,253.92	**0.44**	**0.01**	**6,266.88**	**523.59**	**0.03**	**0.00**	**524.63**	**10,428.52**
Cofferdam and TBM Out	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	-	-	-	-	252.77	0.02	-	253.26	253.26
	Drill Rig	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	-	-	-	-	78.83	0.00	0.00	79.17	79.17
	Grader	-	-	-	-	-	-	-	-	-
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	-	-	-	-	1,124.82	0.08	-	1,126.75	1,126.75
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	-
		-	**-**	**-**	**-**	**1,456.42**	**0.10**	**0.00**	**1,459.17**	**1,459.17**
Connect to Existing Intake	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	27.25	0.00	-	27.33	27.33
	Cranes	-	-	-	-	-	-	-	-	-
	Drill Rig	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	-	-	-	-	78.83	0.00	0.00	79.17	79.17
	Grader	-	-	-	-	-	-	-	-	-
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	-	-	-	-	1,124.82	0.08	-	1,126.75	1,126.75
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	-
		-	**-**	**-**	**-**	**1,230.90**	**0.08**	**0.00**	**1,233.24**	**1,233.24**
Fabricate Inlet	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	27.25	0.00	-	27.33	27.33
	Cranes	-	-	-	-	252.77	0.02	-	253.26	253.26
	Drill Rig	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	-	-	-	-	78.83	0.00	0.00	79.17	79.17
	Grader	-	-	-	-	-	-	-	-	-
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	-	-	-	-	1,124.82	0.08	-	1,126.75	1,126.75
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	-
		-	**-**	**-**	**-**	**1,483.68**	**0.10**	**0.00**	**1,486.51**	**1,486.51**

Table A-19. Annual Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Months	Annual Emissions - 2020 (MT/year)				Annual Emissions - 2021 (MT/year)			
								CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e
Set Inlet and Flood Tunnel	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	1	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-	-	-	-	-
	Cranes	ConstMin - Cranes	4	20	231			-	-	-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221			-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-	-	-	-	-
	Grader	ConstMin - Graders	-	20	188			-	-	-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559			-	-	-	-	-	-	-	-
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a			-	-	-	-	-	-	-	-
Set Inlet and Flood Tunnel Subtotal								**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Construct Aeration Facility	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	10	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	20	18			-	-	-	-	63.60	0.01	-	63.80
	Cranes	ConstMin - Cranes	4	20	231			-	-	-	-	589.19	0.05	-	590.46
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221			-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	1	20	158			-	-	-	-	133.87	0.01	-	134.16
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-	194.60	0.00	0.00	195.39
	Grader	ConstMin - Graders	2	20	188			-	-	-	-	342.01	0.03	-	342.69
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202			-	-	-	-	322.31	0.03	-	322.94
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559			-	-	-	-	2,568.28	0.20	-	2,573.26
	Scraper	ConstMin - Scrapers	1	20	367			-	-	-	-	394.47	0.04	-	395.40
	Water Truck	N/A - Onroad engine	2	20	n/a			-	-	-	-	129.74	0.00	0.00	130.26
Construct Aeration Facility Subtotal								**-**	**-**	**-**	**-**	**4,738.07**	**0.36**	**0.00**	**4,748.36**
Fab and Set Air Tubing	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	6	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231			-	-	-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221			-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-	83.40	0.00	0.00	83.74
	Grader	ConstMin - Graders	-	20	188			-	-	-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559			-	-	-	-	1,100.69	0.09	-	1,102.83
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a			-	-	-	-	-	-	-	-
Fab and Set Air Tubing Subtotal								**-**	**-**	**-**	**-**	**1,184.09**	**0.09**	**0.00**	**1,186.57**
Final Work and Testing	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	4	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231			-	-	-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221			-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-	-	-	-	-
	Grader	ConstMin - Graders	-	20	188			-	-	-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559			-	-	-	-	-	-	-	-
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a			-	-	-	-	-	-	-	-
Final Work and Testing Subtotal								**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Table A-19. Annual Emissions from Construction Equipment

Phase	Equipment	Annual Emissions - 2022 (MT/year)				Annual Emissions - 2023 (MT/year)				Grand Total
		CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e	(MTCO2e/project)
Set Inlet and Flood Tunnel	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	-	-	-	-	84.26	0.01	-	84.42	84.42
	Drill Rig	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	-	-	-	-	26.28	0.00	0.00	26.39	26.39
	Grader	-	-	-	-	-	-	-	-	-
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	-	-	-	-	374.94	0.03	-	375.58	375.58
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	-
		-	**-**	**-**	**-**	**485.47**	**0.03**	**0.00**	**486.39**	**486.39**
Construct Aeration Facility	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	27.25	0.00	-	27.33	-	-	-	-	91.13
	Cranes	252.76	0.02	-	253.28	-	-	-	-	843.74
	Drill Rig	-	-	-	-	-	-	-	-	-
	Excavator	57.39	0.00	-	57.50	-	-	-	-	191.66
	Flatbed Trucks (on site)	81.16	0.00	0.00	81.49	-	-	-	-	276.88
	Grader	146.56	0.01	-	146.84	-	-	-	-	489.53
	Loaders	138.20	0.01	-	138.45	-	-	-	-	461.39
	Portable Diesel Generators	1,112.69	0.08	-	1,114.71	-	-	-	-	3,687.98
	Scraper	168.97	0.02	-	169.35	-	-	-	-	564.75
	Water Truck	54.10	0.00	0.00	54.33	-	-	-	-	184.59
		2,039.08	**0.15**	**0.00**	**2,043.29**	**-**	**-**	**-**	**-**	**6,791.65**
Fab and Set Air Tubing	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	-	-	-	-	-	-	-	-	-
	Drill Rig	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	81.16	0.00	0.00	81.49	-	-	-	-	165.23
	Grader	-	-	-	-	-	-	-	-	-
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	1,112.69	0.08	-	1,114.71	-	-	-	-	2,217.54
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	-
		1,193.85	**0.08**	**0.00**	**1,196.21**	**-**	**-**	**-**	**-**	**2,382.77**
Final Work and Testing	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	-	-	-	-	-	-	-	-	-
	Drill Rig	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	-	-	-	-	105.11	0.00	0.00	105.55	105.55
	Grader	-	-	-	-	-	-	-	-	-
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	-	-	-	-	1,499.76	0.10	-	1,502.33	1,502.33
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	-
		-	**-**	**-**	**-**	**1,604.86**	**0.10**	**0.00**	**1,607.88**	**1,607.88**

Table A-19. Annual Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Months	Annual Emissions - 2020 (MT/year)				Annual Emissions - 2021 (MT/year)			
								CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e
Demobilization	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2023	2	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231			-	-	-	-	-	-	-	-
	Drill Rig	ConstMin - Bore/Drill Rigs	-	20	221			-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-	-	-	-	-
	Grader	ConstMin - Graders	2	20	188			-	-	-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-	-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	7	20	559			-	-	-	-	-	-	-	-
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	2	20	n/a			-	-	-	-	-	-	-	-
Demobilization Subtotal								**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Grand Total (metric tons per year)								**8,592.72**	**0.72**	**0.01**	**8,613.10**	**12,134.57**	**0.91**	**0.01**	**12,160.56**
							Global Warming Potential	1	25	298					

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of grams per hour (g/hr). CO2 emission factors from EMFAC2014 for diesel-fueled medium-duty vehicles in San Joaquin Valley Air Basin.
CH4 and N2O emission factors from "2018 Climate Registry Default Emission Factors" for diesel medium and heavy-duty vehicles.

Onroad Vehicle Speed
40 mph

Air Basin
San Joaquin Valley

Conversions
1,000,000 grams per metric ton
7 days per week
30 days per month

GHG Emission Factors

CH4	0.0051	g/mi	0.204 grams per hour
N2O	0.0048	g/mi	0.192 grams per hour

Source: 2018 Climate Registry Default Emissions Factors
Table 13.4 Default CH4 and N2O Emission Factors for Highway Vehicles by Technology Type
Diesel Medium and Heavy-Duty Vehicles (Trucks and Busses), Uncontrolled
https://www.theclimateregistry.org/wp-content/uploads/2018/06/The-Climate-Registry-2018-Default-Emission-Factor-Document.pdf

Table A-19. Annual Emissions from Construction Equipment

Phase	Equipment	Annual Emissions - 2022 (MT/year)				Annual Emissions - 2023 (MT/year)				Grand Total
		CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e	(MTCO2e/project)
Demobilization	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	-	-	-	-	-	-	-	-	-
	Drill Rig	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	-	-	-	-	52.55	0.00	0.00	52.78	52.78
	Grader	-	-	-	-	97.07	0.01	-	97.25	97.25
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	-	-	-	-	749.88	0.05	-	751.16	751.16
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	35.04	0.00	0.00	35.18	35.18
		-	**-**	**-**	**-**	**934.54**	**0.06**	**0.00**	**936.37**	**936.37**
		9,486.84	**0.67**	**0.01**	**9,506.38**	**7,719.47**	**0.51**	**0.01**	**7,734.20**	**38,014.24**

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) st
CH4 and N2O emission factors from "2018 Climate Registry Default Emission Fac

Onroad Vehicle Speed

40 mph

Air Basin

San Joaquin Valley

Conversions

1,000,000 grams per metric ton
7 days per week
30 days per month

Lower San Felipe Intake Alternative - Pipeline Option

Table A-20. Equipment List

Equipment	Quantity	Mobilization	Site Improvements	Fabricate Inlet	Build Cofferdam and Set Lower Inlet	Lay Pipe	Connect to Existing Intake	Construct Aeration Facility	Fab and Set Air Tubing	Final Work and Testing	Demobilization
Bulldozer	2	X	X								
Concrete Pumpers	1		X					X			
Cranes	3			X	X	X	X	X			
Excavator	1		X					X			
Flatbed Trucks (on site)	3	X	X	X	X	X	X	X	X	X	X
Grader	2	X	X					X			X
Loaders	2	X	X					X			
Portable Diesel Generators	4	X	X	X	X	X	X	X	X	X	X
Scraper	1		X					X			
Water Truck	2	X	X					X			X

Source: Equipment Tables_08012012.docx; EngineeringDataNeeds_July30_2012.xlsx

Table A-21. Annual Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Months	Annual Emissions - 2020 (MT/year)			
								CO2	CH4	N2O	CO2e
Mobilization	Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	2020	6	376.23	0.05	-	377.49
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231			-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			171.12	0.00	0.00	171.79
	Grader	ConstMin - Graders	2	20	188			293.50	0.02	-	294.12
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202			276.21	0.02	-	276.78
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	559			1,244.37	0.11	-	1,247.00
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-
	Water Truck	N/A - Onroad engine	2	20	n/a			114.08	0.00	0.00	114.53
							Mobilization Subtotal	**2,475.51**	**0.21**	**0.00**	**2,481.71**
Site Improvements	Bulldozer	ConstMin - Rubber Tired Dozers	2	20	249	2020	6	376.23	0.05	-	377.49
	Concrete Pumpers	OFF - Light Commercial - Pumps	1	20	18			27.25	0.00	-	27.33
	Cranes	ConstMin - Cranes	-	20	231			-	-	-	-
	Excavator	ConstMin - Excavators	1	20	158			114.74	0.01	-	115.01
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			171.12	0.00	0.00	171.79
	Grader	ConstMin - Graders	2	20	188			293.50	0.02	-	294.12
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202			276.21	0.02	-	276.78
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	559			1,244.37	0.11	-	1,247.00
	Scraper	ConstMin - Scrapers	1	20	367			338.02	0.03	-	338.86
	Water Truck	N/A - Onroad engine	2	20	n/a			114.08	0.00	0.00	114.53
							Site Improvements Subtotal	**2,955.52**	**0.25**	**0.00**	**2,962.91**
Fabricate Inlet	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2020	3	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-
	Cranes	ConstMin - Cranes	3	20	231			189.31	0.02	-	189.74
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			85.56	0.00	0.00	85.90
	Grader	ConstMin - Graders	-	20	188			-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	559			622.18	0.05	-	623.50
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a			-	-	-	-
							Fabricate Inlet Subtotal	**897.05**	**0.07**	**0.00**	**899.14**

Table A-21. Annual Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Months	Annual Emissions - 2020 (MT/year)			
								CO2	CH4	N2O	CO2e
Build Cofferdam and Set Lower Inlet	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2020	4	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-
	Cranes	ConstMin - Cranes	3	20	231			189.31	0.02	-	189.74
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			85.56	0.00	0.00	85.90
	Grader	ConstMin - Graders	-	20	188			-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	559			622.18	0.05	-	623.50
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a			-	-	-	-
Build Cofferdam and Set Lower Inlet Subtotal								**897.05**	**0.07**	**0.00**	**899.14**
Lay Pipe	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	12	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-
	Cranes	ConstMin - Cranes	3	20	231			-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-
	Grader	ConstMin - Graders	-	20	188			-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	559			-	-	-	-
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a			-	-	-	-
Lay Pipe Subtotal								**-**	**-**	**-**	**-**
Connect to Existing Intake	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2022	2	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-
	Cranes	ConstMin - Cranes	3	20	231			-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-
	Grader	ConstMin - Graders	-	20	188			-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	559			-	-	-	-
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a			-	-	-	-
Connect to Existing Intake Subtotal								**-**	**-**	**-**	**-**
Construct Aeration Facility	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	10	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	1	20	18			-	-	-	-
	Cranes	ConstMin - Cranes	3	20	231			-	-	-	-
	Excavator	ConstMin - Excavators	1	20	158			-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-
	Grader	ConstMin - Graders	2	20	188			-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	2	20	202			-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	559			-	-	-	-
	Scraper	ConstMin - Scrapers	1	20	367			-	-	-	-
	Water Truck	N/A - Onroad engine	2	20	n/a			-	-	-	-
Construct Aeration Facility Subtotal								**-**	**-**	**-**	**-**
Fab and Set Air Tubing	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2021	6	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231			-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-
	Grader	ConstMin - Graders	-	20	188			-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	559			-	-	-	-
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a			-	-	-	-
Fab and Set Air Tubing Subtotal								**-**	**-**	**-**	**-**

Table A-21. Annual Emissions from Construction Equipment

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Months	Annual Emissions - 2020 (MT/year)			
								CO2	CH4	N2O	CO2e
Final Work and Testing	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2022	4	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231			-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-
	Grader	ConstMin - Graders	-	20	188			-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	559			-	-	-	-
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-
	Water Truck	N/A - Onroad engine	-	20	n/a			-	-	-	-
Final Work and Testing Subtotal								**-**	**-**	**-**	**-**
Demobilization	Bulldozer	ConstMin - Rubber Tired Dozers	-	20	249	2022	2	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	20	18			-	-	-	-
	Cranes	ConstMin - Cranes	-	20	231			-	-	-	-
	Excavator	ConstMin - Excavators	-	20	158			-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	3	20	n/a			-	-	-	-
	Grader	ConstMin - Graders	2	20	188			-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	20	202			-	-	-	-
	Portable Diesel Generators	Portable Equipment - Non-Rental Generator	4	20	559			-	-	-	-
	Scraper	ConstMin - Scrapers	-	20	367			-	-	-	-
	Water Truck	N/A - Onroad engine	2	20	n/a			-	-	-	-
Demobilization Subtotal								**-**	**-**	**-**	**-**
Grand Total (metric tons per year)								**7,225.13**	**0.60**	**0.01**	**7,242.89**
							GWP	1	25	298	

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of grams per hour (g/hr). CO2 emission factors from EMFAC2014 for diesel-fueled medium-duty vehicles in San Joaquin Valley Air Basin.
CH4 and N2O emission factors from "2018 Climate Registry Default Emission Factors" for diesel medium and heavy-duty vehicles.

Onroad Vehicle Speed

40	mph

Air Basin
San Joaquin Valley

Conversions

1,000,000	grams per metric ton
7	days per week
30	days per month

GHG Emission Factors

CH4	0.0051	g/mi	0.204	grams per hour
N2O	0.0048	g/mi	0.192	grams per hour

Source: 2018 Climate Registry Default Emissions Factors
Table 13.4 Default CH4 and N2O Emission Factors for Highway Vehicles by Technology Type
Diesel Medium and Heavy-Duty Vehicles (Trucks and Busses), Uncontrolled
https://www.theclimateregistry.org/wp-content/uploads/2018/06/The-Climate-Registry-2018-Default-Emission-Factor-Document.pdf

Lower San Felipe Intake Alternative - Pipeline Option

Table A-20. Equipment List

Equipment	Quantity
Bulldozer	2
Concrete Pumpers	1
Cranes	3
Excavator	1
Flatbed Trucks (on site)	3
Grader	2
Loaders	2
Portable Diesel Generators	4
Scraper	1
Water Truck	2

Source: Equipment Tables_08012012.docx; EngineeringDataNeeds_July30_2012.xlsx

Table A-21. Annual Emissions from Construction Equipment

Phase	Equipment	Annual Emissions - 2021 (MT/year)				Annual Emissions - 2022 (MT/year)				Grand Total
		CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e	(MTCO2e/project)
Mobilization	Bulldozer	-	-	-	-	-	-	-	-	377.49
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	-	-	-	-	-	-	-	-	171.79
	Grader	-	-	-	-	-	-	-	-	294.12
	Loaders	-	-	-	-	-	-	-	-	276.78
	Portable Diesel Generators	-	-	-	-	-	-	-	-	1,247.00
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	114.53
		-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2,481.71**
Site Improvements	Bulldozer	-	-	-	-	-	-	-	-	377.49
	Concrete Pumpers	-	-	-	-	-	-	-	-	27.33
	Cranes	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	115.01
	Flatbed Trucks (on site)	-	-	-	-	-	-	-	-	171.79
	Grader	-	-	-	-	-	-	-	-	294.12
	Loaders	-	-	-	-	-	-	-	-	276.78
	Portable Diesel Generators	-	-	-	-	-	-	-	-	1,247.00
	Scraper	-	-	-	-	-	-	-	-	338.86
	Water Truck	-	-	-	-	-	-	-	-	114.53
		-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2,962.91**
Fabricate Inlet	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	-	-	-	-	-	-	-	-	189.74
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	-	-	-	-	-	-	-	-	85.90
	Grader	-	-	-	-	-	-	-	-	-
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	-	-	-	-	-	-	-	-	623.50
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	-
		-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**899.14**

Table A-21. Annual Emissions from Construction Equipment

Phase	Equipment	Annual Emissions - 2021 (MT/year)				Annual Emissions - 2022 (MT/year)				Grand Total
		CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e	(MTCO2e/project)
Build Cofferdam and Set Lower Inlet	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	63.10	0.01	-	63.25	-	-	-	-	252.99
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	27.80	0.00	0.00	27.91	-	-	-	-	113.81
	Grader	-	-	-	-	-	-	-	-	-
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	207.39	0.02	-	207.83	-	-	-	-	831.34
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	-
		298.30	**0.02**	**0.00**	**298.99**	**-**	**-**	**-**	**-**	**1,198.13**
Lay Pipe	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	694.13	0.06	-	695.71	63.10	0.01	-	63.25	758.96
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	305.81	0.00	0.00	307.04	27.05	0.00	0.00	27.16	334.20
	Grader	-	-	-	-	-	-	-	-	-
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	2,281.34	0.19	-	2,286.17	207.39	0.02	-	207.83	2,494.01
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	-
		3,281.27	**0.26**	**0.00**	**3,288.93**	**297.55**	**0.02**	**0.00**	**298.25**	**3,587.17**
Connect to Existing Intake	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	-	-	-	-	126.21	0.01	-	126.49	126.49
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	-	-	-	-	54.10	0.00	0.00	54.33	54.33
	Grader	-	-	-	-	-	-	-	-	-
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	-	-	-	-	414.79	0.04	-	415.67	415.67
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	-
		-	**-**	**-**	**-**	**595.10**	**0.05**	**0.00**	**596.49**	**596.49**
Construct Aeration Facility	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	45.41	0.01	-	45.55	-	-	-	-	45.55
	Cranes	631.03	0.06	-	632.47	-	-	-	-	632.47
	Excavator	191.24	0.02	-	191.68	-	-	-	-	191.68
	Flatbed Trucks (on site)	278.01	0.00	0.00	279.13	-	-	-	-	279.13
	Grader	489.17	0.04	-	490.19	-	-	-	-	490.19
	Loaders	460.35	0.04	-	461.31	-	-	-	-	461.31
	Portable Diesel Generators	2,073.94	0.18	-	2,078.34	-	-	-	-	2,078.34
	Scraper	563.37	0.06	-	564.76	-	-	-	-	564.76
	Water Truck	185.34	0.00	0.00	186.09	-	-	-	-	186.09
		4,917.85	**0.40**	**0.01**	**4,929.51**	**-**	**-**	**-**	**-**	**4,929.51**
Fab and Set Air Tubing	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	166.80	0.00	0.00	167.48	-	-	-	-	167.48
	Grader	-	-	-	-	-	-	-	-	-
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	1,244.37	0.11	-	1,247.00	-	-	-	-	1,247.00
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	-
		1,411.17	**0.11**	**0.00**	**1,414.48**	**-**	**-**	**-**	**-**	**1,414.48**

Table A-21. Annual Emissions from Construction Equipment

Phase	Equipment	Annual Emissions - 2021 (MT/year)				Annual Emissions - 2022 (MT/year)				Grand Total
		CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e	(MTCO2e/project)
Final Work and Testing	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	-	-	-	-	108.21	0.00	0.00	108.66	108.66
	Grader	-	-	-	-	-	-	-	-	-
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	-	-	-	-	829.58	0.07	-	831.34	831.34
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	-	-	-	-	-
		-	**-**	**-**	**-**	**937.79**	**0.07**	**0.00**	**939.99**	**939.99**
Demobilization	Bulldozer	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	-	-	-	-	-	-	-	-	-
	Cranes	-	-	-	-	-	-	-	-	-
	Excavator	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	-	-	-	-	54.10	0.00	0.00	54.33	54.33
	Grader	-	-	-	-	97.83	0.01	-	98.04	98.04
	Loaders	-	-	-	-	-	-	-	-	-
	Portable Diesel Generators	-	-	-	-	414.79	0.04	-	415.67	415.67
	Scraper	-	-	-	-	-	-	-	-	-
	Water Truck	-	-	-	-	36.07	0.00	0.00	36.22	36.22
		-	**-**	**-**	**-**	**602.80**	**0.04**	**0.00**	**604.25**	**604.25**
		9,908.59	**0.79**	**0.01**	**9,931.91**	**2,433.23**	**0.19**	**0.00**	**2,438.98**	**19,613.78**

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown i
CH4 and N2O emission factors from "2018 Climate Registry Default Emission Factors" f

Onroad Vehicle Speed

40 mph

Air Basin
San Joaquin Valley

Conversions

1,000,000 grams per metric ton
7 days per week
30 days per month

Treatment Alternative

Table A-22. Equipment List (Santa Teresa WTP)

Equipment	Quantity	Mobilization and Site Improvements	Retrofit Existing Facilities	Starting and Testing	Demobilization
Bulldozer	1	X			
Concrete Pumpers	2		X		
Concrete Saw Cutters	2		X		
Cranes	2		X		
Excavator	1		X		
Flatbed Trucks (on site)	4	X	X		X
Loaders	1	X	X		
Water Truck	2	X	X		
Wheel Trencher	2		X		

Table A-23. Annual Emissions from Construction Equipment (Santa Teresa WTP)

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Months	Annual Emissions - 2020 (MT/year)				Annual Emissions - 2021 (MT/year)				Annual Emissions - 2022 (MT/year)				Grand Total
								CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e	(MTCO2e/project)
Mobilization and Site Improvements	Bulldozer	ConstMin - Rubber Tired Dozers	1	10	249	2020	2	22.85	0.00	-	22.93	-	-	-	-	-	-	-	-	22.93
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	10	18			-	-	-	-	-	-	-	-	-	-	-	-	-
	Concrete Saw Cutters	OFF - ConstMin - Concrete/Industrial Saws	-	10	31			-	-	-	-	-	-	-	-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	10	231			-	-	-	-	-	-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	10	158			-	-	-	-	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	4	10	n/a			20.39	0.00	0.00	20.43	-	-	-	-	-	-	-	-	20.43
	Loaders	ConstMin - Rubber Tired Loaders	1	10	202			16.94	0.00	-	16.97	-	-	-	-	-	-	-	-	16.97
	Water Truck	N/A - Onroad engine	2	10	n/a			10.20	0.00	0.00	10.22	-	-	-	-	-	-	-	-	10.22
	Wheel Trencher	ConstMin - Trenchers	-	10	79			-	-	-	-	-	-	-	-	-	-	-	-	-
Mobilization and Site Improvements Subtotal								**70.37**	**0.00**	**0.00**	**70.54**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**70.54**
Retrofit Existing Facilities (1)	Bulldozer	ConstMin - Rubber Tired Dozers	-	10	249	2020	14	-	-	-	-	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	10	18			33.31	0.00	-	33.41	13.32	0.00	-	13.36	-	-	-	-	46.77
	Concrete Saw Cutters	OFF - ConstMin - Concrete/Industrial Saws	2	10	31			56.77	0.01	-	56.95	22.72	0.00	-	22.79	-	-	-	-	79.73
	Cranes	ConstMin - Cranes	2	10	231			154.52	0.01	-	154.87	61.79	0.01	-	61.93	-	-	-	-	216.80
	Excavator	ConstMin - Excavators	1	10	158			70.12	0.01	-	70.28	28.04	0.00	-	28.10	-	-	-	-	98.38
	Flatbed Trucks (on site)	N/A - Onroad engine	4	10	n/a			101.96	0.00	0.00	102.16	39.66	0.00	0.00	39.74	-	-	-	-	141.90
	Loaders	ConstMin - Rubber Tired Loaders	1	10	202			84.68	0.01	-	84.85	33.85	0.00	-	33.92	-	-	-	-	118.77
	Water Truck	N/A - Onroad engine	2	10	n/a			50.98	0.00	0.00	51.08	19.83	0.00	0.00	19.87	-	-	-	-	70.95
	Wheel Trencher	ConstMin - Trenchers	2	10	79			92.35	0.02	-	92.79	36.95	0.01	-	37.12	-	-	-	-	129.90
Retrofit Existing Facilities (1) Subtotal								**644.67**	**0.06**	**0.00**	**646.38**	**256.17**	**0.02**	**0.00**	**256.82**	**-**	**-**	**-**	**-**	**903.20**
Retrofit Existing Facilities (2)	Bulldozer	ConstMin - Rubber Tired Dozers	-	10	249	2021	14	-	-	-	-	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	2	10	18			-	-	-	-	19.98	0.00	-	20.04	26.65	0.00	-	26.72	46.77
	Concrete Saw Cutters	OFF - ConstMin - Concrete/Industrial Saws	2	10	31			-	-	-	-	34.08	0.00	-	34.18	45.39	0.00	-	45.51	79.69
	Cranes	ConstMin - Cranes	2	10	231			-	-	-	-	92.69	0.01	-	92.89	123.53	0.01	-	123.78	216.67
	Excavator	ConstMin - Excavators	1	10	158			-	-	-	-	42.07	0.00	-	42.16	56.07	0.00	-	56.18	98.34
	Flatbed Trucks (on site)	N/A - Onroad engine	4	10	n/a			-	-	-	-	59.49	0.00	0.00	59.61	77.03	0.00	0.00	77.19	136.80
	Loaders	ConstMin - Rubber Tired Loaders	1	10	202			-	-	-	-	50.77	0.00	-	50.87	67.70	0.01	-	67.83	118.70
	Water Truck	N/A - Onroad engine	2	10	n/a			-	-	-	-	29.74	0.00	0.00	29.81	38.51	0.00	0.00	38.60	68.40
	Wheel Trencher	ConstMin - Trenchers	2	10	79			-	-	-	-	55.43	0.01	-	55.67	73.86	0.01	-	74.17	129.84
Retrofit Existing Facilities (2) Subtotal								**-**	**-**	**-**	**-**	**384.26**	**0.03**	**0.00**	**385.23**	**508.74**	**0.04**	**0.00**	**509.98**	**895.21**

Table A-23. Annual Emissions from Construction Equipment (Santa Teresa WTP)

Phase	Equipment	OFFROAD Description	Quantity	Hours/ Day	Size (HP)	Start Year	Months	Annual Emissions - 2020 (MT/year)				Annual Emissions - 2021 (MT/year)				Annual Emissions - 2022 (MT/year)				Grand Total
								CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e	(MTCO2e/project)
Starting and Testing (1)	Bulldozer	ConstMin - Rubber Tired Dozers	-	10	249	2021	2	-	-	-	-	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	10	18			-	-	-	-	-	-	-	-	-	-	-	-	-
	Concrete Saw Cutters	OFF - ConstMin - Concrete/Industrial Saws	-	10	31			-	-	-	-	-	-	-	-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	10	231			-	-	-	-	-	-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	10	158			-	-	-	-	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	-	10	n/a			-	-	-	-	-	-	-	-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	10	202			-	-	-	-	-	-	-	-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	10	n/a			-	-	-	-	-	-	-	-	-	-	-	-	-
	Wheel Trencher	ConstMin - Trenchers	-	10	79			-	-	-	-	-	-	-	-	-	-	-	-	-
Starting and Testing (1) Subtotal								**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Starting and Testing (2)	Bulldozer	ConstMin - Rubber Tired Dozers	-	10	249	2022	2	-	-	-	-	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	10	18			-	-	-	-	-	-	-	-	-	-	-	-	-
	Concrete Saw Cutters	OFF - ConstMin - Concrete/Industrial Saws	-	10	31			-	-	-	-	-	-	-	-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	10	231			-	-	-	-	-	-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	10	158			-	-	-	-	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	-	10	n/a			-	-	-	-	-	-	-	-	-	-	-	-	-
	Loaders	ConstMin - Rubber Tired Loaders	-	10	202			-	-	-	-	-	-	-	-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	10	n/a			-	-	-	-	-	-	-	-	-	-	-	-	-
	Wheel Trencher	ConstMin - Trenchers	-	10	79			-	-	-	-	-	-	-	-	-	-	-	-	-
Starting and Testing (2) Subtotal								**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Demobilization	Bulldozer	ConstMin - Rubber Tired Dozers	-	10	249	2022	2	-	-	-	-	-	-	-	-	-	-	-	-	-
	Concrete Pumpers	OFF - Light Commercial - Pumps	-	10	18			-	-	-	-	-	-	-	-	-	-	-	-	-
	Concrete Saw Cutters	OFF - ConstMin - Concrete/Industrial Saws	-	10	31			-	-	-	-	-	-	-	-	-	-	-	-	-
	Cranes	ConstMin - Cranes	-	10	231			-	-	-	-	-	-	-	-	-	-	-	-	-
	Excavator	ConstMin - Excavators	-	10	158			-	-	-	-	-	-	-	-	-	-	-	-	-
	Flatbed Trucks (on site)	N/A - Onroad engine	4	10	n/a			-	-	-	-	-	-	-	-	19.26	0.00	0.00	19.30	19.30
	Loaders	ConstMin - Rubber Tired Loaders	-	10	202			-	-	-	-	-	-	-	-	-	-	-	-	-
	Water Truck	N/A - Onroad engine	-	10	n/a			-	-	-	-	-	-	-	-	-	-	-	-	-
	Wheel Trencher	ConstMin - Trenchers	-	10	79			-	-	-	-	-	-	-	-	-	-	-	-	-
Demobilization Subtotal								**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**19.26**	**0.00**	**0.00**	**19.30**	**19.30**
Santa Teresa WTP Total								**715.04**	**0.06**	**0.00**	**716.93**	**640.43**	**0.05**	**0.00**	**642.06**	**528.00**	**0.04**	**0.00**	**529.28**	**1,888.26**

GWP 1 25 298

Notes:
Emission factors for onroad engines (spreader, flatbed trucks, and water trucks) shown in units of grams per hour (g/hr). CO2 emission factors from EMFAC2014 for diesel-fueled medium-duty vehicles in San Francisco Bay Area Air Basin.
CH4 and N2O emission factors from "2018 Climate Registry Default Emission Factors" for diesel medium and heavy-duty vehicles.

Onroad Vehicle Speed
15 mph

Air Basin
San Francisco Bay Area

Conversions
1,000,000 grams per metric ton
5 days per week
22 days per month

GHG Emission Factors

CH4	0.0051	g/mi	0.0765	grams per hour
N2O	0.0048	g/mi	0.072	grams per hour

Source: 2018 Climate Registry Default Emissions Factors
Table 13.4 Default CH4 and N2O Emission Factors for Highway Vehicles by Technology Type
Diesel Medium and Heavy-Duty Vehicles (Trucks and Busses), Uncontrolled
https://www.theclimateregistry.org/wp-content/uploads/2018/06/The-Climate-Registry-2018-Default-Emission-Factor-Document.pdf

Tunnel Option Start Date 1/1/2020
Pipeline Option Start Date 1/1/2020

Table A-24. Lower San Felipe Intake Alternative Schedule

	Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
Tunnel Option																																																	
Mobilization	6																																															
Site Improvements	6																																															
Construct Vertical Shaft	6																																														
Set Up TBM	2																																														
Tunneling and Spreading of Soils	20																																														
Cofferdam and TBM Out	3																																														
Connect to Existing Intake	3																																														
Fabricate Inlet	3																																														
Set Inlet and Flood Tunnel	1																																														
Construct Aeration Facility	10																																														
Fab and Set Air Tubing	6																																														
Final Work and Testing	4																																														
Demobilization	2																																														
Pipeline Option																																															
Mobilization	6																																															
Site Improvements	6																																															
Fabricate Inlet	3																																														
Build Cofferdam and Set Lower Inlet	4																																														
Lay Pipe	12																																														
Connect to Existing Intake	2																																														
Construct Aeration Facility	10																																														
Fab and Set Air Tubing	6																																														
Final Work and Testing	4																																														
Demobilization	2																																														

Source: SLLPIP_PD_06082012.pdf

Tunnel Option Start Date 1/1/2020
Pipeline Option Start Date 1/1/2020

Table A-24. Lower San Felipe Intake Alternative S

	Months	Dates		Year		Months by Year				
Tunnel Option		**Start**	**End**	**Start**	**End**	**2020**	**2021**	**2022**	**2023**	**Total**
Mobilization	6	1/1/2020	6/30/2020	2020	2020	6	0	0	0	6
Site Improvements	6	4/1/2020	9/30/2020	2020	2020	6	0	0	0	6
Construct Vertical Shaft	6	10/1/2020	3/31/2021	2020	2021	3	3	0	0	6
Set Up TBM	2	4/1/2021	5/31/2021	2021	2021	0	2	0	0	2
Tunneling and Spreading of Soils	20	6/1/2021	1/31/2023	2021	2023	0	7	12	1	20
Cofferdam and TBM Out	3	2/1/2023	4/30/2023	2023	2023	0	0	0	3	3
Connect to Existing Intake	3	2/1/2023	4/30/2023	2023	2023	0	0	0	3	3
Fabricate Inlet	3	2/1/2023	4/30/2023	2023	2023	0	0	0	3	3
Set Inlet and Flood Tunnel	1	5/1/2023	5/31/2023	2023	2023	0	0	0	1	1
Construct Aeration Facility	10	6/1/2021	3/31/2022	2021	2022	0	7	3	0	10
Fab and Set Air Tubing	6	10/1/2021	3/31/2022	2021	2022	0	3	3	0	6
Final Work and Testing	4	6/1/2023	9/30/2023	2023	2023	0	0	0	4	4
Demobilization	2	10/1/2023	11/30/2023	2023	2023	0	0	0	2	2
Pipeline Option										
Mobilization	6	1/1/2020	6/30/2020	2020	2020	6	0	0	0	6
Site Improvements	6	4/1/2020	9/30/2020	2020	2020	6	0	0	0	6
Fabricate Inlet	3	8/1/2020	10/31/2020	2020	2020	3	0	0	0	3
Build Cofferdam and Set Lower Inlet	4	10/1/2020	1/31/2021	2020	2021	3	1	0	0	4
Lay Pipe	12	2/1/2021	1/31/2022	2021	2022	0	11	1	0	12
Connect to Existing Intake	2	2/1/2022	3/31/2022	2022	2022	0	0	2	0	2
Construct Aeration Facility	10	2/1/2021	11/30/2021	2021	2021	0	10	0	0	10
Fab and Set Air Tubing	6	6/1/2021	11/30/2021	2021	2021	0	6	0	0	6
Final Work and Testing	4	4/1/2022	7/31/2022	2022	2022	0	0	4	0	4
Demobilization	2	8/1/2022	9/30/2022	2022	2022	0	0	2	0	2

Source: SLLPIP_PD_06082012.pdf

Table A-25. Santa Teresa WTP - Construction Schedule

	Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Dates		Year		Months by Year		
																																						Start	End	Start	End	2020	2021	2022
Mobilization and Site Improvements	2																																					1/1/2020	2/29/2020	2020	2020	2	0	0
Retrofit Existing Facilities (1)	14																																					3/1/2020	4/30/2021	2020	2021	10	4	0
Retrofit Existing Facilities (2)	14																																					7/1/2021	8/31/2022	2021	2022	0	6	8
Starting and Testing (1)	2																																					5/1/2021	6/30/2021	2021	2021	0	2	0
Starting and Testing (2)	2																																					9/1/2022	10/31/2022	2022	2022	0	0	2
Demobilization	2																																					11/1/2022	12/31/2022	2022	2022	0	0	2
																																								Total	12	12	12

Source: Equipment Tables_08012012.docx

Note: Construction duration originally estimated to be 15 months; however, schedule updated to 36 months after completion of Feasibility Report. Therefore, current schedule scaled up to reflect 36-month construction schedule.

Emission Factor Summary

Table A-26. In-Use Off-Road Construction Equipment Emission Factors (San Joaquin Valley Air Basin)

Equipment Type	Average HP	Emission Factors - 2020 (g/bhp-hr)			Emission Factors - 2021 (g/bhp-hr)			Emission Factors - 2022 (g/bhp-hr)			Emission Factors - 2023 (g/bhp-hr)			Emission Factors - 2024 (g/bhp-hr)		
		CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O
ConstMin - Bore/Drill Rigs	221	262.652	0.010	-	262.297	0.009	-	261.797	0.009	-	261.761	0.009	-	262.470	0.009	-
ConstMin - Cranes	231	151.762	0.014	-	151.821	0.013	-	151.973	0.012	-	151.980	0.012	-	151.984	0.011	-
ConstMin - Crawler Tractors	212	226.488	0.023	-	226.274	0.022	-	226.059	0.021	-	226.295	0.020	-	226.382	0.019	-
ConstMin - Excavators	158	201.731	0.018	-	201.738	0.017	-	201.784	0.016	-	201.812	0.015	-	201.819	0.014	-
ConstMin - Graders	188	216.830	0.018	-	216.573	0.017	-	216.549	0.016	-	215.145	0.016	-	214.395	0.015	-
ConstMin - Off-Highway Tractors	124	229.411	0.037	-	229.481	0.035	-	229.547	0.033	-	229.589	0.032	-	229.846	0.030	-
ConstMin - Off-Highway Trucks	403	201.177	0.016	-	201.162	0.015	-	201.259	0.014	-	201.274	0.014	-	201.438	0.013	-
ConstMin - Other Construction Equipment	172	220.363	0.016	-	220.262	0.015	-	219.861	0.014	-	219.667	0.013	-	219.635	0.012	-
ConstMin - Pavers	129	219.011	0.030	-	218.918	0.028	-	219.297	0.027	-	219.374	0.025	-	219.534	0.024	-
ConstMin - Paving Equipment	131	187.674	0.025	-	187.767	0.024	-	187.504	0.022	-	187.493	0.021	-	187.715	0.020	-
ConstMin - Rollers	80	197.864	0.028	-	197.839	0.026	-	197.890	0.024	-	197.874	0.022	-	197.903	0.020	-
ConstMin - Rough Terrain Forklifts	100	212.252	0.024	-	212.278	0.023	-	212.186	0.021	-	212.164	0.020	-	212.243	0.019	-
ConstMin - Rubber Tired Dozers	249	209.855	0.028	-	209.931	0.027	-	210.154	0.025	-	210.388	0.024	-	210.383	0.023	-
ConstMin - Rubber Tired Loaders	202	189.914	0.016	-	189.949	0.015	-	190.040	0.014	-	190.253	0.013	-	190.304	0.013	-
ConstMin - Scrapers	367	255.843	0.025	-	255.920	0.024	-	255.779	0.023	-	255.761	0.022	-	255.568	0.021	-
ConstMin - Skid Steer Loaders	65	192.346	0.014	-	191.821	0.014	-	192.907	0.013	-	194.580	0.012	-	192.922	0.012	-
ConstMin - Surfacing Equipment	263	159.048	0.011	-	159.126	0.010	-	159.126	0.010	-	159.149	0.009	-	159.109	0.009	-
ConstMin - Sweepers/Scrubbers	64	240.406	0.026	-	240.398	0.024	-	240.589	0.022	-	240.608	0.021	-	240.627	0.019	-
ConstMin - Tractors/Loaders/Backhoes	98	193.422	0.020	-	193.318	0.019	-	193.492	0.017	-	193.817	0.017	-	193.939	0.016	-
ConstMin - Trenchers	79	264.332	0.050	-	264.739	0.047	-	264.872	0.044	-	264.211	0.042	-	264.720	0.039	-
Industrial - Aerial Lifts	63	162.717	0.016	-	162.730	0.015	-	162.722	0.013	-	162.727	0.013	-	162.729	0.012	-
Industrial - Forklifts	89	106.039	0.011	-	106.040	0.010	-	106.037	0.010	-	106.040	0.009	-	106.032	0.009	-
Industrial - Other General Industrial Equipment	88	180.548	0.026	-	180.572	0.023	-	180.572	0.022	-	180.546	0.021	-	180.551	0.019	-
Industrial - Other Material Handling Equipment	167	208.707	0.023	-	208.711	0.021	-	208.722	0.019	-	208.726	0.018	-	208.723	0.017	-
OFF - ConstMin - Bore/Drill Rigs	15	319.893	0.045	-	319.936	0.045	-	319.561	0.045	-	319.225	0.045	-	319.689	0.045	-
OFF - ConstMin - Cement and Mortar Mixers	10	440.196	0.033	-	446.401	0.033	-	452.604	0.033	-	452.436	0.033	-	446.159	0.033	-
OFF - ConstMin - Concrete/Industrial Saws	31	217.013	0.053	-	217.051	0.048	-	216.251	0.043	-	216.298	0.040	-	217.158	0.037	-
OFF - ConstMin - Dumpers/Tenders	16	323.591	0.024	-	324.405	0.024	-	323.853	0.024	-	325.022	0.024	-	324.287	0.024	-
OFF - ConstMin - Excavators	23	352.585	0.035	-	352.509	0.035	-	352.604	0.035	-	352.494	0.035	-	352.386	0.035	-
OFF - ConstMin - Other Construction Equipment	14	360.435	0.037	-	359.878	0.037	-	360.248	0.037	-	361.516	0.037	-	360.962	0.037	-
OFF - ConstMin - Pavers	24	305.081	0.038	-	303.993	0.038	-	302.079	0.038	-	301.925	0.038	-	302.192	0.038	-
OFF - ConstMin - Paving Equipment	19	244.271	0.033	-	244.297	0.033	-	244.438	0.033	-	244.346	0.033	-	244.445	0.033	-
OFF - ConstMin - Plate Compactors	8	318.146	0.026	-	318.243	0.026	-	318.332	0.026	-	318.427	0.026	-	318.311	0.026	-
OFF - ConstMin - Rollers	12	307.783	0.033	-	309.933	0.033	-	309.896	0.033	-	306.379	0.033	-	307.070	0.033	-
OFF - ConstMin - Rubber Tired Loaders	25	466.020	0.033	-	466.010	0.033	-	466.001	0.033	-	466.012	0.033	-	466.021	0.033	-
OFF - ConstMin - Signal Boards	6	467.378	0.049	-	467.756	0.049	-	476.336	0.049	-	470.484	0.049	-	472.804	0.049	-
OFF - ConstMin - Skid Steer Loaders	20	312.501	0.035	-	312.616	0.035	-	312.583	0.034	-	312.374	0.034	-	312.589	0.034	-
OFF - ConstMin - Tractors/Loaders/Backhoes	23	426.810	0.034	-	426.330	0.034	-	426.618	0.034	-	426.681	0.034	-	427.004	0.034	-
OFF - ConstMin - Trenchers	22	261.415	0.046	-	261.495	0.046	-	261.404	0.046	-	261.245	0.046	-	261.060	0.046	-
OFF - Industrial - Aerial Lifts	17	289.654	0.030	-	289.571	0.029	-	289.648	0.029	-	289.808	0.029	-	289.596	0.029	-
OFF - Industrial - Other General Industrial Equipment	18	388.843	0.032	-	389.170	0.032	-	386.992	0.032	-	387.756	0.032	-	387.359	0.032	-
OFF - Industrial - Sweepers/Scrubbers	18	274.343	0.042	-	274.362	0.042	-	273.291	0.042	-	273.629	0.042	-	273.088	0.042	-
OFF - Light Commercial - Air Compressors	35	420.591	0.045	-	420.595	0.040	-	420.546	0.037	-	420.576	0.034	-	420.564	0.032	-
OFF - Light Commercial - Generator Sets	21	420.527	0.048	-	420.577	0.048	-	420.491	0.047	-	420.508	0.047	-	420.566	0.047	-
OFF - Light Commercial - Pressure Washers	21	170.638	0.020	-	171.199	0.019	-	170.857	0.019	-	169.529	0.019	-	170.596	0.019	-
OFF - Light Commercial - Pumps	18	420.494	0.052	-	420.662	0.051	-	420.591	0.050	-	420.592	0.049	-	420.656	0.048	-
OFF - Light Commercial - Welders	33	403.602	0.040	-	403.536	0.035	-	403.502	0.032	-	403.402	0.030	-	403.469	0.027	-
Portable Equipment - Non-Rental Compressor	210	154.587	0.013	-	156.272	0.012	-	157.976	0.011	-	159.698	0.011	-	161.439	0.010	-
Portable Equipment - Non-Rental Generator	559	154.587	0.013	-	156.272	0.012	-	157.976	0.011	-	159.698	0.011	-	161.439	0.010	-
Portable Equipment - Non-Rental Other Portable Equipment	382	154.587	0.012	-	156.272	0.011	-	157.976	0.010	-	159.698	0.010	-	161.439	0.009	-
Portable Equipment - Non-Rental Pump	593	154.587	0.014	-	156.272	0.013	-	157.976	0.012	-	159.698	0.012	-	161.439	0.011	-
Portable Equipment - Rental Compressor	233	154.587	0.013	-	156.272	0.012	-	157.976	0.011	-	159.698	0.011	-	161.439	0.010	-
Portable Equipment - Rental Generator	232	154.587	0.014	-	156.272	0.013	-	157.976	0.012	-	159.698	0.011	-	161.439	0.011	-
Portable Equipment - Rental Other Portable Equipment	169	154.587	0.016	-	156.272	0.015	-	157.976	0.014	-	159.698	0.013	-	161.439	0.012	-
Portable Equipment - Rental Pump	212	154.587	0.015	-	156.272	0.013	-	157.976	0.013	-	159.698	0.012	-	161.439	0.012	-

Source:
CO2 Emission Factors: California Air Resources Board (CARB). 2017. OFFROAD2017 - ORION Web Database. Available online at https://www.arb.ca.gov/orion/ [Accessesd October 17, 2018].
CH4 and N2O Emission Factors: California Air Resources Board. 2007. OFFROAD2007.
Notes:
1. Horsepower used in modeling is average calculated from OFFROAD2017 (e.g., "Horsepower_Hours_hhpy" divided by "Total_Activity_hpy.")

Table A-27. In-Use Off-Road Construction Equipment Emission Factors (San Francisco Bay Area Air Basin)

Equipment Type	Average HP	Emission Factors - 2020 (g/bhp-hr)			Emission Factors - 2021 (g/bhp-hr)			Emission Factors - 2022 (g/bhp-hr)			Emission Factors - 2023 (g/bhp-hr)			Emission Factors - 2024 (g/bhp-hr)		
		CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O
ConstMin - Bore/Drill Rigs	221	263.425	0.010	-	262.928	0.009	-	262.502	0.009	-	263.106	0.009	-	263.778	0.009	-
ConstMin - Cranes	231	152.030	0.014	-	151.992	0.013	-	151.917	0.012	-	151.961	0.012	-	151.994	0.011	-
ConstMin - Crawler Tractors	212	226.232	0.023	-	226.303	0.022	-	226.169	0.021	-	226.103	0.020	-	226.185	0.019	-
ConstMin - Excavators	158	201.716	0.018	-	201.703	0.017	-	201.646	0.016	-	201.689	0.015	-	201.646	0.014	-
ConstMin - Graders	188	215.884	0.018	-	215.791	0.017	-	215.796	0.016	-	215.935	0.016	-	215.756	0.015	-
ConstMin - Off-Highway Tractors	124	229.814	0.037	-	229.915	0.035	-	229.920	0.033	-	229.754	0.032	-	229.704	0.030	-
ConstMin - Off-Highway Trucks	403	201.408	0.016	-	201.512	0.015	-	201.621	0.014	-	201.864	0.014	-	201.556	0.013	-
ConstMin - Other Construction Equipment	172	218.483	0.016	-	218.490	0.015	-	218.418	0.014	-	218.426	0.013	-	218.448	0.012	-
ConstMin - Pavers	129	219.689	0.030	-	219.565	0.028	-	219.710	0.027	-	219.720	0.025	-	219.677	0.024	-
ConstMin - Paving Equipment	131	187.116	0.025	-	187.076	0.024	-	187.105	0.022	-	187.022	0.021	-	187.154	0.020	-
ConstMin - Rollers	80	198.122	0.028	-	198.170	0.026	-	198.043	0.024	-	198.119	0.022	-	198.149	0.020	-
ConstMin - Rough Terrain Forklifts	100	212.432	0.024	-	212.381	0.023	-	212.337	0.021	-	212.434	0.020	-	212.465	0.019	-
ConstMin - Rubber Tired Dozers	249	208.552	0.028	-	208.834	0.027	-	209.362	0.025	-	209.048	0.024	-	209.022	0.023	-
ConstMin - Rubber Tired Loaders	202	190.541	0.016	-	190.425	0.015	-	190.430	0.014	-	190.492	0.013	-	190.556	0.013	-
ConstMin - Scrapers	367	254.998	0.025	-	254.980	0.024	-	255.037	0.023	-	255.223	0.022	-	255.178	0.021	-
ConstMin - Skid Steer Loaders	65	194.497	0.014	-	194.524	0.014	-	194.538	0.013	-	194.506	0.012	-	194.634	0.012	-
ConstMin - Surfacing Equipment	263	159.194	0.011	-	159.157	0.010	-	159.337	0.010	-	159.398	0.009	-	159.538	0.009	-
ConstMin - Sweepers/Scrubbers	64	241.387	0.025	-	240.737	0.023	-	240.058	0.021	-	239.690	0.020	-	238.843	0.019	-
ConstMin - Tractors/Loaders/Backhoes	98	194.991	0.020	-	195.069	0.019	-	195.218	0.017	-	195.215	0.017	-	195.284	0.016	-
ConstMin - Trenchers	79	265.676	0.050	-	265.766	0.047	-	265.593	0.044	-	265.848	0.042	-	265.793	0.039	-
Industrial - Aerial Lifts	63	162.723	0.015	-	162.700	0.013	-	162.705	0.012	-	162.687	0.012	-	162.686	0.011	-
Industrial - Forklifts	89	105.944	0.011	-	105.948	0.010	-	105.947	0.009	-	105.948	0.009	-	105.937	0.008	-
Industrial - Other General Industrial Equipment	88	180.179	0.024	-	180.697	0.022	-	181.296	0.021	-	181.118	0.019	-	180.767	0.018	-
Industrial - Other Material Handling Equipment	167	208.974	0.021	-	208.946	0.020	-	208.951	0.019	-	208.611	0.017	-	208.613	0.016	-
OFF - ConstMin - Bore/Drill Rigs	16	426.163	0.046	-	426.124	0.046	-	426.962	0.046	-	427.339	0.046	-	426.638	0.046	-
OFF - ConstMin - Cement and Mortar Mixers	10	318.366	0.033	-	318.616	0.033	-	318.857	0.033	-	318.711	0.033	-	318.495	0.033	-
OFF - ConstMin - Concrete/Industrial Saws	31	416.174	0.053	-	416.439	0.048	-	415.984	0.043	-	416.245	0.040	-	416.038	0.037	-
OFF - ConstMin - Dumpers/Tenders	16	215.693	0.024	-	216.319	0.024	-	217.088	0.024	-	216.906	0.024	-	217.498	0.024	-
OFF - ConstMin - Excavators	23	323.955	0.035	-	323.774	0.035	-	323.956	0.035	-	323.780	0.035	-	324.100	0.035	-
OFF - ConstMin - Other Construction Equipment	14	352.350	0.037	-	352.428	0.037	-	352.345	0.037	-	352.346	0.037	-	352.278	0.037	-
OFF - ConstMin - Pavers	24	352.776	0.038	-	352.994	0.038	-	353.867	0.038	-	355.052	0.038	-	352.648	0.038	-
OFF - ConstMin - Paving Equipment	19	301.439	0.033	-	302.037	0.033	-	301.809	0.033	-	300.798	0.033	-	301.378	0.033	-
OFF - ConstMin - Plate Compactors	8	244.393	0.026	-	244.410	0.026	-	244.409	0.026	-	244.368	0.026	-	244.370	0.026	-
OFF - ConstMin - Rollers	12	318.218	0.033	-	318.228	0.033	-	318.254	0.033	-	318.234	0.033	-	318.200	0.033	-
OFF - ConstMin - Rubber Tired Loaders	25	306.838	0.033	-	307.631	0.033	-	307.344	0.033	-	306.288	0.033	-	307.054	0.033	-
OFF - ConstMin - Signal Boards	6	466.012	0.049	-	466.011	0.049	-	466.013	0.049	-	466.023	0.049	-	466.008	0.049	-
OFF - ConstMin - Skid Steer Loaders	20	312.583	0.035	-	312.559	0.035	-	312.567	0.034	-	312.563	0.034	-	312.564	0.034	-
OFF - ConstMin - Tractors/Loaders/Backhoes	23	312.495	0.034	-	312.625	0.034	-	312.588	0.034	-	312.500	0.034	-	312.612	0.034	-
OFF - ConstMin - Trenchers	22	426.250	0.046	-	426.410	0.046	-	425.937	0.046	-	426.076	0.046	-	425.703	0.046	-
OFF - Industrial - Aerial Lifts	17	261.445	0.029	-	261.450	0.029	-	261.461	0.029	-	261.474	0.029	-	261.457	0.029	-
OFF - Industrial - Other General Industrial Equipment	18	289.849	0.032	-	289.813	0.032	-	289.857	0.032	-	289.872	0.032	-	289.840	0.032	-
OFF - Industrial - Sweepers/Scrubbers	18	386.220	0.042	-	386.415	0.042	-	386.278	0.042	-	386.874	0.042	-	386.273	0.042	-
OFF - Light Commercial - Air Compressors	35	272.805	0.040	-	272.772	0.036	-	272.768	0.033	-	272.793	0.031	-	272.800	0.029	-
OFF - Light Commercial - Generator Sets	21	420.551	0.048	-	420.560	0.047	-	420.553	0.047	-	420.543	0.047	-	420.552	0.046	-
OFF - Light Commercial - Pressure Washers	21	171.473	0.019	-	171.839	0.019	-	171.620	0.019	-	170.941	0.019	-	171.212	0.019	-
OFF - Light Commercial - Pumps	18	420.527	0.051	-	420.531	0.050	-	420.569	0.049	-	420.537	0.048	-	420.568	0.048	-
OFF - Light Commercial - Welders	33	255.740	0.035	-	255.746	0.032	-	255.732	0.029	-	255.741	0.027	-	255.728	0.025	-
Portable Equipment - Non-Rental Compressor	167	154.587	0.015	-	156.272	0.014	-	157.976	0.013	-	159.698	0.013	-	161.439	0.012	-
Portable Equipment - Non-Rental Generator	369	154.587	0.012	-	156.272	0.011	-	157.976	0.011	-	159.698	0.010	-	161.439	0.010	-
Portable Equipment - Non-Rental Other Portable Equipment	407	154.587	0.012	-	156.272	0.011	-	157.976	0.010	-	159.698	0.010	-	161.439	0.009	-
Portable Equipment - Non-Rental Pump	197	154.587	0.014	-	156.272	0.013	-	157.976	0.012	-	159.698	0.011	-	161.439	0.011	-
Portable Equipment - Rental Compressor	361	154.587	0.012	-	156.272	0.011	-	157.976	0.011	-	159.698	0.010	-	161.439	0.010	-
Portable Equipment - Rental Generator	406	154.587	0.012	-	156.272	0.011	-	157.976	0.011	-	159.698	0.010	-	161.439	0.010	-
Portable Equipment - Rental Other Portable Equipment	657	154.587	0.012	-	156.272	0.011	-	157.976	0.010	-	159.698	0.010	-	161.439	0.009	-
Portable Equipment - Rental Pump	165	154.587	0.018	-	156.272	0.017	-	157.976	0.016	-	159.698	0.015	-	161.439	0.014	-

Source:
California Air Resources Board (CARB). 2017. OFFROAD2017 - ORION Web Database. Available online at https://www.arb.ca.gov/orion/ [Accessesd October 17, 2018].
Notes:
1. Horsepower used in modeling is average calculated from OFFROAD2017 (e.g., "Horsepower_Hours_hhpy" divided by "Total_Activity_hpy.")

San Luis Low Point Improvement Project
EMFAC2014 Emission Factor Summary

Table A-28. On-Road Medium-Duty Vehicle Diesel CO2 Emission Factors (San Joaquin Valley Air Basin), grams per hour

Speed	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
5	5,339.09	5,204.46	5,064.45	4,919.52	4,771.13	4,621.31	4,492.53	4,368.08	4,255.26	4,157.09	4,069.82
10	9,055.21	8,831.00	8,592.63	8,345.14	8,091.43	7,837.35	7,613.21	7,401.75	7,212.14	7,046.27	6,899.49
15	11,522.17	11,229.84	10,925.87	10,610.17	10,286.04	9,961.67	9,675.04	9,408.38	9,169.59	8,958.80	8,771.96
20	12,773.40	12,448.95	12,114.36	11,766.75	11,415.27	11,058.40	10,747.79	10,447.20	10,180.65	9,946.81	9,738.89
25	13,491.02	13,148.77	12,792.80	12,422.48	12,046.90	11,669.86	11,338.65	11,025.14	10,745.75	10,498.88	10,279.78
30	13,975.52	13,623.34	13,255.46	12,873.33	12,484.04	12,093.16	11,747.76	11,424.76	11,136.57	10,881.32	10,654.30
35	14,810.72	14,435.72	14,046.86	13,643.01	13,231.98	12,818.18	12,452.25	12,107.30	11,799.78	11,528.95	11,288.00
40	15,844.56	15,444.77	15,029.07	14,597.95	14,158.60	13,715.81	13,329.96	12,958.35	12,625.83	12,335.31	12,076.80
45	17,158.81	16,724.96	16,275.47	15,808.19	15,328.81	14,848.96	14,418.97	14,016.45	13,658.41	13,344.05	13,064.87
50	19,143.51	18,657.05	18,153.15	17,629.83	17,100.79	16,564.76	16,102.56	15,652.36	15,252.01	14,900.94	14,589.00
55	22,217.42	21,646.97	21,061.23	20,452.14	19,836.93	19,216.25	18,705.66	18,181.31	17,716.05	17,308.15	16,945.64
60	26,303.61	25,635.63	24,945.79	24,228.98	23,495.26	22,760.95	22,110.77	21,491.16	20,941.22	20,458.17	20,028.32
65	31,911.43	31,109.91	30,272.95	29,402.73	28,515.84	27,627.11	26,833.48	26,095.33	25,439.19	24,857.60	24,339.31
70	36,952.25	36,015.30	35,043.45	34,034.78	33,010.10	31,981.25	31,075.23	30,224.17	29,464.62	28,792.78	28,194.02

Table A-29. On-Road Medium-Duty Vehicle Diesel Emission Factors (San Francisco Bay Area Air Basin), grams per hour

Speed	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
5	5,335.24	5,190.32	5,042.84	4,891.44	4,738.47	4,585.27	4,453.02	4,333.36	4,226.99	4,134.20	4,051.88
10	9,061.54	8,815.38	8,564.04	8,305.84	8,044.73	7,783.39	7,556.62	7,352.88	7,172.74	7,014.92	6,874.88
15	11,585.95	11,266.48	10,941.40	10,607.53	10,270.71	9,933.31	9,640.98	9,377.80	9,143.99	8,939.20	8,757.65
20	12,725.83	12,379.54	12,026.54	11,663.95	11,298.07	10,931.80	10,615.58	10,331.46	10,080.08	9,860.21	9,665.16
25	13,455.78	13,089.96	12,716.94	12,333.81	11,947.09	11,559.93	11,225.43	10,924.85	10,659.01	10,426.39	10,220.02
30	13,938.32	13,559.46	13,173.55	12,777.18	12,377.30	11,976.86	11,631.74	11,320.71	11,045.15	10,804.57	10,591.21
35	14,784.54	14,379.20	13,966.55	13,542.89	13,115.40	12,687.24	12,318.41	11,985.46	11,690.32	11,433.46	11,206.00
40	15,779.91	15,348.81	14,909.89	14,458.98	14,003.72	13,548.11	13,155.84	12,801.57	12,487.59	12,214.53	11,972.77
45	17,063.49	16,603.53	16,134.97	15,653.57	15,168.04	14,681.66	14,262.38	13,884.17	13,548.71	13,255.23	12,994.54
50	19,040.69	18,523.59	17,996.69	17,455.74	16,909.48	16,362.56	15,891.68	15,467.11	15,091.43	14,764.05	14,473.93
55	22,145.35	21,544.69	20,932.70	20,304.08	19,670.03	19,034.75	18,487.21	17,992.60	17,554.13	17,171.58	16,832.19
60	26,111.76	25,403.47	24,681.94	23,941.23	23,194.31	22,446.14	21,801.74	21,222.00	20,708.94	20,260.34	19,862.33
65	31,823.18	30,948.94	30,059.10	29,145.79	28,223.56	27,300.60	26,506.23	25,790.37	25,156.66	24,605.57	24,118.01

San Luis Low Point Improvement Project
Lower San Felipe Intake Alternative - Tunnel Option
Haul Truck and Construction Worker Commuting Emissions

Construction Duration	47	months
	3.9	years
Months in Final Year	11	

Table A-30. Trip Rate Information

	Round Trips		One-Way Trips		One-Way Distance	VMT		Annual VMT	
Vehicle Type	**Max Day Trips**	**Total Trips**	**Max Day Trips**	**Total Trips**	**(miles)**	**Daily**	**Total**	**2020 - 2022**	**2023**
Dump Truck	6	100	12	200	40	480	8,000	2,043	1,872
Concrete Trucks	15	7,500	30	15,000	40	1,200	600,000	153,191	140,426
Delivery Trucks (non-soil)	5	1,300	10	2,600	40	400	104,000	26,553	24,340
Gravel/paving trucks	3	250	6	500	40	240	20,000	5,106	4,681
Haul trucks (soil)	40	19,420	80	38,840	5	400	194,200	49,583	45,451
Total Truck Trips	69	28,570	138	57,140	165	2,720	926,200	236,476	216,770
Workers	100	43,800	200	87,600	40	8,000	3,504,000	894,638	820,085
Grand Total	**169**	**72,370**	**338**	**144,740**	**205**	**10,720**	**4,430,200**	**1,131,114**	**1,036,855**

Source: EngineeringDataNeeds_July30_2012.xlsx
Note:
Assume earliest alternative could start would be 2020.

Table A-31. Annual Emissions

	Truck Emission Factors (g/mi)		1,628.32	0.0051	0.0048		1,611.17	0.0051	0.0048		1,593.35	0.0051	0.0048		1,538.91	0.0051	0.0048	
	Worker Emission Factors (g/mi)		308.94	0.1838	0.0762		297.33	0.1837	0.0761		285.97	0.1837	0.0761		274.71	0.1836	0.0761	
	Annual VMT (miles/year)		**Annual Emissions - 2020 (metric tons/year)**				**Annual Emissions - 2021 (metric tons/year)**				**Annual Emissions - 2022 (metric tons/year)**				**Annual Emissions - 2023 (metric tons/year)**			
Truck Type	**2020 - 2022**	**2023**	**CO2**	**CH4**	**N2O**	**CO2e**	**CO2**	**CH4**	**N2O**	**CO2e**	**CO2**	**CH4**	**N2O**	**CO2e**	**CO2**	**CH4**	**N2O**	**CO2e**
Dump Truck	2,043	1,872	3.33	0.00	0.00	3.33	3.29	0.00	0.00	3.29	3.26	0.00	0.00	3.26	2.88	0.00	0.00	2.88
Concrete Trucks	153,191	140,426	249.44	0.00	0.00	249.68	246.82	0.00	0.00	247.06	244.09	0.00	0.00	244.32	216.10	0.00	0.00	216.32
Delivery Trucks (non-soil)	26,553	24,340	43.24	0.00	0.00	43.28	42.78	0.00	0.00	42.82	42.31	0.00	0.00	42.35	37.46	0.00	0.00	37.50
Gravel/paving trucks	5,106	4,681	8.31	0.00	0.00	8.32	8.23	0.00	0.00	8.23	8.14	0.00	0.00	8.14	7.20	0.00	0.00	7.21
Haul trucks (soil)	49,583	45,451	80.74	0.00	0.00	80.81	79.89	0.00	0.00	79.96	79.00	0.00	0.00	79.08	69.95	0.00	0.00	70.02
Truck Subtotal	236,476	216,770	385.06	0.00	0.00	385.43	381.00	0.00	0.00	381.37	376.79	0.00	0.00	377.16	333.59	0.00	0.00	333.93
Workers	894,638	820,085	276.39	0.16	0.07	300.82	266.00	0.16	0.07	290.41	255.84	0.16	0.07	280.24	245.76	0.16	0.07	270.17
Grand Total	**1,131,114**	**1,036,855**	**661.45**	**0.17**	**0.07**	**686.25**	**647.00**	**0.17**	**0.07**	**671.78**	**632.62**	**0.17**	**0.07**	**657.40**	**579.35**	**0.17**	**0.07**	**604.10**
		GWP	1	25	298													

Start Year: 2020
Air Basin: San Joaquin Valley

Conversions

1,000,000 grams per metric ton

Lower San Felipe Intake Alternative - Pipeline Option
Haul Truck and Construction Worker Commuting Emissions

Construction Duration 33 months
2.8 years
Months in Final Year 9

Table A-32. Trip Rate Information

Vehicle Type	Round Trips		One-Way Trips		One-Way Distance	VMT		Annual VMT	
	Max Day Trips	Total Trips	Max Day Trips	Total Trips	(miles)	Daily	Total	2020 - 2021	2022
Dump Truck	6	100	12	200	40	480	8,000	2,909	2,182
Concrete Trucks	2	5	4	10	40	160	400	145	109
Delivery Trucks (non-soil)	5	1,950	10	3,900	40	400	156,000	56,727	42,545
Gravel/paving trucks	3	250	6	500	40	240	20,000	7,273	5,455
Haul trucks (soil)	2	4,100	4	8,200	5	20	41,000	14,909	11,182
Total Truck Trips	18	6,405	36	12,810	165	1,300	225,400	81,963	61,473
Workers	30	15,000	60	30,000	40	2,400	1,200,000	436,364	327,273
Grand Total	**48**	**21,405**	**96**	**42,810**	**205**	**3,700**	**1,425,400**	**518,327**	**388,746**

Source: EngineeringDataNeeds_July30_2012.xlsx
Note:
Assume earliest alternative could start would be 2020.

Table A-33. Annual Emissions

	Truck Emission Factors (g/mi)		1,628.32	0.0051	0.0048		1,611.17	0.0051	0.0048		1,593.35	0.0051	0.0048	
	Worker Emission Factors (g/mi)		308.94	0.1838	0.0762		297.33	0.1837	0.0761		285.97	0.1837	0.0761	
	Annual VMT (miles/year)		Annual Emissions - 2020 (metric tons/year)				Annual Emissions - 2021 (metric tons/year)				Annual Emissions - 2022 (metric tons/year)			
Truck Type	2020 - 2021	2022	CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e
Dump Truck	2,909	2,182	4.74	0.00	0.00	4.74	4.69	0.00	0.00	4.69	3.48	0.00	0.00	3.48
Concrete Trucks	145	109	0.24	0.00	0.00	0.24	0.23	0.00	0.00	0.23	0.17	0.00	0.00	0.17
Delivery Trucks (non-soil)	56,727	42,545	92.37	0.00	0.00	92.46	91.40	0.00	0.00	91.49	67.79	0.00	0.00	67.86
Gravel/paving trucks	7,273	5,455	11.84	0.00	0.00	11.85	11.72	0.00	0.00	11.73	8.69	0.00	0.00	8.70
Haul trucks (soil)	14,909	11,182	24.28	0.00	0.00	24.30	24.02	0.00	0.00	24.04	17.82	0.00	0.00	17.83
Truck Subtotal	81,963	61,473	133.46	0.00	0.00	133.59	132.06	0.00	0.00	132.18	97.95	0.00	0.00	98.04
Workers	436,364	327,273	134.81	0.08	0.03	146.73	129.74	0.08	0.03	141.65	93.59	0.06	0.02	102.52
Grand Total	**518,327**	**388,746**	**268.27**	**0.08**	**0.03**	**280.32**	**261.80**	**0.08**	**0.03**	**273.83**	**191.54**	**0.06**	**0.03**	**200.56**
		GWP	1	25	298									

Start Year: 2020
Air Basin: San Joaquin Valley

Conversions

1,000,000 grams per metric ton

Treatment Alternative
Haul Truck and Construction Worker Commuting Emissions

Construction Duration

Santa Teresa WTP — 36 months
3 years

Table A-34. Trip Rate Information

Vehicle Type	Round Trips		One-Way Trips		One-Way Distance	VMT		Annual VMT
	Max Day Trips	Total Trips	Max Day Trips	Total Trips	(miles)	Daily	Total	2020-2022
Dump Truck	2	302	4	604	10	40	6,040	2,013
Concrete Trucks	2	155	4	310	10	40	3,100	1,033
Delivery Trucks (non-soil)	3	604	6	1,208	25	150	30,200	10,067
Gravel/paving trucks	2	30	4	60	10	40	600	200
Haul trucks (soil)	2	279	4	558	15	60	8,370	2,790
Total Truck Trips	11	1,370	22	2,740	70	330	48,310	16,103
Workers	80	16,538	160	33,076	30	4,800	992,280	330,760
Grand Total	**91**	**17,908**	**182**	**35,816**	**100**	**5,130**	**1,040,590**	**346,863**

Source: EngineeringDataNeeds_July30_2012.xlsx

Note:

Assume earliest alternative could start would be 2020.

Table A-35. Annual Emissions

Truck Emission Factors (g/mi)		1,636.72	0.0051	0.0048		1,619.44	0.0051	0.0048		1,601.47	0.0051	0.0048	
Worker Emission Factors (g/mi)		298.78	0.1837	0.0763		287.63	0.1837	0.0763		276.51	0.1837	0.0763	
	Annual VMT (miles/year)	Annual Emissions - 2020 (metric tons)				Annual Emissions - 2021 (metric tons)				Annual Emissions - 2022 (metric tons)			
Truck Type	2020-2022	CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e
Dump Truck	2,013	3.29	0.00	0.00	3.30	3.26	0.00	0.00	3.26	3.22	0.00	0.00	3.23
Concrete Trucks	1,033	1.69	0.00	0.00	1.69	1.67	0.00	0.00	1.67	1.65	0.00	0.00	1.66
Delivery Trucks (non-soil)	10,067	16.48	0.00	0.00	16.49	16.30	0.00	0.00	16.32	16.12	0.00	0.00	16.14
Gravel/paving trucks	200	0.33	0.00	0.00	0.33	0.32	0.00	0.00	0.32	0.32	0.00	0.00	0.32
Haul trucks (soil)	2,790	4.57	0.00	0.00	4.57	4.52	0.00	0.00	4.52	4.47	0.00	0.00	4.47
Truck Subtotal	16,103	26.36	0.00	0.00	26.38	26.08	0.00	0.00	26.10	25.79	0.00	0.00	25.81
Workers	330,760	98.82	0.06	0.03	107.86	95.14	0.06	0.03	104.17	91.46	0.06	0.03	100.50
Grand Total	**346,863**	**125.18**	**0.06**	**0.03**	**134.24**	**121.21**	**0.06**	**0.03**	**130.28**	**117.25**	**0.06**	**0.03**	**126.31**
		GWP	1	25	298								

Start Year: 2020
Air Basin: San Francisco Bay Area

Conversions

1,000,000 grams per metric ton

Emission Factors - Weighted Average

Table A-36. Emission Factors (grams per mile)

Air Basin	Year	Trucks			Workers		
		CO2	CH4	N2O	CO2	CH4	N2O
San Joaquin Valley	2020	1,628.322	0.0051	0.0048	308.945	0.1838	0.0762
	2021	1,611.170	0.0051	0.0048	297.328	0.1837	0.0761
	2022	1,593.346	0.0051	0.0048	285.965	0.1837	0.0761
	2023	1,538.912	0.0051	0.0048	274.706	0.1836	0.0761
San Francisco Bay Area	2020	1,636.721	0.0051	0.0048	298.775	0.1837	0.0763
	2021	1,619.438	0.0051	0.0048	287.628	0.1837	0.0763
	2022	1,601.474	0.0051	0.0048	276.506	0.1837	0.0763
	2023	1,546.356	0.0051	0.0048	265.441	0.1837	0.0763

CH4 and N2O Emission Factors

Table A-37. San Joaquin Valley Air Basin Emission Factors

Year	Type	Fuel	VMT	CH4 (g/mi)	N2O (g/mi)
2020	LDA	GAS	51,905,504	0.1780	0.0647
		DSL	526,303	0.0006	0.0012
	LDT1	GAS	3,603,221	0.2024	0.1056
		DSL	4,007	0.0011	0.0017
	LDT2	GAS	18,124,513	0.2024	0.1056
		DSL	31,156	0.0011	0.0017
	Weighted Average Emission Factor (2020), grams per mile			**0.1838**	**0.0762**
2021	LDA	GAS	53,113,271	0.1780	0.0647
		DSL	564,773	0.0006	0.0012
	LDT1	GAS	3,581,948	0.2024	0.1056
		DSL	3,767	0.0011	0.0017
	LDT2	GAS	18,596,624	0.2024	0.1056
		DSL	33,720	0.0011	0.0017
	Weighted Average Emission Factor (2021), grams per mile			**0.1837**	**0.0761**
2022	LDA	GAS	54,099,432	0.1780	0.0647
		DSL	599,371	0.0006	0.0012
	LDT1	GAS	3,567,882	0.2024	0.1056
		DSL	3,563	0.0011	0.0017
	LDT2	GAS	19,045,161	0.2024	0.1056
		DSL	35,993	0.0011	0.0017
	Weighted Average Emission Factor (2022), grams per mile			**0.1837**	**0.0761**
2023	LDA	GAS	55,046,389	0.1780	0.0647
		DSL	632,276	0.0006	0.0012
	LDT1	GAS	3,568,656	0.2024	0.1056
		DSL	3,380	0.0011	0.0017
	LDT2	GAS	19,525,102	0.2024	0.1056
		DSL	38,163	0.0011	0.0017
	Weighted Average Emission Factor (2023), grams per mile			**0.1836**	**0.0761**

Table A-38. San Francisco Bay Area Air Basin County Emission Factors

Year	Type	Fuel	VMT	CH4 (g/mi)	N2O (g/mi)
2020	LDA	GAS	93,944,227	0.1780	0.0647
		DSL	1,057,189	0.0006	0.0012
	LDT1	GAS	6,961,771	0.2024	0.1056
		DSL	5,656	0.0011	0.0017
	LDT2	GAS	33,008,227	0.2024	0.1056
		DSL	64,034	0.0011	0.0017
	Weighted Average Emission Factor (2020), grams per mile			**0.1837**	**0.0763**
2021	LDA	GAS	94,103,223	0.1780	0.0647
		DSL	1,091,742	0.0006	0.0012
	LDT1	GAS	6,877,710	0.2024	0.1056
		DSL	5,385	0.0011	0.0017
	LDT2	GAS	33,244,983	0.2024	0.1056
		DSL	66,742	0.0011	0.0017
	Weighted Average Emission Factor (2021), grams per mile			**0.1837**	**0.0763**
2022	LDA	GAS	93,958,360	0.1780	0.0647
		DSL	1,119,674	0.0006	0.0012
	LDT1	GAS	6,799,689	0.2024	0.1056
		DSL	5,169	0.0011	0.0017
	LDT2	GAS	33,430,716	0.2024	0.1056
		DSL	68,832	0.0011	0.0017
	Weighted Average Emission Factor (2022), grams per mile			**0.1837**	**0.0763**
2023	LDA	GAS	93,832,714	0.1780	0.0647
		DSL	1,145,151	0.0006	0.0012
	LDT1	GAS	6,746,772	0.2024	0.1056
		DSL	4,980	0.0011	0.0017
	LDT2	GAS	33,675,803	0.2024	0.1056
		DSL	70,749	0.0011	0.0017
	Weighted Average Emission Factor (2023), grams per mile			**0.1837**	**0.0763**

Table A-39. Emission Factors for Highway Vehicles by Technology Type

Vehicle Type/ Control Technology	CH4 (g/mi)	N2O (g/mi)
Gasoline Passenger Cars		
EPA Tier 2	0.0173	0.0036
Low Emission Vehicles	0.0105	0.0150
EPA Tier 1	0.0271	0.0429
EPA Tier 0	0.0704	0.0647
Oxidation Catalyst	0.1355	0.0504
Non-Catalyst Control	0.1696	0.0197
Uncontrolled	0.1780	0.0197
Gasoline Light Trucks (Vans, Pickup Trucks, SUVs)		
EPA Tier 2	0.0163	0.0066
Low Emission Vehicles	0.0148	0.0157
EPA Tier 1	0.0452	0.0871
EPA Tier 0	0.0776	0.1056
Oxidation Catalyst	0.1516	0.0639
Non-Catalyst Control	0.1908	0.0218
Uncontrolled	0.2024	0.0220
Gasoline Medium and Heavy-Duty Vehicles (Trucks and Busses)		
EPA Tier 2	0.0333	0.0134
Low Emission Vehicles	0.0303	0.0320
EPA Tier 1	0.0655	0.1750
EPA Tier 0	0.2630	0.2135
Oxidation Catalyst	0.2356	0.1317
Non-Catalyst Control	0.4181	0.0473
Uncontrolled	0.4604	0.0497
Diesel Passenger Cars		
Advanced	0.0005	0.0010
Moderate	0.0005	0.0010
Uncontrolled	0.0006	0.0012
Diesel Light Trucks		
Advanced	0.0010	0.0015
Moderate	0.0009	0.0014
Uncontrolled	0.0011	0.0017
Diesel Medium and Heavy-Duty Vehicles (Trucks and Busses)		
Aftertreatment	0.0051	0.0048
Advanced	0.0051	0.0048
Moderate	0.0051	0.0048
Uncontrolled	0.0051	0.0048
Motorcycles		
Non-Catalyst Control	0.0672	0.0069
Uncontrolled	0.0899	0.0087

Source:

2018 Climate Registry Default Emissions Factors

Table 13.4 Default CH4 and N2O Emission Factors for Highway Vehicles by Technology Type

https://www.theclimateregistry.org/wp-content/uploads/2018/06/The-Climate-Registry-2018-Default-Emission-Factor-Document.

Lower San Felipe Intake Alternative - Tunnel Option
Marine Emissions

Table A-40. Propulsion Engine Emission Factors

Vessel Type	Average HP	Fuel Consumption (lb/hr)	Fuel Consumption (gal/hr)	Emission Factor (kg/hr) CO2	CH4	N2O
Tug Boats	1,274	517	72	735.27	0.004	0.032
Crew and Supply	439	178	25	253.36	0.001	0.011

Note:
Barges and dredgers are not typically self-propelled and emissions from barge/dredger propulsion engines are not estimated.

Table A-41. Auxiliary Engine Emission Factors

Vessel Type	Average HP	Fuel Consumption (lb/hr)	Fuel Consumption (gal/hr)	Emission Factor (kg/hr) CO2	CH4	N2O
Tug Boats	111	45	6	64.06	0.0004	0.0028
Crew and Supply	79	32	4	45.59	0.0003	0.0020

Construction Start Date 2020

Table A-42. Annual Marine Vessel Emissions

Vessel Type	Quantity	Trips per project	Hours per Trip	No. Propulsion Engines	No. Auxiliary Engines	Propulsion Engine Emissions (MT/project) CO2	CH4	N2O	CO2e	Auxiliary Engine Emissions (MT/project) CO2	CH4	N2O	CO2e	Total Engine Emissions (MT/project) CO2	CH4	N2O	CO2e
Tug Boats	2	270	2	2	2	1,588.19	0.01	0.07	1,609.28	138.37	0.00	0.01	140.21	1,726.56	0.01	0.08	1,749.49
Crew and Supply	2	270	2	3	1	820.90	0.00	0.04	831.80	49.24	0.00	0.00	49.90	870.14	0.01	0.04	881.69
Total	**4**	**540**	**4**	**5**	**3**	**2,409.09**	**0.01**	**0.11**	**2,441.08**	**187.62**	**0.00**	**0.01**	**190.11**	**2,596.70**	**0.02**	**0.11**	**2,631.19**
GWP						1		25	298								

Note:
Hours per trip estimated to assume that marine vessels would be operating 8 hours per day.
"Trips" represent one-day trips and are double the data provided by the engineers.

Table A-43. Annual Marine Vessel Emissions by Year

Vessel Type	Annual Emissions - 2021 (metric tons per year) CO2	CH4	N2O	CO2e	Annual Emissions - 2022 (metric tons per year) CO2	CH4	N2O	CO2e	Annual Emissions - 2023 (metric tons per year) CO2	CH4	N2O	CO2e
Tug Boats	604.30	0.00	0.03	612.32	1,035.94	0.01	0.05	1,049.70	86.33	0.00	0.00	87.47
Crew and Supply	304.55	0.00	0.01	308.59	522.08	0.00	0.02	529.02	43.51	0.00	0.00	44.08
Total	**908.85**	**0.01**	**0.04**	**920.92**	**1,558.02**	**0.01**	**0.07**	**1,578.71**	**129.84**	**0.00**	**0.01**	**131.56**

Conversion Factors

453.6 grams per pound
1,000 kilograms per metric ton
1,000 grams per kilogram

BSFC = 184 g/hp-hr (http://www.arb.ca.gov/regact/2007/chc07/appb.pdf)

Density

0.86 g/mL
7.18 lb/gal

Lower San Felipe Intake Alternative - Pipeline Option
Marine Emissions

Table A-44. Propulsion Engine Emission Factors

Vessel Type	Average HP	Fuel Consumption (lb/hr)	Fuel Consumption (gal/hr)	Emission Factor (kg/hr) CO2	CH4	N2O
Tug Boats	1,274	517	72	735.27	0.004	0.032
Crew and Supply	439	178	25	253.36	0.001	0.011

Note:
Barges and dredgers are not typically self-propelled and emissions from barge/dredger propulsion engines are not estimated.

Table A-45. Auxiliary Engine Emission Factors

Vessel Type	Average HP	Fuel Consumption (lb/hr)	Fuel Consumption (gal/hr)	Emission Factor (kg/hr) CO2	CH4	N2O
Tug Boats	111	45	6	64.06	0.0004	0.0028
Crew and Supply	79	32	4	45.59	0.0003	0.0020

Construction Start Date 2020

Table A-46. Annual Marine Vessel Emissions

Vessel Type	Quantity	Trips per project	Hours per Trip	No. Propulsion	No. Auxiliary	Propulsion Engine Emissions (MT/project) CO2	CH4	N2O	CO2e	Auxiliary Engine Emissions (MT/project) CO2	CH4	N2O	CO2e	Total Engine Emissions (MT/project) CO2	CH4	N2O	CO2e
Tug Boats	4	739	2	2	2	8,693.87	0.05	0.38	8,809.33	757.47	0.00	0.03	767.53	9,451.34	0.06	0.42	9,576.86
Crew and Supply	4	739	2	3	1	4,493.65	0.03	0.20	4,553.33	269.55	0.00	0.01	273.13	4,763.20	0.03	0.21	4,826.46
Total	**8**	**1,478**	**4**	**5**	**3**	**13,187.52**	**0.08**	**0.58**	**13,362.67**	**1,027.02**	**0.01**	**0.05**	**1,040.66**	**14,214.54**	**0.08**	**0.63**	**14,403.33**
					GWP	1	25	298									

Note:
Hours per trip estimated to assume that marine vessels would be operating 8 hours per day.
"Trips" represent one-day trips and are double the data provided by the engineers.

Table A-47. Annual Marine Emissions by Year

Vessel Type	Annual Emissions - 2021 (metric tons per year) CO2	CH4	N2O	CO2e	Annual Emissions - 2022 (metric tons per year) CO2	CH4	N2O	CO2e
Tug Boats	8,663.73	0.05	0.38	8,778.79	787.61	0.00	0.03	798.07
Crew and Supply	4,366.27	0.03	0.19	4,424.26	396.93	0.00	0.02	402.21
Total	**13,030.00**	**0.08**	**0.57**	**13,203.05**	**1,184.55**	**0.01**	**0.05**	**1,200.28**

Conversion Factors
453.6 grams per pound
1,000 kilograms per metric ton
1,000 grams per kilogram

BSFC = 184 g/hp-hr (http://www.arb.ca.gov/regact/2007/chc07/appb.pdf)

Density
0.86 g/mL
7.18 lb/gal

Lower San Felipe Intake Alternative
Data Tables

Table A-48. California Commercial Harbor Craft Engine Profile by Vessel Type

	Propulsion Engine			Auxiliary Engine		
Vessel Type	# of Engines per Vessel	Average Annual Operating Hrs	Useful Life	# of Engines per Vessel	Average Annual Operating Hrs	Useful Life
Commercial Fishing	1.12	1,250	21	0.46	1,633	15
Charter Fishing	1.77	1,622	16	0.75	2,077	15
Ferry/excursion Vessels	2.01	1,843	20	1.23	1,254	20
Crew and Supply	2.5	788	22	1.1	3,036	22
Pilot Vessels	1.7	1,031	19	0.14	994	25
Tug Boats	1.92	2,274	21	1.59	2,486	23
Tow Boats	2.1	1,993	26	1.17	2,965	25
Work Boats	1.46	675	17	0.32	750	23
Others	1.11	779	23	0.46	805	22

Source: California Air Resources Board (CARB). Emissions Estimation Methodology for Commercial Harbor Craft Operating in California, Appendix B [2007 Rulemaking], Available online at: http://www.arb.ca.gov/regact/2007/chc07/appb.pdf [Accessed on: June 15, 2016].

Table A-49. Quantity of Auxiliary Engines and Average Horsepower

	# Auxiliary	Horsepower			
Vessel Category	Engines	Range	Average	min	max
Commercial Fishing	212	6 - 300	71	30	111
Tug Boats	120	7 - 300	111		
Ferry/excursion Vessels	98	10 - 400	94		
Charter Fishing	82	4 - 185	50		
Others	34	10 - 240	56		
Work Boats	26	9 - 221	101		
Crew and Supply	22	16 - 110	79		
Tow Boats	21	18 - 175	79		
Pilot Vessels	1	N/A	30		

Source: CARB. 2004. Statewide Commercial Harbor Craft Survey, Final Report. March. Available online at: http://www.arb.ca.gov/ports/marinevess/documents/hcsurveyrep0304.pdf [Accessed on: June 15, 2016].

Note:

Vessel categories changed from cited document to be consistent with names used in 2007 and 2010 rulemaking documents to assist with VLOOKUP formulas.

Table A-50. Quantity of Propulsion Engines and Average Horsepower

	# Propulsion	Horsepower			
Vessel Category	Engines	Range	Average	min	max
Commercial Fishing	516	8 – 1,485	230	230	1274
Charter Fishing	192	80 – 1,400	381		
Ferry/excursion Vessels	164	35 – 3,110	733		
Tug Boats	144	24 – 3,600	1,274		
Work Boats	99	15 – 1,300	239		
Others	89	28 - 764	281		
Crew and Supply	50	225 - 750	439		
Tow Boats	38	24 – 1,500	500		
Pilot Vessels	15	230 - 550	408		

Source: CARB. 2004. Statewide Commercial Harbor Craft Survey, Final Report. March. Available online at: http://www.arb.ca.gov/ports/marinevess/documents/hcsurveyrep0304.pdf [Accessed on: June 16, 2016].

Note:

Vessel categories changed from cited document to be consistent with names used in 2007 and 2010 rulemaking documents to assist with VLOOKUP formulas.

GHG Emission Factors

Table A-51. US Default CO2 Emission Factors for Transport Fuels

Fuel Type	Carbon Content (Per Unit Energy)	Heat Content	Fraction Oxidized	CO2 Emission Factor (Per Unit Volume)
Fuels Measured in Gallons	**kg C / MMBtu**	**MMBtu / barrel**		**kg CO2 / gallon**
Gasoline	19.2	5.25	1	8.78
Diesel Fuel	20.2	5.80	1	10.21
Aviation Gasoline	18.9	5.04	1	8.31
Jet Fuel (Jet A or A-1)	19.7	5.67	1	9.75
Kerosene	20.5	5.67	1	10.15
Residual Fuel Oil No. 5	19.9	5.88	1	10.21
Residual Fuel Oil No. 6	20.5	6.30	1	11.27
Crude Oil	20.3	5.80	1	10.29
Biodiesel (B100)	20.1	5.38	1	9.45
Ethanol (E100)	18.7	3.53	1	5.75
Methanol	NA	NA	1	4.10
Liquefied Natural Gas (LNG)	NA	NA	1	4.46
Liquefied Petroleum Gas (LPG)	17.2	3.86	1	5.68
Propane (Liquid)	16.8	3.82	1	5.72
Ethane	17.1	2.86	1	4.11
Isobutane	17.7	4.16	1	6.30
Butane	17.8	4.33	1	6.54
Renewable Diesel (R100)	20.2	5.80	1	10.21
Fuels Measured in Standard Cubic Feet	**kg C / MMBtu**	**Btu / Standard cubic foot**		**kg CO2 / Standard cubic foot**
Compressed Natural Gas (CNG)	14.5	1,027	1	0.05444
Propane (Gas)	16.8	2,516	1	0.15
Renewable Diesel (R100)	14.5	1,027	1	0

Source: 2018 Climate Registry Default Emission Factors, Table 13.1
https://www.theclimateregistry.org/wp-content/uploads/2018/06/The-Climate-Registry-2018-Default-Emission-Factor-Document.p

Table A-52. US Default CH4 and N2O Emission Factors for Non-Highway Vehicles

Vehicle Type / Fuel Type	CH4 (g / gallon)	N2O (g / gallon)
Ships and Boats		
Residual Fuel Oil	0.11	0.60
Diesel Fuel	0.06	0.45
Gasoline	0.64	0.22
Locomotives		
Diesel Fuel	0.80	0.26
Agricultural Equipment		
Gasoline	1.26	0.22
Diesel Fuel	1.44	0.26
Construction/Mining Equipment		
Gasoline	0.50	0.22
Diesel Fuel	0.58	0.26
Other Non-Highway		
Snowmobiles (Gasoline)	0.50	0.22
Other Recreational (Gasoline)	0.50	0.22
Other Small Utility (Gasoline)	0.50	0.22
Other Large Utility (Gasoline)	0.50	0.22
Other Large Utility (Diesel)	0.58	0.26
Aircraft		
Jet Fuel	0.00	0.31
Aviation Gasoline	7.05	0.11

Source: 2018 Climate Registry Default Emission Factors, Table 13.7
https://www.theclimateregistry.org/wp-content/uploads/2018/06/The-Climate-Registry-2018-Default-Emission-Factor-Document.p

Lower San Felipe Intake Alternative - Pipeline Option
Dredge Emissions

Start Year 2021

Table A-53. Auxiliary Engine Emission Factors

Type	Size (hp)	Fuel Consumption		Emission Factor (kg/hr)		
		(lb/hr)	(gal/hr)	CO2	CH4	N2O
Compressor	353	143	20	203.73	0.0012	0.0090
Crane	377	153	21	217.58	0.0013	0.0096
Deck door engine	86	35	5	49.63	0.0003	0.0022
Generator	464	188	26	267.79	0.0016	0.0118
Hoist swing winch	379	154	21	218.74	0.0013	0.0096
Other	390	158	22	225.08	0.0013	0.0099
Pump	518	210	29	298.96	0.0018	0.0132

Table A-54. Annual Emissions

Type	Quantity	Hours/ Day	Total Emissions (metric tons per project)				Annual Emissions - 2021 (tons per year)				Annual Emissions - 2022 (tons per year)			
			CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e	CO2	CH4	N2O	CO2e
Compressor	12	8	19.56	0.00	0.00	19.82	17.93	0.00	0.00	18.17	1.63	0.00	0.00	1.65
Crane	12	8	20.89	0.00	0.00	21.17	19.15	0.00	0.00	19.40	1.74	0.00	0.00	1.76
Deck door engine	12	8	4.76	0.00	0.00	4.83	4.37	0.00	0.00	4.43	0.40	0.00	0.00	0.40
Generator	12	8	25.71	0.00	0.00	26.05	23.57	0.00	0.00	23.88	2.14	0.00	0.00	2.17
Hoist swing winch	12	8	21.00	0.00	0.00	21.28	19.25	0.00	0.00	19.50	1.75	0.00	0.00	1.77
Other	12	8	21.61	0.00	0.00	21.90	19.81	0.00	0.00	20.07	1.80	0.00	0.00	1.82
Pump	12	8	28.70	0.00	0.00	29.08	26.31	0.00	0.00	26.66	2.39	0.00	0.00	2.42
Total			142.23	0.00	0.01	144.11	**130.37**	**0.00**	**0.01**	**132.10**	**11.85**	**0.00**	**0.00**	**12.01**
		GWP	1	25	298									

Conversions

453.6 grams per pound
1,000 kilograms per metric ton
1,000 grams per kilogram

Dredge Trips

1 dredge (1 trip per day)
12 trips per project

BSFC = 184 g/hp-hr (http://www.arb.ca.gov/regact/2007/chc07/appb.pdf)

Density

0.86 g/mL
7.18 lb/gal

Lower San Felipe Intake Alternative - Pipeline Option

Table A-55. Sample Auxiliary Engine Data

VES	MY	Engine_tier	hp	AnnualHrs	SulfurContent
Generator	2001	1	95	890	15
Pump	2001	1	156	991	15
Pump	2001	1	156	1077	15
Pump	2001	1	255	1420	15
Pump	2001	1	255	726	15
Pump	2001	1	371	350	15
Pump	2001	1	371	412	15
Pump	2001	1	371	444	15
Pump	2001	1	371	408	15
Generator	2001	1	95	205	15
Pump	2001	1	156	1276	15
Pump	2001	1	156	571	15
Pump	2001	1	255	851	15
Pump	2001	1	255	932	15
Pump	2001	1	371	510	15
Pump	2001	1	371	79	15
Pump	2001	1	371	87	15
Pump	2001	1	371	546	15
Generator	2001	1	95	1853	15
Pump	2001	1	156	1511	15
Pump	2001	1	156	953	15
Pump	2001	1	255	111	15
Pump	2001	1	255	1362	15
Pump	2001	1	371	583	15
Pump	2001	1	371	213	15
Pump	2001	1	371	207	15
Pump	2001	1	371	764	15
Generator	2001	1	95	273	15
Pump	2001	1	156	1330	15
Pump	2001	1	156	637	15
Pump	2001	1	255	994	15
Pump	2001	1	255	1220	15
Pump	2001	1	371	589	15
Pump	2001	1	371	148	15
Pump	2001	1	371	159	15
Pump	2001	1	371	751	15
Generator	2004	1	95	220	15
Pump	2004	1	1900	1500	15
Pump	2004	1	1900	1500	15
Generator	2006	2	95	250	15
Pump	2006	1	1900	1500	15
Pump	2006	1	1900	1500	15
Generator	2008	3	95	1	15
Pump	2008	2	1900	1	15
Pump	2008	2	1900	1	15
Generator	1976	0	46	1	15
Pump	1976	0	160	1	15
Pump	1976	0	200	1	15
Pump	1976	0	200	1	15
Pump	1976	0	200	1	15
Pump	1990	0	160	1	15
Pump	1990	0	160	1	15
Pump	1990	0	160	1	15

Lower San Felipe Intake Alternative - Pipeline Option

Table A-55. Sample Auxiliary Engine Data

VES	MY	Engine_tier	hp	AnnualHrs	SulfurContent
Pump	1990	0	160	1	15
Pump	1990	0	160	1	15
Pump	1990	0	160	1	15
Generator	1999	1	202	1	15
Compressor	1997	1	80	91	15
Crane	1978	0	287	290	15
Other	1996	0	90	670	15
Hoist swing winch	1960	0	120	8	15
Hoist swing winch	1988	0	185	12	15
Compressor	1969	0	250	17	15
Crane	1966	0	185	450	15
Hoist swing winch	1960	0	45	30	15
Hoist swing winch	1988	0	110	24	15
Hoist swing winch	1974	0	270	0	15
Hoist swing winch	1988	0	291	0	15
Hoist swing winch	1988	0	318	0	15
Compressor	2001	1	71	160	15
Crane	1945	0	316	59	15
Hoist swing winch	1988	0	185	6	15
Hoist swing winch	1969	0	194	5	15
Generator	1998	1	77	55	15
Crane	2005	2	445	1050	15
Hoist swing winch	1988	0	120	26	15
Hoist swing winch	1988	0	210	2	15
Compressor	2007	2	65	360	15
Pump	2008	3	665	800	15
Pump	2008	3	665	1210	15
Pump	2008	3	665	625	15
Pump	2008	3	665	520	15
Pump	2008	3	665	0	15
Pump	2008	3	665	0	15
Other	1999		126	620	15
Hoist swing winch	1988	0	160	90	15
Hoist swing winch	1978	0	100	528	15
Other	1999	1	65	637	15
Other	1999	1	350	445	15
Other	1999	1	350	445	15
Pump	2000	2	409	1497	15
Pump	2000	2	409	562	15
Other	1999	1	65	858	15
Other	1999	1	65	912	15
Other	2002	1	126	1536	15
Other	2002	2	440	193	15
Other	2002	2	440	180	15
Other	2001	1	1100	600	15
Dredger	2006	3	665	0	15
Dredger	2006	3	665	0	15
Dredger	2006	3	665	0	15
Dredger	2003	2	425	0	15
Dredger	2003	2	425	0	15
Dredger	2003	2	425	0	15
Dredger	2003	2	425	0	15
Other	1984	0	265	4284	15

Lower San Felipe Intake Alternative - Pipeline Option

Table A-55. Sample Auxiliary Engine Data

VES	MY	Engine_tier	hp	AnnualHrs	SulfurContent
Other	1984	0	304	257	15
Other	1984	0	375	600	15
Other	1983	0	1000	1390	15
Other	2007	3	765	183	15
Other	2006	3	300	5	15
Other	2007	3	700	183	15
Other	2006	3	540	183	15
Other	2006	3	300	5	15
Other	1999	1	210	150	15
Other	2001	1	2934	1300	15
Other	2003	2	106	1300	15
Other	2006	3	225	213	15
Other	2005	2	440	213	15
Other	2006	3	350	213	15
Other	2006	3	225	15	15
Other	1999	1	180	60	15
Other	1999	1	180	60	15
Hoist swing winch	2007	3	185	24	15
Deck door engine	1970	0	86	1400	15
Generator	1999	1	349	2209	15
Other	2002	2	425	1531	15
Hoist swing winch	1997	1	180	200	15
Pump	1997	0	60	200	15
Hoist swing winch	1997	1	228	200	15
Hoist swing winch	1997	1	180	200	15
Deck door engine	1970	0	86	1400	15
Other	2006	3	375	500	15
Hoist swing winch	1970	0	238	280	15
Generator	2000	1	49	100	15
Pump	2003	2	460	1325	15
Other	1998	1	400	1865	15
Generator	1991	0	685	1825	15
Pump	1966	0	1846	1410	15
Pump	1986	0	1325	0	15
Other	1991	0	390	0	15
Pump	2002	2	425	471	15
Pump	2002	2	425	354	15
Pump	2002	2	425	121	15
Pump	2002	2	425	55	15
Generator	2002	1	190	589	15
Generator	2002	1	190	1319	15
Pump	2002	2	500	388	15
Pump	2002	2	500	415	15
Generator	2002	1	166	589	15
Generator	2002	1	166	1319	15
Pump	2005	2	500	229	15
Pump	2005	2	500	247	15
Compressor	2005	2	500	180	15
Compressor	2005	2	500	169	15
Generator	2005	2	219	1618	15
Generator	2005	2	219	713	15
Pump	2006	3	425	606	15
Pump	2006	3	425	276	15

Lower San Felipe Intake Alternative - Pipeline Option

Table A-55. Sample Auxiliary Engine Data

VES	MY	Engine_tier	hp	AnnualHrs	SulfurContent
Pump	2006	3	425	654	15
Pump	2006	3	425	213	15
Generator	2005	2	219	1798	15
Generator	2005	2	219	628	15
Compressor	2006	3	425	391	15
Compressor	2006	3	425	483	15
Compressor	2003	2	425	346	15
Pump	2006	3	425	189	15
Pump	2006	3	425	195	15
Pump	2006	3	425	546	15
Pump	2006	3	425	535	15
Generator	2007	3	237	628	15
Generator	2007	3	237	1074	15
Compressor	2006	3	500	468	15
Compressor	2006	3	500	451	15
Compressor	2003	2	500	428	15
Pump	2003	2	500	1487	15
Pump	2003	2	500	1464	15
Generator	2004	2	219	1626	15
Generator	2004	2	219	734	15
Other	1997	1	225	520	15
Other	2000	1	210	0	15
Crane	1998	0	650	1	15
Generator	1985	0	38	0.25	15
Hoist swing winch	1999	1	120	0.25	15
Hoist swing winch	1985	0	365	0.25	15
Other	2004	2	72	6710	15
Other	2004	2	72	806	15
Other	2004	2	325	90	15
Other	2004	2	325	266	15
Other	2003	1	5	3500	15
Other	2003	1	15	250	15
Other	2003	1	15	250	15
Other	1983	0	325	468	15
Other	1983	0	325	468	15
Other	1993	0	160	1076	15
Other	1999	1	300	0	15
Other	1999	1	300	0	15
Other	1999	1	276.7857143	0	15
Other	1999	1	276.7857143	0	15
Other	1999	1	276.7857143	0	15
Other	2003	1	72	0	15
Other	2003	1	72	0	15
Other	2003	2	300	0	15
Other	2003	2	300	0	15
Other	1999	0	325	519	15
Other	1999	0	325	519	15
Other	1999	0	90	580	15
Other	2003	1	90	684	15
Other	2003	2	325	80	15
Other	2003	2	325	84	15
Other	1993	0	250	290	15
Other	1993	0	250	290	15

Lower San Felipe Intake Alternative - Pipeline Option

Table A-55. Sample Auxiliary Engine Data

VES	MY	Engine_tier	hp	AnnualHrs	SulfurContent
Other	1993	0	276.7857143	758	15
Other	1993	0	276.7857143	1778	15
Other	1993	0	250	375	15
Other	1992	0	250	504	15
Other	2001	2	325	265	15
Other	2001	2	325	265	15
Other	2006	2	40	280	15
Other	1975	0	210	135	15
Other	1975	0	120	135	15
Other	1975	0	96	322	15
Other	1975	0	120	322	15
Other	1984	0	211	191	15
Other	1984	0	211	191	15
Other	1984	0	211	406	15
Other	1984	0	211	406	15
Other	1980	0	260	103	15
Other	1980	0	260	103	15
Other	1971	0	120	69	15
Other	1971	0	96	69	15
Other	2008	3	225	83	15
Other	2008	3	225	83	15
Other	1975	0	120	200	15
Other	1975	0	120	90	15
Other	1975	0	120	50	15
Other	1975	0	120	50	15
Other	1975	0	96	550	15
Other	1975	0	210	550	15
Pump	2007	3	155	200	15
Pump	2007	3	280	580	15
Pump	2007	3	517.7849462	1300	15
Pump	2003	1	100	185	15
Pump	2003	1	100	190	15
Generator	1999	1	31	375	15
Pump	2007	3	173	130	15
Pump	2007	3	173	400	15
Generator	2006	2	55	500	15
Pump	2000	1	170	500	15
Pump	2000	1	170	500	15
Generator	2006	2	32	300	15
Other	1999	1	100	159	15
Hoist swing winch	1982	0	478	81.775	15
Generator	2002	2	440	748.0431034	15
Other	1999	1	500	771.1818182	15
Other	1999	1	500	771.1818182	15
Pump	1999	0	1500	560.954023	15
Pump	1999	0	1500	560.954023	15
Generator	1999	1	359	748.0431034	15
Generator	1995	0	230	748.0431034	15
Generator	1999	1	359	748.0431034	15
Pump	2001	1	2500	560.954023	15
Hoist swing winch	1980	0	400	81.775	15
Generator	2002	1	335	748.0431034	15
Generator	2002	2	425	748.0431034	15

Lower San Felipe Intake Alternative - Pipeline Option

Table A-55. Sample Auxiliary Engine Data

VES	MY	Engine_tier	hp	AnnualHrs	SulfurContent
Hoist swing winch	2002	2	440	81.775	15
Hoist swing winch	1997	1	290	81.775	15
Hoist swing winch	2004	2	300	81.775	15
Generator	2000	2	550	748.0431034	15
Hoist swing winch	2000	1	211	81.775	15
Generator	1998	0	2600	748.0431034	15
Generator	1998	0	2600	748.0431034	15
Generator	1998	0	2600	748.0431034	15
Generator	1998	1	550	748.0431034	15
Generator	1998	0	2600	748.0431034	15
Generator	1989	1	500	748.0431034	15
Generator	1974	0	245	748.0431034	15
Hoist swing winch	1974	0	243	81.775	15
Hoist swing winch	2000	1	1650	81.775	15
Other	2007	3	174	771.1818182	15
Hoist swing winch	1976	0	182	81.775	15
Hoist swing winch	1969	0	180	81.775	15
Hoist swing winch	1974	0	400	81.775	15
Generator	2007	3	197	748.0431034	15
Generator	1994	0	500	748.0431034	15
Hoist swing winch	2008	3	300	81.775	15
Generator	2000	1	205	748.0431034	15
Hoist swing winch	1997	1	250	81.775	15
Hoist swing winch	1997	1	250	81.775	15
Generator	2005	1	2686	748.0431034	15
Hoist swing winch	2007	3	202	81.775	15
Generator	2004	2	425	748.0431034	15
Generator	2008	3	235	748.0431034	15
Generator	2002	2	440	748.0431034	15
Generator	1979	0	180	748.0431034	15
Generator	1982	0	425	748.0431034	15
Hoist swing winch	1999	1	599	81.775	15
Hoist swing winch	1999	1	599	81.775	15
Generator	2000	2	550	748.0431034	15
Hoist swing winch	2000	1	2935	81.775	15
Hoist swing winch	2000	1	250	81.775	15
Generator	2002	2	440	748.0431034	15
Hoist swing winch	2007	3	173	81.775	15
Hoist swing winch	2007	3	173	81.775	15
Hoist swing winch	2003	2	425	81.775	15
Generator	2008	3	80	748.0431034	15
Hoist swing winch	1956	0	300	81.775	15
Hoist swing winch	2000	1	860	81.775	15
Generator	2000	1	635	748.0431034	15
Generator	2002	1	112	748.0431034	15
Generator	2004	2	275	748.0431034	15
Hoist swing winch	1982	0	239	81.775	15
Hoist swing winch	1982	0	239	81.775	15
Generator	2005	2	500	748.0431034	15
Hoist swing winch	1989	0	1200	81.775	15
Hoist swing winch	2000	1	250	81.775	15
Generator	1995	0	350	748.0431034	15
Generator	2007	2	2206	748.0431034	15

Lower San Felipe Intake Alternative - Pipeline Option

Table A-55. Sample Auxiliary Engine Data

VES	MY	Engine_tier	hp	AnnualHrs	SulfurContent
Generator	2008	3	384	748.0431034	15
Pump	2008	3	630	560.954023	15
Pump	2007	3	630	560.954023	15
Generator	1974	0	180	748.0431034	15
Hoist swing winch	1954	0	400	81.775	15
Hoist swing winch	1970	0	400	81.775	15
Hoist swing winch	1980	0	475	81.775	15
Generator	1963	0	700	748.0431034	15
Other	1982	0	235	1200	15
Other	1982	0	280	1200	15
Other	1982	0	280	1200	15
Other	2006	3	425	1200	15
Other	2006	3	425	1200	15
Other	2006	2	157	1400	15
Other	2006	2	157	1400	15
Other	2006	2	157	1400	15
Other	2006	2	54	360	15
Other	1999	1	49	360	15
Other	1999	1	50	175	15
Other	1999	1	82	162	15
Other	1999	1	300	771.1818182	15
Other	1999	1	300	771.1818182	15
Other	2004	2	276.7857143	771.1818182	15
Other	2000	1	56	771.1818182	15
Other	2001	1	75	771.1818182	15
Other	1999	1	160	771.1818182	15
Other	1999	1	230	771.1818182	15
Other	1999	1	160	771.1818182	15
Other	1999	1	85	771.1818182	15
Other	1999	1	85	771.1818182	15
Pump	1982	0	565	560.954023	15
Pump	1982	0	565	560.954023	15
Other	1982	0	565	771.1818182	15
Other	1982	0	565	771.1818182	15
Other	2007	2	1476	771.1818182	15
Other	2007	2	1476	771.1818182	15
Other	2007	2	1476	771.1818182	15
Other	1999	0	1175	771.1818182	15
Generator	1998	1	400	748.0431034	15
Other	1999	1	400	771.1818182	15
Other	1999	1	280	771.1818182	15
Other	1999	1	460	771.1818182	15
Other	1999	1	460	771.1818182	15
Other	1999	1	180	771.1818182	15
Other	1999	1	565	771.1818182	15
Other	1999	1	565	771.1818182	15
Other	1999	1	565	771.1818182	15
Other	1999	1	565	771.1818182	15
Other	1994	0	89	771.1818182	15
Other	2005	2	90	771.1818182	15
Other	1999	1	245	771.1818182	15
Other	1999	1	385	771.1818182	15
Other	1999	1	385	771.1818182	15

Lower San Felipe Intake Alternative - Pipeline Option

Table A-55. Sample Auxiliary Engine Data

VES	MY	Engine_tier	hp	AnnualHrs	SulfurContent
Other	1999	1	99	771.1818182	15
Hoist swing winch	1988	0	800	81.775	15
Generator	1998	1	147	748.0431034	15
Other	1999	1	380	771.1818182	15
Generator	1998	1	390	748.0431034	15
Hoist swing winch	1988	0	240	81.775	15
Hoist swing winch	1988	0	240	81.775	15
Generator	1998	1	390	748.0431034	15
Other	1999	1	540	771.1818182	15
Other	1999	0	2600	771.1818182	15
Other	1999	0	2600	771.1818182	15
Other	1999	0	2600	771.1818182	15
Other	1999	0	2600	771.1818182	15
Generator	1998	1	550	748.0431034	15
Hoist swing winch	1988	0	379.4	81.775	15
Generator	1998	1	464.3472222	748.0431034	15
Hoist swing winch	1988	0	490	81.775	15
Generator	1998	1	464.3472222	748.0431034	15
Generator	1998	1	249	748.0431034	15
Other	1999	0	930	771.1818182	15
Other	1999	0	930	771.1818182	15
Generator	1998	1	240	748.0431034	15
Generator	1998	1	240	748.0431034	15
Other	1999	1	520	771.1818182	15
Other	1999	1	315	771.1818182	15

Source: CARB. California Barge and Dredge Emissions Inventory Database (Access Database). "View Sample Auxiliary Engine Data" input data table. Accessed on: July 27, 2016. Available at: http://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles.

Table A-56. Average Engine Data

Type	Average HP	Average Hours	Percentage
Compressor	353	295	7%
Crane	377	370	9%
Deck door engine	86	1400	34%
Dredger	528	0	0%
Generator	464	748	18%
Hoist swing winch	379	82	2%
Other	390	635	16%
Pump	518	561	14%

San Luis Low Point Improvement Project
GHG Emission Factors

Table A-57. US Default CO2 Emission Factors for Transport Fuels

Fuel Type	Carbon Content (Per Unit Energy)	Heat Content	Fraction Oxidized	CO2 Emission Factor (Per Unit Volume)
Fuels Measured in Gallons	**kg C / MMBtu**	**MMBtu / barrel**		**kg CO2 / gallon**
Gasoline	19.2	5.25	1	8.78
Diesel Fuel	20.2	5.80	1	10.21
Aviation Gasoline	18.9	5.04	1	8.31
Jet Fuel (Jet A or A-1)	19.7	5.67	1	9.75
Kerosene	20.5	5.67	1	10.15
Residual Fuel Oil No. 5	19.9	5.88	1	10.21
Residual Fuel Oil No. 6	20.5	6.30	1	11.27
Crude Oil	20.3	5.80	1	10.29
Biodiesel (B100)	20.1	5.38	1	9.45
Ethanol (E100)	18.7	3.53	1	5.75
Methanol	NA	NA	1	4.10
Liquefied Natural Gas (LNG)	NA	NA	1	4.46
Liquefied Petroleum Gas (LPG)	17.2	3.86	1	5.68
Propane (Liquid)	16.8	3.82	1	5.72
Ethane	17.1	2.86	1	4.11
Isobutane	17.7	4.16	1	6.30
Butane	17.8	4.33	1	6.54
Renewable Diesel (R100)	20.2	5.80	1	10.21
Fuels Measured in Standard Cubic Feet	**kg C / MMBtu**	**Btu / Standard cubic foot**		**kg CO2 / Standard cubic foot**
Compressed Natural Gas (CNG)	14.5	1,027	1	0.05444
Propane (Gas)	16.8	2,516	1	0.15
Renewable Diesel (R100)	14.5	1,027	1	0

Source: 2018 Climate Registry Default Emission Factors, Table 13.1
https://www.theclimateregistry.org/wp-content/uploads/2018/06/The-Climate-Registry-2018-Default-Emission-Factor-Document.pd

Table A-58. US Default CH4 and N2O Emission Factors for Non-Highway Vehicles

Vehicle Type / Fuel Type	CH4 (g / gallon)	N2O (g / gallon)
Ships and Boats		
Residual Fuel Oil	0.11	0.60
Diesel Fuel	0.06	0.45
Gasoline	0.64	0.22
Locomotives		
Diesel Fuel	0.80	0.26
Agricultural Equipment		
Gasoline	1.26	0.22
Diesel Fuel	1.44	0.26
Construction/Mining Equipment		
Gasoline	0.50	0.22
Diesel Fuel	0.58	0.26
Other Non-Highway		
Snowmobiles (Gasoline)	0.50	0.22
Other Recreational (Gasoline)	0.50	0.22
Other Small Utility (Gasoline)	0.50	0.22
Other Large Utility (Gasoline)	0.50	0.22
Other Large Utility (Diesel)	0.58	0.26
Aircraft		
Jet Fuel	0.00	0.31
Aviation Gasoline	7.05	0.11

Source: 2018 Climate Registry Default Emission Factors, Table 13.7
https://www.theclimateregistry.org/wp-content/uploads/2018/06/The-Climate-Registry-2018-Default-Emission-Factor-Document.pd

CVP Reservoir Expansion Alternative

Table A-59. Onsite Construction Equipment Emission Factors

Equipment	Quantity	OFFROAD Description	HP	2020			2021			2022			2023		
				CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O
Excavators	3	ConstMin - Excavators	158	201.97	0.0183	0.0051	201.92	0.0171	0.0051	201.81	0.0160	0.0051	201.83	0.0151	0.0051
Bulldozers	4	ConstMin - Rubber Tired Dozers	249	206.92	0.0280	0.0053	208.04	0.0266	0.0053	209.35	0.0253	0.0053	208.78	0.0241	0.0053
Cranes/Lifts	5	ConstMin - Cranes	231	152.24	0.0138	0.0039	152.26	0.0131	0.0039	152.20	0.0124	0.0039	152.22	0.0118	0.0039
Compactors	5	ConstMin - Rollers	80	198.40	0.0280	0.0050	198.50	0.0257	0.0050	198.31	0.0237	0.0050	198.40	0.0219	0.0050
Graders	2	ConstMin - Graders	188	215.08	0.0181	0.0055	214.84	0.0172	0.0055	215.45	0.0163	0.0055	216.38	0.0155	0.0055
Scrapers	2	ConstMin - Scrapers	367	255.60	0.0254	0.0065	255.63	0.0241	0.0065	255.66	0.0230	0.0065	255.86	0.0220	0.0065
Loaders (small)	2	ConstMin - Rubber Tired Loaders	188	190.37	0.0158	0.0049	190.31	0.0149	0.0049	190.37	0.0142	0.0049	190.43	0.0135	0.0049
Loaders (large)	3	ConstMin - Rubber Tired Loaders	541	191.82	0.0153	0.0048	191.38	0.0145	0.0048	191.18	0.0138	0.0048	191.19	0.0132	0.0048
Dump trucks	13	ConstMin - Off-Highway Trucks	403	202.12	0.0160	0.0051	202.37	0.0152	0.0051	202.31	0.0145	0.0051	202.43	0.0138	0.0051
Water Trucks	5		N/A	768.14	0.0051	0.0048	748.66	0.0051	0.0048	728.39	0.0051	0.0048	707.34	0.0051	0.0048

Table A-60. Onsite Construction Equipment Emissions by Pollutant

Equipment	Quantity	OFFROAD Description	HP	2020			2021			2022			2023		
				CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O
Excavators	3	ConstMin - Excavators	158	698.84	0.06	0.02	698.67	0.06	0.02	698.31	0.06	0.02	698.38	0.05	0.02
Bulldozers	4	ConstMin - Rubber Tired Dozers	249	1,504.45	0.20	0.04	1,512.65	0.19	0.04	1,522.13	0.18	0.04	1,518.01	0.18	0.04
Cranes/Lifts	5	ConstMin - Cranes	231	1,283.64	0.12	0.03	1,283.81	0.11	0.03	1,283.28	0.10	0.03	1,283.45	0.10	0.03
Compactors	5	ConstMin - Rollers	80	579.33	0.08	0.01	579.62	0.08	0.01	579.07	0.07	0.01	579.32	0.06	0.01
Graders	2	ConstMin - Graders	188	590.34	0.05	0.02	589.68	0.05	0.02	591.38	0.04	0.02	593.91	0.04	0.02
Scrapers	2	ConstMin - Scrapers	367	1,369.53	0.14	0.03	1,369.72	0.13	0.03	1,369.85	0.12	0.03	1,370.93	0.12	0.03
Loaders (small)	2	ConstMin - Rubber Tired Loaders	188	522.53	0.04	0.01	522.37	0.04	0.01	522.54	0.04	0.01	522.71	0.04	0.01
Loaders (large)	3	ConstMin - Rubber Tired Loaders	541	2,272.65	0.18	0.06	2,267.43	0.17	0.06	2,265.04	0.16	0.06	2,265.25	0.16	0.06
Dump trucks	13	ConstMin - Off-Highway Trucks	403	7,730.06	0.61	0.20	7,739.51	0.58	0.20	7,737.28	0.55	0.20	7,741.75	0.53	0.20
Water Trucks	5		N/A	420.56	0.00	0.00	409.89	0.00	0.00	398.79	0.00	0.00	387.27	0.00	0.00
			Total	**16,971.93**	**1.49**	**0.42**	**16,973.36**	**1.41**	**0.42**	**16,967.67**	**1.34**	**0.42**	**16,960.98**	**1.28**	**0.42**

Table A-61. Summary of Onsite Construction Equipment Emissions

Equipment	Quantity	OFFROAD Description	HP	Annual Emissions (MTCO2e per year)										Project Total	
				2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	No Shear Key	Shear Key
Excavators	3	ConstMin - Excavators	158	706	705	705	705	705	705	704	704	704	704	5,639	7,048
Bulldozers	4	ConstMin - Rubber Tired Dozers	249	1,521	1,529	1,538	1,534	1,534	1,533	1,533	1,531	1,531	1,530	12,253	15,313
Cranes/Lifts	5	ConstMin - Cranes	231	1,296	1,296	1,296	1,296	1,295	1,294	1,294	1,294	1,294	1,294	10,362	12,950
Compactors	5	ConstMin - Rollers	80	586	586	585	585	585	585	585	585	585	585	4,681	5,850
Graders	2	ConstMin - Graders	188	596	595	597	599	599	598	598	599	599	598	4,782	5,980
Scrapers	2	ConstMin - Scrapers	367	1,383	1,383	1,383	1,384	1,383	1,383	1,382	1,380	1,380	1,380	11,062	13,822
Loaders (small)	2	ConstMin - Rubber Tired Loaders	188	528	527	527	528	528	528	528	528	528	528	4,222	5,278
Loaders (large)	3	ConstMin - Rubber Tired Loaders	541	2,294	2,289	2,286	2,286	2,283	2,287	2,285	2,286	2,283	2,279	18,297	22,859
Dump trucks	13	ConstMin - Off-Highway Trucks	403	7,804	7,813	7,810	7,814	7,797	7,810	7,816	7,813	7,814	7,815	62,475	78,104
Water Trucks	5		N/A	421	411	400	388	376	364	354	344	336	328	3,059	3,722
			Total	**17,135**	**17,135**	**17,127**	**17,119**	**17,085**	**17,087**	**17,079**	**17,064**	**17,054**	**17,042**	**136,832**	**170,927**

Notes:
No Shear Key option assumes that construction will occur from 2020 to 2027 (8 years).
Shear Key option assumes that construction will occur from 2020 to 2029 (10 years).

Operating Schedule
8 years without shear key
10 years with shear key
20 hours per day
365 days per year

Global Warming Potential
CO2 1
CH4 25
N2O 298

Conversions
1,000,000 grams per metric ton

Speed Limit
15 miles per hour

CVP Reservoir Expansion Alternative

Table A-59. Onsite Construction Equipment Emission Factors

Equipment	Quantity	OFFROAD Description	Emission Factors (g/hp-hr or g/mi)															
			2024			2025			2026			2027			2028			2029	
			CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O
Excavators	3	ConstMin - Excavators	201.72	0.0142	0.0051	201.74	0.0135	0.0051	201.69	0.0128	0.0051	201.75	0.0123	0.0051	201.78	0.0118	0.0051	201.78	0.0114	0.0051
Bulldozers	4	ConstMin - Rubber Tired Dozers	208.79	0.0230	0.0053	208.70	0.0219	0.0053	208.71	0.0209	0.0053	208.44	0.0201	0.0053	208.45	0.0193	0.0053	208.43	0.0185	0.0053
Cranes/Lifts	5	ConstMin - Cranes	152.20	0.0112	0.0039	152.11	0.0107	0.0039	152.08	0.0102	0.0039	152.08	0.0098	0.0039	152.12	0.0094	0.0039	152.11	0.0090	0.0039
Compactors	5	ConstMin - Rollers	198.34	0.0203	0.0050	198.24	0.0191	0.0050	198.23	0.0180	0.0050	198.27	0.0172	0.0050	198.32	0.0164	0.0051	198.33	0.0157	0.0051
Graders	2	ConstMin - Graders	216.24	0.0148	0.0055	216.01	0.0142	0.0055	215.99	0.0136	0.0055	216.23	0.0131	0.0055	216.15	0.0127	0.0055	216.06	0.0123	0.0055
Scrapers	2	ConstMin - Scrapers	255.68	0.0210	0.0065	255.59	0.0202	0.0065	255.46	0.0194	0.0065	255.24	0.0187	0.0065	255.21	0.0180	0.0065	255.10	0.0174	0.0065
Loaders (small)	2	ConstMin - Rubber Tired Loaders	190.63	0.0128	0.0049	190.55	0.0123	0.0049	190.58	0.0118	0.0049	190.69	0.0113	0.0049	190.71	0.0109	0.0049	190.66	0.0106	0.0049
Loaders (large)	3	ConstMin - Rubber Tired Loaders	190.92	0.0126	0.0048	191.26	0.0121	0.0049	191.16	0.0116	0.0049	191.23	0.0112	0.0049	190.99	0.0108	0.0049	190.69	0.0105	0.0049
Dump trucks	13	ConstMin - Off-Highway Trucks	202.01	0.0132	0.0051	202.36	0.0127	0.0051	202.52	0.0122	0.0051	202.45	0.0119	0.0051	202.49	0.0116	0.0051	202.52	0.0113	0.0052
Water Trucks	5		685.74	0.0051	0.0048	664.11	0.0051	0.0048	645.00	0.0051	0.0048	627.23	0.0051	0.0048	611.31	0.0051	0.0048	597.25	0.0051	0.0048

Table A-60. Onsite Construction Equipment Emissions by Po

Equipment	Quantity	OFFROAD Description	Emission Factors (g/hp-hr or g/mi)															
			2024			2025			2026			2027			2028			2029	
			CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O
Excavators	3	ConstMin - Excavators	697.98	0.05	0.02	698.06	0.05	0.02	697.88	0.04	0.02	698.09	0.04	0.02	698.18	0.04	0.02	698.18	0.04	0.02
Bulldozers	4	ConstMin - Rubber Tired Dozers	1,518.03	0.17	0.04	1,517.42	0.16	0.04	1,517.51	0.15	0.04	1,515.52	0.15	0.04	1,515.56	0.14	0.04	1,515.44	0.13	0.04
Cranes/Lifts	5	ConstMin - Cranes	1,283.29	0.09	0.03	1,282.49	0.09	0.03	1,282.28	0.09	0.03	1,282.28	0.08	0.03	1,282.58	0.08	0.03	1,282.54	0.08	0.03
Compactors	5	ConstMin - Rollers	579.15	0.06	0.01	578.87	0.06	0.01	578.84	0.05	0.01	578.96	0.05	0.01	579.09	0.05	0.01	579.12	0.05	0.01
Graders	2	ConstMin - Graders	593.53	0.04	0.02	592.89	0.04	0.02	592.85	0.04	0.02	593.50	0.04	0.02	593.30	0.03	0.02	593.04	0.03	0.02
Scrapers	2	ConstMin - Scrapers	1,369.98	0.11	0.03	1,369.53	0.11	0.03	1,368.82	0.10	0.03	1,367.61	0.10	0.03	1,367.45	0.10	0.03	1,366.85	0.09	0.03
Loaders (small)	2	ConstMin - Rubber Tired Loaders	523.24	0.04	0.01	523.01	0.03	0.01	523.11	0.03	0.01	523.41	0.03	0.01	523.47	0.03	0.01	523.31	0.03	0.01
Loaders (large)	3	ConstMin - Rubber Tired Loaders	2,261.97	0.15	0.06	2,266.01	0.14	0.06	2,264.82	0.14	0.06	2,265.61	0.13	0.06	2,262.82	0.13	0.06	2,259.24	0.12	0.06
Dump trucks	13	ConstMin - Off-Highway Trucks	7,725.82	0.51	0.20	7,739.20	0.49	0.20	7,745.28	0.47	0.20	7,742.72	0.45	0.20	7,744.08	0.44	0.20	7,745.37	0.43	0.20
Water Trucks	5		375.44	0.00	0.00	363.60	0.00	0.00	353.14	0.00	0.00	343.41	0.00	0.00	334.69	0.00	0.00	327.00	0.00	0.00
			16,928.43	**1.22**	**0.42**	**16,931.08**	**1.16**	**0.42**	**16,924.53**	**1.12**	**0.42**	**16,911.10**	**1.08**	**0.42**	**16,901.23**	**1.04**	**0.42**	**16,890.08**	**1.01**	**0.42**

Table A-61. Summary of Onsite Construction Equipment Emi

Equipment	Quantity	OFFROAD Description
Excavators	3	ConstMin - Excavators
Bulldozers	4	ConstMin - Rubber Tired Dozers
Cranes/Lifts	5	ConstMin - Cranes
Compactors	5	ConstMin - Rollers
Graders	2	ConstMin - Graders
Scrapers	2	ConstMin - Scrapers
Loaders (small)	2	ConstMin - Rubber Tired Loaders
Loaders (large)	3	ConstMin - Rubber Tired Loaders
Dump trucks	13	ConstMin - Off-Highway Trucks
Water Trucks	5	

Notes:
No Shear Key option assumes that construction will occur from 2020 to 2
Shear Key option assumes that construction will occur from 2020 to 202

Operating Schedule

8	years without shear key
10	years with shear key
20	hours per day
365	days per year

CVP Reservoir Expansion Alternative

Table A-62. Offsite Construction Emissions - Construction Worker Commuting

Year	Annual VMT	Emission Factors (g/mi)			Annual Emissions (metric tons per year)			
		CO2	CH4	N2O	CO2	CH4	N2O	CO2e
2020	6,336,400	308.94	0.18	0.08	1,958	1.16	0.48	2,131
2021	6,336,400	297.33	0.18	0.08	1,884	1.16	0.48	2,057
2022	6,336,400	285.97	0.18	0.08	1,812	1.16	0.48	1,985
2023	6,336,400	274.71	0.18	0.08	1,741	1.16	0.48	1,914
2024	6,336,400	263.78	0.18	0.08	1,671	1.16	0.48	1,844
2025	6,336,400	252.94	0.18	0.08	1,603	1.16	0.48	1,776
2026	6,336,400	243.76	0.18	0.08	1,545	1.16	0.48	1,718
2027	6,336,400	235.29	0.18	0.08	1,491	1.16	0.48	1,664
2028	6,336,400	227.85	0.18	0.08	1,444	1.16	0.48	1,617
2029	6,336,400	221.32	0.18	0.08	1,402	1.16	0.48	1,576

Table A-63. Offsite Construction Emissions - Haul Trucks

Year	Annual VMT	Emission Factors (g/mi)			Annual Emissions (metric tons per year)			
		CO2	CH4	N2O	CO2	CH4	N2O	CO2e
2020	7,008,000	1,628.32	0.01	0.00	11,411	0.04	0.03	11,422
2021	7,008,000	1,611.17	0.01	0.00	11,291	0.04	0.03	11,302
2022	7,008,000	1,593.35	0.01	0.00	11,166	0.04	0.03	11,177
2023	7,008,000	1,538.91	0.01	0.00	10,785	0.04	0.03	10,796
2024	7,008,000	1,532.08	0.01	0.00	10,737	0.04	0.03	10,748
2025	7,008,000	1,526.55	0.01	0.00	10,698	0.04	0.03	10,709
2026	7,008,000	1,521.41	0.01	0.00	10,662	0.04	0.03	10,673
2027	7,008,000	1,516.18	0.01	0.00	10,625	0.04	0.03	10,636
2028	7,008,000	1,511.65	0.01	0.00	10,594	0.04	0.03	10,605
2029	7,008,000	1,507.41	0.01	0.00	10,564	0.04	0.03	10,575

Note: CO2 emission factors estimated from EMFAC2014; CH4 and N2O emission factors estimated from The Climate Registry (2016 Default Emission Factors for Highway Vehicles)

One-way trip distance

Workers	40	miles per trip
Trucks	40	miles per trip

Global Warming Potential

CO2	1
CH4	25
N2O	298

Conversions

1,000,000 grams per metric ton

Maximum Daily Workers and Trucks

217 workers per day (130 day time workers and 87 night time workers)

240 trucks per day

Operating Schedule

365 days per year

On-Road Motor Vehicle Emission Factors

Table A-64. Unmitigated Emission Factors for Construction Worker Commutes

	grams per mile		
Year	CO2	CH4	N2O
2020	308.94	0.1838	0.0762
2021	297.33	0.1837	0.0761
2022	285.97	0.1837	0.0761
2023	274.71	0.1836	0.0761
2024	263.78	0.1836	0.0762
2025	252.94	0.1836	0.0762
2026	243.76	0.1836	0.0763
2027	235.29	0.1836	0.0763
2028	227.85	0.1836	0.0764
2029	221.32	0.1836	0.0764

Note:
Vehicle fleet mix includes gasoline, diesel, and electric automobiles (LDA) and light-duty trucks (LDT1 and LDT2).

Table A-65. Unmitigated Emission Factors for Haul and Delivery Trucks

	grams per mile		
Year	CO2	CH4	N2O
2020	1,628.32	0.0051	0.0048
2021	1,611.17	0.0051	0.0048
2022	1,593.35	0.0051	0.0048
2023	1,538.91	0.0051	0.0048
2024	1,532.08	0.0051	0.0048
2025	1,526.55	0.0051	0.0048
2026	1,521.41	0.0051	0.0048
2027	1,516.18	0.0051	0.0048
2028	1,511.65	0.0051	0.0048
2029	1,507.41	0.0051	0.0048

Table A-66. Unmitigated Emission Factors for On-Site Water Trucks (San Joaquin Valley Air Basin)

	CO2, grams per mile									
Speed	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
5	1,067.82	1,040.89	1,012.89	983.90	954.23	924.26	898.51	873.62	851.05	831.42
10	905.52	883.10	859.26	834.51	809.14	783.74	761.32	740.17	721.21	704.63
15	768.14	748.66	728.39	707.34	685.74	664.11	645.00	627.23	611.31	597.25
20	638.67	622.45	605.72	588.34	570.76	552.92	537.39	522.36	509.03	497.34
25	539.64	525.95	511.71	496.90	481.88	466.79	453.55	441.01	429.83	419.96
30	465.85	454.11	441.85	429.11	416.13	403.11	391.59	380.83	371.22	362.71
35	423.16	412.45	401.34	389.80	378.06	366.23	355.78	345.92	337.14	329.40
40	396.11	386.12	375.73	364.95	353.97	342.90	333.25	323.96	315.65	308.38
45	381.31	371.67	361.68	351.29	340.64	329.98	320.42	311.48	303.52	296.53
50	382.87	373.14	363.06	352.60	342.02	331.30	322.05	313.05	305.04	298.02
55	403.95	393.58	382.93	371.86	360.67	349.39	340.10	330.57	322.11	314.69
60	438.39	427.26	415.76	403.82	391.59	379.35	368.51	358.19	349.02	340.97
65	490.95	478.61	465.74	452.35	438.71	425.03	412.82	401.47	391.37	382.42
70	527.89	514.50	500.62	486.21	471.57	456.88	443.93	431.77	420.92	411.33
Aggregated	459.80	447.68	435.61	423.08	410.18	397.37	386.25	375.57	366.06	357.68

CH4 and N2O Emission Factors

Table A-67. San Joaquin Valley Air Basin On-Road Emission Factors

Year	Type	Fuel	VMT	CH4 (g/mi)	N2O (g/mi)
2020	LDA	GAS	51,905,504	0.1780	0.0647
		DSL	526,303	0.0006	0.0012
	LDT1	GAS	3,603,221	0.2024	0.1056
		DSL	4,007	0.0011	0.0017
	LDT2	GAS	18,124,513	0.2024	0.1056
		DSL	31,156	0.0011	0.0017
Weighted Average Emission Factor (2020), grams per mile				**0.1838**	**0.0762**
2021	LDA	GAS	53,113,271	0.1780	0.0647
		DSL	564,773	0.0006	0.0012
	LDT1	GAS	3,581,948	0.2024	0.1056
		DSL	3,767	0.0011	0.0017
	LDT2	GAS	18,596,624	0.2024	0.1056
		DSL	33,720	0.0011	0.0017
Weighted Average Emission Factor (2021), grams per mile				**0.1837**	**0.0761**
2022	LDA	GAS	54,099,432	0.1780	0.0647
		DSL	599,371	0.0006	0.0012
	LDT1	GAS	3,567,882	0.2024	0.1056
		DSL	3,563	0.0011	0.0017
	LDT2	GAS	19,045,161	0.2024	0.1056
		DSL	35,993	0.0011	0.0017
Weighted Average Emission Factor (2022), grams per mile				**0.1837**	**0.0761**
2023	LDA	GAS	55,046,389	0.1780	0.0647
		DSL	632,276	0.0006	0.0012
	LDT1	GAS	3,568,656	0.2024	0.1056
		DSL	3,380	0.0011	0.0017
	LDT2	GAS	19,525,102	0.2024	0.1056
		DSL	38,163	0.0011	0.0017
Weighted Average Emission Factor (2023), grams per mile				**0.1836**	**0.0761**
2024	LDA	GAS	55,886,650	0.1780	0.0647
		DSL	662,231	0.0006	0.0012
	LDT1	GAS	3,578,540	0.2024	0.1056
		DSL	3,217	0.0011	0.0017
	LDT2	GAS	20,004,793	0.2024	0.1056
		DSL	40,154	0.0011	0.0017
Weighted Average Emission Factor (2024), grams per mile				**0.1836**	**0.0762**
2025	LDA	GAS	56,636,618	0.1780	0.0647
		DSL	689,781	0.0006	0.0012
	LDT1	GAS	3,596,711	0.2024	0.1056
		DSL	3,033	0.0011	0.0017
	LDT2	GAS	20,482,570	0.2024	0.1056
		DSL	41,985	0.0011	0.0017
Weighted Average Emission Factor (2025), grams per mile				**0.1836**	**0.0762**
2026	LDA	GAS	57,234,421	0.1780	0.0647
		DSL	712,741	0.0006	0.0012
	LDT1	GAS	3,613,533	0.2024	0.1056
		DSL	2,869	0.0011	0.0017
	LDT2	GAS	20,899,655	0.2024	0.1056
		DSL	43,509	0.0011	0.0017
Weighted Average Emission Factor (2026), grams per mile				**0.1836**	**0.0763**

Table A-67. San Joaquin Valley Air Basin On-Road Emission Factors

Year	Type	Fuel	VMT	CH4 (g/mi)	N2O (g/mi)
2027	LDA	GAS	57,968,341	0.1780	0.0647
		DSL	735,400	0.0006	0.0012
	LDT1	GAS	3,644,805	0.2024	0.1056
		DSL	2,553	0.0011	0.0017
	LDT2	GAS	21,355,536	0.2024	0.1056
		DSL	44,981	0.0011	0.0017
Weighted Average Emission Factor (2027), grams per mile				**0.1836**	**0.0763**
2028	LDA	GAS	58,703,958	0.1780	0.0647
		DSL	756,268	0.0006	0.0012
	LDT1	GAS	3,682,046	0.2024	0.1056
		DSL	2,371	0.0011	0.0017
	LDT2	GAS	21,803,176	0.2024	0.1056
		DSL	46,345	0.0011	0.0017
Weighted Average Emission Factor (2028), grams per mile				**0.1836**	**0.0764**
2029	LDA	GAS	59,445,637	0.1780	0.0647
		DSL	775,919	0.0006	0.0012
	LDT1	GAS	3,723,593	0.2024	0.1056
		DSL	2,252	0.0011	0.0017
	LDT2	GAS	22,242,150	0.2024	0.1056
		DSL	47,604	0.0011	0.0017
Weighted Average Emission Factor (2029), grams per mile				**0.1836**	**0.0764**

Table A-68. Emission Factors for Highway Vehicles by Technology Type

Vehicle Type/ Control Technology	CH4 (g/mi)	N2O (g/mi)
Gasoline Passenger Cars		
EPA Tier 2	0.0173	0.0036
Low Emission Vehicles	0.0105	0.0150
EPA Tier 1	0.0271	0.0429
EPA Tier 0	0.0704	0.0647
Oxidation Catalyst	0.1355	0.0504
Non-Catalyst Control	0.1696	0.0197
Uncontrolled	0.1780	0.0197
Gasoline Light Trucks (Vans, Pickup Trucks, SUVs)		
EPA Tier 2	0.0163	0.0066
Low Emission Vehicles	0.0148	0.0157
EPA Tier 1	0.0452	0.0871
EPA Tier 0	0.0776	0.1056
Oxidation Catalyst	0.1516	0.0639
Non-Catalyst Control	0.1908	0.0218
Uncontrolled	0.2024	0.0220
Gasoline Medium and Heavy-Duty Vehicles (Trucks and Busses)		
EPA Tier 2	0.0333	0.0134
Low Emission Vehicles	0.0303	0.0320
EPA Tier 1	0.0655	0.1750
EPA Tier 0	0.2630	0.2135
Oxidation Catalyst	0.2356	0.1317
Non-Catalyst Control	0.4181	0.0473
Uncontrolled	0.4604	0.0497
Diesel Passenger Cars		
Advanced	0.0005	0.0010
Moderate	0.0005	0.0010
Uncontrolled	0.0006	0.0012

Table A-68. Emission Factors for Highway Vehicles by Technology Type

Vehicle Type/ Control Technology	CH4 (g/mi)	N2O (g/mi)
Diesel Light Trucks		
Advanced	0.0010	0.0015
Moderate	0.0009	0.0014
Uncontrolled	0.0011	0.0017
Diesel Medium and Heavy-Duty Vehicles (Trucks and Busses)		
Aftertreatment	0.0051	0.0048
Advanced	0.0051	0.0048
Moderate	0.0051	0.0048
Uncontrolled	0.0051	0.0048
Motorcycles		
Non-Catalyst Control	0.0672	0.0069
Uncontrolled	0.0899	0.0087

Source:
2018 Climate Registry Default Emissions Factors
Table 13.4 Default CH4 and N2O Emission Factors for Highway Vehicles by Technology Type
https://www.theclimateregistry.org/wp-content/uploads/2018/06/The-Climate-Registry-2018-Default-Emission-Factor-Document.

Table A-69. Off-Road Equipment N2O Emission Factors

Vehicle Class	HP Bin	N2O Emission Factor (g/hp-hr)									
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
ConstMin - Bore/Drill Rigs	25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ConstMin - Bore/Drill Rigs	50	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0076	0.0076
ConstMin - Bore/Drill Rigs	75	0.0067	0.0067	0.0066	0.0066	0.0066	0.0064	0.0065	0.0067	0.0067	0.0067
ConstMin - Bore/Drill Rigs	100	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067
ConstMin - Bore/Drill Rigs	175	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068
ConstMin - Bore/Drill Rigs	300	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067
ConstMin - Bore/Drill Rigs	600	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067
ConstMin - Bore/Drill Rigs	750	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068
ConstMin - Bore/Drill Rigs	9999	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067
ConstMin - Cranes	25	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043
ConstMin - Cranes	50	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043
ConstMin - Cranes	75	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
ConstMin - Cranes	100	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
ConstMin - Cranes	175	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
ConstMin - Cranes	300	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
ConstMin - Cranes	600	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
ConstMin - Cranes	750	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
ConstMin - Cranes	9999	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
ConstMin - Crawler Tractors	25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ConstMin - Crawler Tractors	50	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064
ConstMin - Crawler Tractors	75	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0059	0.0059	0.0059	0.0059
ConstMin - Crawler Tractors	100	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058
ConstMin - Crawler Tractors	175	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058
ConstMin - Crawler Tractors	300	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058
ConstMin - Crawler Tractors	600	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058
ConstMin - Crawler Tractors	750	0.0058	0.0058	0.0057	0.0057	0.0057	0.0057	0.0057	0.0058	0.0057	0.0058
ConstMin - Crawler Tractors	9999	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058
ConstMin - Excavators	25	0.0057	0.0057	0.0057	0.0057	0.0057	0.0057	0.0057	0.0057	0.0057	0.0057
ConstMin - Excavators	50	0.0057	0.0057	0.0057	0.0057	0.0057	0.0057	0.0057	0.0057	0.0057	0.0057
ConstMin - Excavators	75	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0052	0.0052	0.0052	0.0051
ConstMin - Excavators	100	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051
ConstMin - Excavators	175	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051
ConstMin - Excavators	300	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051
ConstMin - Excavators	600	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051
ConstMin - Excavators	750	0.0051	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0051	0.0052
ConstMin - Excavators	9999	0.0051	0.0051	0.0051	0.0051	0.0052	0.0052	0.0052	0.0052	0.0052	0.0051
ConstMin - Graders	25	0.0000	0.0061	0.0061	0.0061	0.0061	0.0061	0.0000	0.0061	0.0061	0.0061
ConstMin - Graders	50	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061
ConstMin - Graders	75	0.0055	0.0055	0.0056	0.0057	0.0057	0.0057	0.0059	0.0057	0.0057	0.0055
ConstMin - Graders	100	0.0054	0.0054	0.0054	0.0054	0.0055	0.0054	0.0055	0.0055	0.0055	0.0055
ConstMin - Graders	175	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
ConstMin - Graders	300	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
ConstMin - Graders	600	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0054	0.0054	0.0055
ConstMin - Graders	9999	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
ConstMin - Off-Highway Tractors	25	0.0000	0.0065	0.0000	0.0065	0.0065	0.0065	0.0000	0.0065	0.0065	0.0065
ConstMin - Off-Highway Tractors	50	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065
ConstMin - Off-Highway Tractors	75	0.0059	0.0059	0.0059	0.0059	0.0059	0.0058	0.0058	0.0058	0.0058	0.0058
ConstMin - Off-Highway Tractors	100	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059
ConstMin - Off-Highway Tractors	175	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059
ConstMin - Off-Highway Tractors	300	0.0058	0.0058	0.0058	0.0058	0.0059	0.0059	0.0059	0.0059	0.0059	0.0058
ConstMin - Off-Highway Tractors	600	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0059	0.0059	0.0059
ConstMin - Off-Highway Tractors	750	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0059
ConstMin - Off-Highway Tractors	9999	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059
ConstMin - Off-Highway Trucks	25	0.0057	0.0057	0.0057	0.0000	0.0057	0.0000	0.0057	0.0000	0.0057	0.0057
ConstMin - Off-Highway Trucks	50	0.0057	0.0057	0.0057	0.0057	0.0057	0.0057	0.0057	0.0057	0.0057	0.0057
ConstMin - Off-Highway Trucks	75	0.0051	0.0051	0.0051	0.0052	0.0052	0.0051	0.0052	0.0052	0.0052	0.0052

Table A-69. Off-Road Equipment N2O Emission Factors

Vehicle Class	HP Bin	N2O Emission Factor (g/hp-hr)									
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
ConstMin - Off-Highway Trucks	100	0.0051	0.0051	0.0051	0.0051	0.0051	0.0052	0.0051	0.0051	0.0051	0.0051
ConstMin - Off-Highway Trucks	175	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051
ConstMin - Off-Highway Trucks	300	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051
ConstMin - Off-Highway Trucks	600	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0052
ConstMin - Off-Highway Trucks	750	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051
ConstMin - Off-Highway Trucks	9999	0.0052	0.0051	0.0052	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051
ConstMin - Other Construction Equipment	25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ConstMin - Other Construction Equipment	50	0.0062	0.0062	0.0062	0.0062	0.0062	0.0063	0.0062	0.0062	0.0062	0.0062
ConstMin - Other Construction Equipment	75	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0056	0.0056
ConstMin - Other Construction Equipment	100	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
ConstMin - Other Construction Equipment	175	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
ConstMin - Other Construction Equipment	300	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
ConstMin - Other Construction Equipment	600	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
ConstMin - Other Construction Equipment	750	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
ConstMin - Other Construction Equipment	9999	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
ConstMin - Pavers	25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ConstMin - Pavers	50	0.0062	0.0062	0.0062	0.0062	0.0062	0.0062	0.0062	0.0062	0.0062	0.0062
ConstMin - Pavers	75	0.0056	0.0056	0.0055	0.0055	0.0055	0.0056	0.0056	0.0056	0.0056	0.0056
ConstMin - Pavers	100	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
ConstMin - Pavers	175	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
ConstMin - Pavers	300	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
ConstMin - Pavers	600	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
ConstMin - Pavers	750	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0000
ConstMin - Pavers	9999	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0056
ConstMin - Paving Equipment	25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0053	0.0053	0.0053	0.0053
ConstMin - Paving Equipment	50	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
ConstMin - Paving Equipment	75	0.0048	0.0048	0.0048	0.0048	0.0048	0.0047	0.0048	0.0048	0.0048	0.0048
ConstMin - Paving Equipment	100	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048
ConstMin - Paving Equipment	175	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048
ConstMin - Paving Equipment	300	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048
ConstMin - Paving Equipment	600	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048
ConstMin - Paving Equipment	750	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048
ConstMin - Paving Equipment	9999	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048
ConstMin - Rollers	25	0.0056	0.0056	0.0000	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
ConstMin - Rollers	50	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
ConstMin - Rollers	75	0.0051	0.0051	0.0051	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
ConstMin - Rollers	100	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0051	0.0051
ConstMin - Rollers	175	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
ConstMin - Rollers	300	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
ConstMin - Rollers	600	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051
ConstMin - Rough Terrain Forklifts	25	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060
ConstMin - Rough Terrain Forklifts	50	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060
ConstMin - Rough Terrain Forklifts	75	0.0058	0.0054	0.0054	0.0054	0.0058	0.0054	0.0054	0.0054	0.0054	0.0054
ConstMin - Rough Terrain Forklifts	100	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054
ConstMin - Rough Terrain Forklifts	175	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054
ConstMin - Rough Terrain Forklifts	300	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054
ConstMin - Rough Terrain Forklifts	600	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054
ConstMin - Rough Terrain Forklifts	750	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054
ConstMin - Rubber Tired Dozers	25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ConstMin - Rubber Tired Dozers	50	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059
ConstMin - Rubber Tired Dozers	75	0.0054	0.0054	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
ConstMin - Rubber Tired Dozers	100	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054
ConstMin - Rubber Tired Dozers	175	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
ConstMin - Rubber Tired Dozers	300	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
ConstMin - Rubber Tired Dozers	600	0.0053	0.0053	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054
ConstMin - Rubber Tired Dozers	750	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053

Table A-69. Off-Road Equipment N2O Emission Factors

Vehicle Class	HP Bin	N2O Emission Factor (g/hp-hr)									
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
ConstMin - Rubber Tired Loaders	25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0054	0.0054
ConstMin - Rubber Tired Loaders	50	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054
ConstMin - Rubber Tired Loaders	75	0.0000	0.0000	0.0000	0.0049	0.0048	0.0049	0.0049	0.0049	0.0049	0.0049
ConstMin - Rubber Tired Loaders	100	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048
ConstMin - Rubber Tired Loaders	175	0.0049	0.0049	0.0049	0.0049	0.0049	0.0048	0.0049	0.0049	0.0049	0.0049
ConstMin - Rubber Tired Loaders	300	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049
ConstMin - Rubber Tired Loaders	600	0.0048	0.0048	0.0048	0.0048	0.0048	0.0049	0.0049	0.0049	0.0049	0.0049
ConstMin - Rubber Tired Loaders	750	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0049	0.0049	0.0048	0.0048
ConstMin - Rubber Tired Loaders	9999	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049
ConstMin - Scrapers	25	0.0072	0.0000	0.0072	0.0072	0.0072	0.0072	0.0072	0.0072	0.0072	0.0072
ConstMin - Scrapers	50	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071
ConstMin - Scrapers	75	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065
ConstMin - Scrapers	100	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065
ConstMin - Scrapers	175	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065
ConstMin - Scrapers	300	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065
ConstMin - Scrapers	600	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065
ConstMin - Scrapers	750	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065
ConstMin - Scrapers	9999	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065
ConstMin - Skid Steer Loaders	25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ConstMin - Skid Steer Loaders	50	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
ConstMin - Skid Steer Loaders	75	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
ConstMin - Skid Steer Loaders	100	0.0049	0.0049	0.0049	0.0050	0.0049	0.0050	0.0050	0.0050	0.0050	0.0049
ConstMin - Skid Steer Loaders	175	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0050	0.0050	0.0050	0.0050
ConstMin - Skid Steer Loaders	300	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
ConstMin - Skid Steer Loaders	600	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
ConstMin - Skid Steer Loaders	9999	0.0049	0.0050	0.0049	0.0050	0.0050	0.0049	0.0049	0.0050	0.0050	0.0049
ConstMin - Surfacing Equipment	25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0045	0.0045
ConstMin - Surfacing Equipment	50	0.0046	0.0046	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045
ConstMin - Surfacing Equipment	75	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041
ConstMin - Surfacing Equipment	100	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041
ConstMin - Surfacing Equipment	175	0.0040	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0040	0.0040
ConstMin - Surfacing Equipment	300	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041
ConstMin - Surfacing Equipment	600	0.0041	0.0041	0.0041	0.0041	0.0041	0.0040	0.0041	0.0040	0.0041	0.0040
ConstMin - Surfacing Equipment	750	0.0041	0.0040	0.0041	0.0040	0.0041	0.0041	0.0040	0.0040	0.0040	0.0041
ConstMin - Surfacing Equipment	9999	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041
ConstMin - Sweepers/Scrubbers	25	0.0068	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0068
ConstMin - Sweepers/Scrubbers	50	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068
ConstMin - Sweepers/Scrubbers	75	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061
ConstMin - Sweepers/Scrubbers	100	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061
ConstMin - Sweepers/Scrubbers	175	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061
ConstMin - Sweepers/Scrubbers	300	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061
ConstMin - Sweepers/Scrubbers	600	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061
ConstMin - Sweepers/Scrubbers	9999	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061
ConstMin - Tractors/Loaders/Backhoes	25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ConstMin - Tractors/Loaders/Backhoes	50	0.0055	0.0055	0.0055	0.0055	0.0055	0.0054	0.0054	0.0054	0.0054	0.0054
ConstMin - Tractors/Loaders/Backhoes	75	0.0050	0.0049	0.0050	0.0050	0.0050	0.0049	0.0050	0.0050	0.0050	0.0050
ConstMin - Tractors/Loaders/Backhoes	100	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
ConstMin - Tractors/Loaders/Backhoes	175	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049
ConstMin - Tractors/Loaders/Backhoes	300	0.0049	0.0050	0.0049	0.0049	0.0049	0.0049	0.0050	0.0049	0.0049	0.0049
ConstMin - Tractors/Loaders/Backhoes	600	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0050	0.0050	0.0050
ConstMin - Tractors/Loaders/Backhoes	750	0.0049	0.0049	0.0048	0.0049	0.0049	0.0047	0.0048	0.0049	0.0049	0.0049
ConstMin - Tractors/Loaders/Backhoes	9999	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
ConstMin - Trenchers	25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ConstMin - Trenchers	50	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075
ConstMin - Trenchers	75	0.0068	0.0068	0.0068	0.0068	0.0068	0.0067	0.0067	0.0067	0.0067	0.0067
ConstMin - Trenchers	100	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068

Table A-69. Off-Road Equipment N2O Emission Factors

Vehicle Class	HP Bin	N2O Emission Factor (g/hp-hr)									
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
ConstMin - Trenchers	175	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067
ConstMin - Trenchers	300	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068
ConstMin - Trenchers	600	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068
ConstMin - Trenchers	750	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068
ConstMin - Trenchers	9999	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068
Industrial - Aerial Lifts	25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Industrial - Aerial Lifts	50	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
Industrial - Aerial Lifts	75	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041
Industrial - Aerial Lifts	100	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041
Industrial - Aerial Lifts	175	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041
Industrial - Aerial Lifts	300	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041
Industrial - Aerial Lifts	600	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041
Industrial - Forklifts	25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Industrial - Forklifts	50	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030
Industrial - Forklifts	75	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027
Industrial - Forklifts	100	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027
Industrial - Forklifts	175	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027
Industrial - Forklifts	300	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027
Industrial - Forklifts	600	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027
Industrial - Forklifts	9999	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027
Industrial - Other General Industrial Equipment	25	0.0051	0.0051	0.0051	0.0000	0.0051	0.0051	0.0051	0.0051	0.0051	0.0000
Industrial - Other General Industrial Equipment	50	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051
Industrial - Other General Industrial Equipment	75	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
Industrial - Other General Industrial Equipment	100	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
Industrial - Other General Industrial Equipment	175	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
Industrial - Other General Industrial Equipment	300	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
Industrial - Other General Industrial Equipment	600	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
Industrial - Other General Industrial Equipment	750	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
Industrial - Other General Industrial Equipment	9999	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
Industrial - Other Material Handling Equipment	25	0.0059	0.0000	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059
Industrial - Other Material Handling Equipment	50	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059
Industrial - Other Material Handling Equipment	75	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
Industrial - Other Material Handling Equipment	100	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
Industrial - Other Material Handling Equipment	175	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
Industrial - Other Material Handling Equipment	300	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
Industrial - Other Material Handling Equipment	600	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
Industrial - Other Material Handling Equipment	750	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
Industrial - Other Material Handling Equipment	9999	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
OFF - ConstMin - Bore/Drill Rigs	25	0.0111	0.0111	0.0111	0.0110	0.0110	0.0110	0.0111	0.0111	0.0112	0.0111
OFF - ConstMin - Cement and Mortar Mixers	25	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083
OFF - ConstMin - Concrete/Industrial Saws	25	0.0106	0.0108	0.0108	0.0106	0.0103	0.0104	0.0103	0.0103	0.0107	0.0110
OFF - ConstMin - Concrete/Industrial Saws	50	0.0110	0.0110	0.0109	0.0110	0.0109	0.0109	0.0109	0.0110	0.0109	0.0109
OFF - ConstMin - Dumpers/Tenders	25	0.0054	0.0054	0.0054	0.0054	0.0054	0.0055	0.0055	0.0055	0.0056	0.0055
OFF - ConstMin - Excavators	25	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085
OFF - ConstMin - Other Construction Equipment	25	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092
OFF - ConstMin - Pavers	25	0.0093	0.0093	0.0093	0.0093	0.0092	0.0092	0.0091	0.0091	0.0091	0.0091
OFF - ConstMin - Paving Equipment	25	0.0079	0.0079	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078	0.0079
OFF - ConstMin - Plate Compactors	25	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064	0.0064
OFF - ConstMin - Rollers	25	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083
OFF - ConstMin - Rubber Tired Loaders	25	0.0080	0.0081	0.0081	0.0079	0.0079	0.0080	0.0080	0.0080	0.0080	0.0080
OFF - ConstMin - Signal Boards	25	0.0122	0.0122	0.0122	0.0122	0.0122	0.0122	0.0122	0.0122	0.0122	0.0122
OFF - ConstMin - Signal Boards	50	0.0119	0.0120	0.0122	0.0120	0.0121	0.0123	0.0122	0.0122	0.0123	0.0122
OFF - ConstMin - Skid Steer Loaders	25	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082
OFF - ConstMin - Tractors/Loaders/Backhoes	25	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082
OFF - ConstMin - Trenchers	25	0.0111	0.0111	0.0111	0.0111	0.0111	0.0111	0.0111	0.0111	0.0111	0.0111
OFF - Industrial - Aerial Lifts	25	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068

Table A-69. Off-Road Equipment N2O Emission Factors

Vehicle Class	HP Bin	N2O Emission Factor (g/hp-hr)									
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
OFF - Industrial - Other General Industrial Equipment	25	0.0076	0.0076	0.0076	0.0076	0.0076	0.0076	0.0076	0.0076	0.0076	0.0076
OFF - Industrial - Sweepers/Scrubbers	25	0.0100	0.0100	0.0100	0.0101	0.0100	0.0100	0.0100	0.0100	0.0101	0.0101
OFF - Light Commercial - Air Compressors	25	0.0071	0.0072	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071
OFF - Light Commercial - Air Compressors	50	0.0072	0.0072	0.0072	0.0072	0.0072	0.0072	0.0072	0.0072	0.0072	0.0072
OFF - Light Commercial - Generator Sets	25	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110
OFF - Light Commercial - Generator Sets	50	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110
OFF - Light Commercial - Pressure Washers	25	0.0036	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0037	0.0038	0.0038
OFF - Light Commercial - Pressure Washers	50	0.0043	0.0043	0.0042	0.0041	0.0040	0.0040	0.0040	0.0041	0.0041	0.0042
OFF - Light Commercial - Pumps	25	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110
OFF - Light Commercial - Pumps	50	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110
OFF - Light Commercial - Welders	25	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067
OFF - Light Commercial - Welders	50	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067
Portable Equipment - Non-Rental Compressor	50	0.0044	0.0044	0.0045	0.0045	0.0046	0.0046	0.0047	0.0047	0.0048	0.0048
Portable Equipment - Non-Rental Compressor	75	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Compressor	100	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Compressor	175	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Compressor	300	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Compressor	600	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Compressor	750	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Compressor	9999	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Generator	50	0.0044	0.0044	0.0045	0.0045	0.0046	0.0046	0.0047	0.0047	0.0048	0.0048
Portable Equipment - Non-Rental Generator	75	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Generator	100	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Generator	175	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Generator	300	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Generator	600	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Generator	750	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Generator	9999	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Other Portable Equipment	50	0.0044	0.0044	0.0045	0.0045	0.0046	0.0046	0.0047	0.0047	0.0048	0.0048
Portable Equipment - Non-Rental Other Portable Equipment	75	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Other Portable Equipment	100	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Other Portable Equipment	175	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Other Portable Equipment	300	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Other Portable Equipment	600	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Other Portable Equipment	750	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Other Portable Equipment	9999	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Pump	50	0.0044	0.0044	0.0045	0.0045	0.0046	0.0046	0.0047	0.0047	0.0048	0.0048
Portable Equipment - Non-Rental Pump	75	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Pump	100	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Pump	175	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Pump	300	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Pump	600	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Pump	750	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Non-Rental Pump	9999	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Compressor	75	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Compressor	100	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Compressor	175	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Compressor	300	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Compressor	600	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Compressor	750	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Compressor	9999	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Generator	75	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Generator	100	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Generator	175	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Generator	300	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Generator	600	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043

Table A-69. Off-Road Equipment N2O Emission Factors

Vehicle Class	HP Bin	N2O Emission Factor (g/hp-hr)									
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Portable Equipment - Rental Generator	750	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Generator	9999	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Other Portable Equipment	50	0.0044	0.0044	0.0045	0.0045	0.0046	0.0046	0.0047	0.0047	0.0048	0.0048
Portable Equipment - Rental Other Portable Equipment	75	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Other Portable Equipment	100	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Other Portable Equipment	175	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Other Portable Equipment	300	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Other Portable Equipment	600	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Other Portable Equipment	750	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Other Portable Equipment	9999	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Pump	50	0.0044	0.0044	0.0045	0.0045	0.0046	0.0046	0.0047	0.0047	0.0048	0.0048
Portable Equipment - Rental Pump	75	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Pump	100	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Pump	175	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Pump	300	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Pump	600	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Pump	750	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043
Portable Equipment - Rental Pump	9999	0.0039	0.0040	0.0040	0.0041	0.0041	0.0042	0.0042	0.0042	0.0043	0.0043

N2O Emission Factor

0.26 grams per gallon

Source: The Climate Registry. 2018. Default Emission Factors. Table 13.7 U.S. Default Factors for Calculating CH4 and N2O Emissions from Non-Highway Vehicles, Construction/Mining Equipment, Diesel Fuel.

Note:
Calculated fuel consumption factor (gallons per horsepower-hour) calculated from OFFROAD2017 and multiplied by N2O emission factor to convert to grams per horsepower-hour.

Table A-70. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Emission Factors - 2024 (g/hp-hr or g/hr)			Emission Factors - 2025 (g/hp-hr or g/hr)		
							CO2	CH4	N2O	CO2	CH4	N2O
Earthmoving Equipment												
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	53	110	1	g/hp-hr	208.7387	0.0286	0.0000	208.7713	0.0272	0.0000
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	71,036	170	2	g/hp-hr	208.7387	0.0286	0.0000	208.7713	0.0272	0.0000
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	110,098	305	3	g/hp-hr	210.3833	0.0217	0.0000	210.3710	0.0208	0.0000
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	1,867	202	1	g/hp-hr	190.5561	0.0128	0.0000	190.5542	0.0123	0.0000
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	59,824	373	2	g/hp-hr	190.3041	0.0126	0.0000	190.7207	0.0121	0.0000
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	9,507	699	1	g/hp-hr	190.3624	0.0126	0.0000	190.3781	0.0121	0.0000
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	914	193	1	g/hp-hr	226.1851	0.0191	0.0000	226.1049	0.0183	0.0000
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	138	36	1	g/hp-hr	217.0388	0.0219	0.0000	217.1252	0.0214	0.0000
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	70,318	200	2	g/hp-hr	215.7561	0.0148	0.0000	215.6772	0.0142	0.0000
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	914	27	1	g/hp-hr	214.0815	0.0303	0.0000	213.9154	0.0294	0.0000
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	11,600	235	1	g/hp-hr	193.8874	0.0109	0.0000	194.1451	0.0104	0.0000
2.0 CY Excavator	ConstMin - Excavators	Diesel	75	235	1	g/hp-hr	201.8187	0.0124	0.0000	201.7514	0.0119	0.0000
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,063	286	1	g/hp-hr	193.8874	0.0108	0.0000	194.1451	0.0103	0.0000
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	5,755	290	1	g/hp-hr	193.8874	0.0108	0.0000	194.1451	0.0103	0.0000
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	24,968	80	1	g/hp-hr	195.2836	0.0159	0.0000	195.2576	0.0153	0.0000
5 Ton Flatbed Truck	n/a - onroad	Diesel	5,457	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	83	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	5,080	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	256,985	340	6	g/hp-hr	201.5560	0.0132	0.0000	201.8708	0.0127	0.0000
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	43,944	680	2	g/hp-hr	201.4380	0.0132	0.0000	201.9102	0.0127	0.0000
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	12,112	783	1	g/hp-hr	254.5773	0.0211	0.0000	254.5773	0.0202	0.0000
22" Smooth Drum Manual (Bomag 55)	OFF - ConstMin - Plate Compactors	Diesel	2,021	4	1	g/hp-hr	244.3700	0.0257	0.0000	244.3860	0.0257	0.0000
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	50	120	1	g/hp-hr	197.9028	0.0203	0.0000	197.9031	0.0191	0.0000
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	597	145	1	g/hp-hr	197.9028	0.0156	0.0000	197.9031	0.0147	0.0000
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	157	145	1	g/hp-hr	197.9028	0.0156	0.0000	197.9031	0.0147	0.0000
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	5,391	165	1	g/hp-hr	197.9028	0.0156	0.0000	197.9031	0.0147	0.0000
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	55	190	1	g/hp-hr	198.1512	0.0129	0.0000	198.1409	0.0123	0.0000
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	23,482	315	1	g/hp-hr	199.0623	0.0126	0.0000	198.7551	0.0121	0.0000
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	2,210	180	1	g/hp-hr	420.4925	0.0000	0.0000	420.4925	0.0000	0.0000
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	2,210	210	1	g/hp-hr	420.4925	0.0000	0.0000	420.4925	0.0000	0.0000
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	1,105	150	1	g/hp-hr	420.5488	0.0000	0.0000	420.5069	0.0000	0.0000
Concrete Equipment												
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	5,334	10	1	g/hp-hr	318.4946	0.0334	0.0000	318.3822	0.0334	0.0000
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	15,182	220	1	g/hp-hr	161.4394	0.0109	0.0000	163.1994	0.0103	0.0000
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	917	330	1	g/hp-hr	161.4394	0.0106	0.0000	163.1994	0.0101	0.0000
Grout Pump	OFF - Light Commercial - Pumps	Diesel	8,685	18	1	g/hp-hr	420.5680	0.0477	0.0000	420.5160	0.0472	0.0000
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	9,808	100	1	g/hp-hr	161.4394	0.0177	0.0000	163.1994	0.0167	0.0000
Utility Equipment												
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	34,088	13	1	g/hp-hr	292.0282	0.1790	0.2368	292.0268	0.1786	0.2365
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	200	134	1	g/hp-hr	161.4394	0.0127	0.0000	163.1994	0.0118	0.0000
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	20,262	268	1	g/hp-hr	161.4394	0.0098	0.0000	163.1994	0.0093	0.0000
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	2,843	429	1	g/hp-hr	161.4394	0.0098	0.0000	163.1994	0.0093	0.0000
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	483,274	12	12	g/hp-hr	466.0080	0.0489	0.0000	466.0129	0.0489	0.0000
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	200	18	1	g/hp-hr	296.3187	0.2757	0.2104	296.3256	0.2757	0.2104
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	1,060	35	1	g/hp-hr	272.8000	0.0289	0.0000	272.7981	0.0272	0.0000
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	19,943	61	1	g/hp-hr	161.4394	0.0152	0.0000	163.1994	0.0144	0.0000
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	7,171	130	1	g/hp-hr	161.4394	0.0120	0.0000	163.1994	0.0113	0.0000
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	30,483	266	1	g/hp-hr	161.4394	0.0096	0.0000	163.1994	0.0092	0.0000
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	19,230	19	1	g/hp-hr	255.7471	0.0290	0.0000	255.7515	0.0287	0.0000
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	38,711	22	1	g/hp-hr	255.7471	0.0290	0.0000	255.7515	0.0287	0.0000
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	237	24	1	g/hp-hr	255.7471	0.0290	0.0000	255.7515	0.0287	0.0000
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	111	33	1	g/hp-hr	255.7284	0.0248	0.0000	255.7439	0.0231	0.0000
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	19,299	21	1	g/hp-hr	171.2121	0.0188	0.0000	171.3677	0.0188	0.0000
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	12,675	21	1	g/hp-hr	171.2121	0.0188	0.0000	171.3677	0.0188	0.0000
Hoisting Equipment												
20 Ton Truck Crane	ConstMin - Cranes	Diesel	50	123	1	g/hp-hr	152.2348	0.0134	0.0000	152.3160	0.0127	0.0000
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	148	170	1	g/hp-hr	152.2348	0.0134	0.0000	152.3160	0.0127	0.0000
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	26,245	178	1	g/hp-hr	151.9944	0.0112	0.0000	151.9937	0.0107	0.0000
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	14,545	308	1	g/hp-hr	151.9844	0.0110	0.0000	151.9996	0.0105	0.0000
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	6,457	123	1	g/hp-hr	152.2348	0.0134	0.0000	152.3160	0.0127	0.0000
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	300	130	1	g/hp-hr	152.2348	0.0134	0.0000	152.3160	0.0127	0.0000
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	1,050	355	1	g/hp-hr	151.9844	0.0110	0.0000	151.9996	0.0105	0.0000
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	375	63	1	g/hp-hr	162.6858	0.0108	0.0000	162.6905	0.0102	0.0000
Drilling & Tunneling Equipment												
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	54,435	221	2	g/hp-hr	263.7776	0.0088	0.0000	264.1227	0.0087	0.0000
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	4,319	221	1	g/hp-hr	263.7776	0.0088	0.0000	264.1227	0.0087	0.0000
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	338	44	1	g/hp-hr	300.8277	0.0236	0.0000	301.4897	0.0236	0.0000
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	19	63	1	g/hp-hr	162.6858	0.0108	0.0000	162.6905	0.0102	0.0000
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,585	98	1	g/hp-hr	195.2836	0.0159	0.0000	195.2576	0.0153	0.0000

Table A-70. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Emission Factors - 2026 (g/hp-hr or g/hr)			Emission Factors - 2027 (g/hp-hr or g/hr)			Emission Factors - 2028 (g/hp-hr or g/hr)			Emission Factors - 2029 (g/hp-hr or g/hr)		
			CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O
Earthmoving Equipment														
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	208.7348	0.0258	0.0000	208.6262	0.0245	0.0000	208.8690	0.0233	0.0000	208.6620	0.0222	0.0000
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	208.7348	0.0258	0.0000	208.6262	0.0245	0.0000	208.8690	0.0233	0.0000	208.6620	0.0222	0.0000
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	210.5205	0.0199	0.0000	210.5242	0.0191	0.0000	210.6423	0.0184	0.0000	210.4711	0.0178	0.0000
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	190.5246	0.0118	0.0000	190.5502	0.0113	0.0000	190.5905	0.0109	0.0000	190.5592	0.0106	0.0000
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	190.7433	0.0116	0.0000	190.9095	0.0112	0.0000	190.7549	0.0108	0.0000	190.5371	0.0105	0.0000
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	190.5311	0.0116	0.0000	190.6300	0.0112	0.0000	190.3180	0.0108	0.0000	190.2403	0.0105	0.0000
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	226.0976	0.0175	0.0000	225.9929	0.0168	0.0000	226.1379	0.0162	0.0000	226.1042	0.0157	0.0000
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	216.9195	0.0210	0.0000	216.8927	0.0208	0.0000	216.8882	0.0206	0.0000	216.8243	0.0205	0.0000
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	215.6734	0.0136	0.0000	215.7870	0.0131	0.0000	215.8074	0.0127	0.0000	215.7782	0.0123	0.0000
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	213.6159	0.0287	0.0000	213.5477	0.0281	0.0000	213.6382	0.0276	0.0000	213.6795	0.0271	0.0000
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	194.4190	0.0100	0.0000	194.3012	0.0097	0.0000	194.2654	0.0094	0.0000	194.3088	0.0092	0.0000
2.0 CY Excavator	ConstMin - Excavators	Diesel	201.7146	0.0115	0.0000	201.7091	0.0111	0.0000	201.6957	0.0108	0.0000	201.6771	0.0106	0.0000
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	194.4190	0.0100	0.0000	194.3012	0.0096	0.0000	194.2654	0.0094	0.0000	194.3088	0.0092	0.0000
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	194.4190	0.0100	0.0000	194.3012	0.0096	0.0000	194.2654	0.0094	0.0000	194.3088	0.0092	0.0000
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	195.2002	0.0148	0.0000	195.1675	0.0144	0.0000	195.1481	0.0140	0.0000	195.0370	0.0138	0.0000
5 Ton Flatbed Truck	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	202.0926	0.0122	0.0000	202.0321	0.0119	0.0000	202.1420	0.0116	0.0000	202.2226	0.0113	0.0000
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	201.9395	0.0123	0.0000	201.9863	0.0119	0.0000	201.9561	0.0116	0.0000	201.9875	0.0113	0.0000
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	254.5773	0.0194	0.0000	254.6479	0.0187	0.0000	254.5067	0.0180	0.0000	254.7150	0.0174	0.0000
22" Smooth Drum Manual (Bomag 55)	OFF - ConstMin - Plate Compactors	Diesel	244.4017	0.0257	0.0000	244.3351	0.0257	0.0000	244.3897	0.0257	0.0000	244.3118	0.0257	0.0000
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	197.8719	0.0180	0.0000	197.8826	0.0172	0.0000	197.8870	0.0164	0.0000	197.9027	0.0157	0.0000
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	197.8719	0.0139	0.0000	197.8826	0.0132	0.0000	197.8870	0.0125	0.0000	197.9027	0.0119	0.0000
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	197.8719	0.0139	0.0000	197.8826	0.0132	0.0000	197.8870	0.0125	0.0000	197.9027	0.0119	0.0000
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	197.8719	0.0139	0.0000	197.8826	0.0132	0.0000	197.8870	0.0125	0.0000	197.9027	0.0119	0.0000
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	198.1622	0.0117	0.0000	198.1290	0.0112	0.0000	198.1809	0.0107	0.0000	198.1744	0.0103	0.0000
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	198.4627	0.0115	0.0000	198.3839	0.0110	0.0000	199.1161	0.0106	0.0000	199.2778	0.0101	0.0000
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	420.9484	0.0000	0.0000	420.2649	0.0000	0.0000	420.1512	0.0000	0.0000	421.0626	0.0000	0.0000
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	420.9484	0.0000	0.0000	420.2649	0.0000	0.0000	420.1512	0.0000	0.0000	421.0626	0.0000	0.0000
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	420.5069	0.0000	0.0000	420.4231	0.0000	0.0000	420.6745	0.0000	0.0000	420.6326	0.0000	0.0000
Concrete Equipment														
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	318.5246	0.0334	0.0000	318.6793	0.0334	0.0000	318.6552	0.0334	0.0000	318.3736	0.0334	0.0000
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	164.9786	0.0098	0.0000	166.7772	0.0094	0.0000	168.5953	0.0090	0.0000	170.4333	0.0087	0.0000
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	164.9786	0.0097	0.0000	166.7772	0.0093	0.0000	168.5953	0.0089	0.0000	170.4333	0.0086	0.0000
Grout Pump	OFF - Light Commercial - Pumps	Diesel	420.5444	0.0467	0.0000	420.5388	0.0464	0.0000	420.5336	0.0462	0.0000	420.5497	0.0460	0.0000
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	164.9786	0.0156	0.0000	166.7772	0.0147	0.0000	168.5953	0.0138	0.0000	170.4333	0.0131	0.0000
Utility Equipment														
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	292.0261	0.1784	0.2364	292.0286	0.1783	0.2363	292.0281	0.1784	0.2364	292.0282	0.1784	0.2364
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	164.9786	0.0110	0.0000	166.7772	0.0103	0.0000	168.5953	0.0096	0.0000	170.4333	0.0090	0.0000
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	164.9786	0.0089	0.0000	166.7772	0.0085	0.0000	168.5953	0.0082	0.0000	170.4333	0.0079	0.0000
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	164.9786	0.0089	0.0000	166.7772	0.0085	0.0000	168.5953	0.0082	0.0000	170.4333	0.0079	0.0000
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	466.0080	0.0489	0.0000	466.0127	0.0489	0.0000	466.0237	0.0489	0.0000	466.0165	0.0489	0.0000
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	296.3135	0.2756	0.2104	296.3214	0.2757	0.2104	296.3178	0.2757	0.2104	296.3166	0.2757	0.2104
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	272.7594	0.0256	0.0000	272.7864	0.0242	0.0000	272.8144	0.0230	0.0000	272.8182	0.0220	0.0000
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	164.9786	0.0136	0.0000	166.7772	0.0128	0.0000	168.5953	0.0122	0.0000	170.4333	0.0116	0.0000
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	164.9786	0.0106	0.0000	166.7772	0.0098	0.0000	168.5953	0.0092	0.0000	170.4333	0.0086	0.0000
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	164.9786	0.0088	0.0000	166.7772	0.0084	0.0000	168.5953	0.0080	0.0000	170.4333	0.0077	0.0000
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	255.7636	0.0284	0.0000	255.7551	0.0282	0.0000	255.7555	0.0281	0.0000	255.7432	0.0280	0.0000
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	255.7636	0.0284	0.0000	255.7551	0.0282	0.0000	255.7555	0.0281	0.0000	255.7432	0.0280	0.0000
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	255.7636	0.0284	0.0000	255.7551	0.0282	0.0000	255.7555	0.0281	0.0000	255.7432	0.0280	0.0000
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	255.7373	0.0217	0.0000	255.7388	0.0203	0.0000	255.7398	0.0192	0.0000	255.7319	0.0183	0.0000
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	171.0577	0.0187	0.0000	171.1097	0.0187	0.0000	171.0342	0.0186	0.0000	171.5747	0.0186	0.0000
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	171.0577	0.0187	0.0000	171.1097	0.0187	0.0000	171.0342	0.0186	0.0000	171.5747	0.0186	0.0000
Hoisting Equipment														
20 Ton Truck Crane	ConstMin - Cranes	Diesel	152.3557	0.0120	0.0000	152.3506	0.0114	0.0000	152.3181	0.0108	0.0000	152.2907	0.0103	0.0000
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	152.3557	0.0120	0.0000	152.3506	0.0114	0.0000	152.3181	0.0108	0.0000	152.2907	0.0103	0.0000
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	151.9935	0.0102	0.0000	151.9926	0.0098	0.0000	151.9875	0.0094	0.0000	151.9976	0.0090	0.0000
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	151.9639	0.0101	0.0000	151.9623	0.0096	0.0000	152.0485	0.0092	0.0000	152.0071	0.0089	0.0000
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	152.3557	0.0120	0.0000	152.3506	0.0114	0.0000	152.3181	0.0108	0.0000	152.2907	0.0103	0.0000
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	152.3557	0.0120	0.0000	152.3506	0.0114	0.0000	152.3181	0.0108	0.0000	152.2907	0.0103	0.0000
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	151.9639	0.0101	0.0000	151.9623	0.0096	0.0000	152.0485	0.0092	0.0000	152.0071	0.0089	0.0000
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	162.6926	0.0095	0.0000	162.6912	0.0089	0.0000	162.6862	0.0084	0.0000	162.6989	0.0080	0.0000
Drilling & Tunneling Equipment														
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	264.0234	0.0087	0.0000	264.0272	0.0087	0.0000	263.5919	0.0086	0.0000	263.8880	0.0086	0.0000
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	264.0234	0.0087	0.0000	264.0272	0.0087	0.0000	263.5919	0.0086	0.0000	263.8880	0.0086	0.0000
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	303.7846	0.0236	0.0000	301.5427	0.0236	0.0000	299.0406	0.0236	0.0000	299.5863	0.0236	0.0000
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	162.6926	0.0095	0.0000	162.6912	0.0089	0.0000	162.6862	0.0084	0.0000	162.6989	0.0080	0.0000
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	195.2002	0.0148	0.0000	195.1675	0.0144	0.0000	195.1481	0.0140	0.0000	195.0370	0.0138	0.0000

Operating Schedule
20 hours per day
365 days per year
6 years per project
7,300 hours per year
43,800 hours per project

Starting Year
2024

Conversions
1,000,000 grams per metric ton

Onsite Speed Limit
15 miles per hour

Global Warming Potential
CO2 1
CH4 25
N2O 298

Table A-70. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Emission Factors - 2024 (g/hp-hr or g/hr)			Emission Factors - 2025 (g/hp-hr or g/hr)		
							CO2	CH4	N2O	CO2	CH4	N2O
Service & Maintenance Equipment												
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	1,287	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	404,389	n/a	10	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	117,268	n/a	3	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
5 Ton Flat Bed Truck	n/a - onroad	Diesel	22,262	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
10 Ton Flat Bed Truck	n/a - onroad	Diesel	3,158	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
1- Ton Mechanic Truck	n/a - onroad	Diesel	3,250	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
2-Ton Mechanic Truck	n/a - onroad	Diesel	116,578	n/a	3	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
Lube Truck	n/a - onroad	Diesel	76,667	n/a	2	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	38,333	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
1000 Gallon Watertruck	n/a - onroad	Diesel	2,091	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
3000 Gallon Watertruck	n/a - onroad	Diesel	26,605	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
5000 Gallon Watertanker	n/a - onroad	Diesel	597	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	74,735	500	2	g/hp-hr	229.1850	0.0226	0.0000	229.3586	0.0216	0.0000
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	3,803	500	1	g/hp-hr	229.1850	0.0226	0.0000	229.3586	0.0216	0.0000
5 Ton Boomtruck	n/a - onroad	Diesel	212	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
10 Ton Boomtruck	n/a - onroad	Diesel	249	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720
20 Ton Boomtruck	n/a - onroad	Diesel	375	n/a	1	g/hr	10,270.7083	0.0765	0.0720	9,933.3115	0.0765	0.0720

Notes:
No logging equipment is available in the OFFROAD2017 database for the San Francisco Bay Area Air Basin. Therefore, equipment from the San Joaquin Valley Air Basin was used to estimate emission factors for skidders.
Emission factors are in units of grams per horsepower-hour (g/hp-hr) for offroad construction equipment and grams per hour (g/hr) for on-road motor vehicles (e.g., flatbed trucks).

Table A-70. Emission Factor Summary by Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Emission Factors - 2026 (g/hp-hr or g/hr)			Emission Factors - 2027 (g/hp-hr or g/hr)			Emission Factors - 2028 (g/hp-hr or g/hr)			Emission Factors - 2029 (g/hp-hr or g/hr)		
			CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O
Service & Maintenance Equipment														
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
5 Ton Flat Bed Truck	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
10 Ton Flat Bed Truck	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
1- Ton Mechanic Truck	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
2-Ton Mechanic Truck	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
Lube Truck	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
1000 Gallon Watertruck	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
3000 Gallon Watertruck	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
5000 Gallon Watertanker	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	229.4675	0.0207	0.0000	229.6831	0.0199	0.0000	229.8542	0.0192	0.0000	229.6532	0.0185	0.0000
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	229.4675	0.0207	0.0000	229.6831	0.0199	0.0000	229.8542	0.0192	0.0000	229.6532	0.0185	0.0000
5 Ton Boomtruck	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
10 Ton Boomtruck	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720
20 Ton Boomtruck	n/a - onroad	Diesel	9,640.9808	0.0765	0.0720	9,377.7968	0.0765	0.0720	9,143.9901	0.0765	0.0720	8,939.1982	0.0765	0.0720

Notes:
No logging equipment is available in the OFFROAD2017 database for the San Francisco Bay Area Air Basin. Therefore, equipment from th
Emission factors are in units of grams per horsepower-hour (g/hp-hr) for offroad construction equipment and grams per hour (g/hr) for on-r

Table A-71. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Annual Emissions - 2024 (metric tons per year)			Annual Emissions - 2025 (metric tons per year)			Annual Emissions - 2026 (metric tons per year)			Annual Emissions - 2027 (metric tons per year)		
							CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O
Earthmoving Equipment																		
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	53	110	1	g/hp-hr	1.22	0.00	--	--	--	--	--	--	--	--	--	--
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	71,036	170	2	g/hp-hr	518.09	0.07	--	518.17	0.07	--	518.08	0.06	--	517.81	0.06	--
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	110,098	305	3	g/hp-hr	1,405.26	0.14	--	1,405.17	0.14	--	1,406.17	0.13	--	1,406.20	0.13	--
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	1,867	202	1	g/hp-hr	71.87	0.00	--	--	--	--	--	--	--	--	--	--
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	59,824	373	2	g/hp-hr	1,036.36	0.07	--	1,038.63	0.07	--	1,038.75	0.06	--	1,039.65	0.06	--
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	9,507	699	1	g/hp-hr	971.36	0.06	--	293.65	0.02	--	--	--	--	--	--	--
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	914	193	1	g/hp-hr	39.92	0.00	--	--	--	--	--	--	--	--	--	--
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	138	36	1	g/hp-hr	1.07	0.00	--	--	--	--	--	--	--	--	--	--
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	70,318	200	2	g/hp-hr	630.01	0.04	--	629.78	0.04	--	629.77	0.04	--	630.10	0.04	--
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	914	27	1	g/hp-hr	5.29	0.00	--	--	--	--	--	--	--	--	--	--
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	11,600	235	1	g/hp-hr	332.61	0.02	--	196.18	0.01	--	--	--	--	--	--	--
2.0 CY Excavator	ConstMin - Excavators	Diesel	75	235	1	g/hp-hr	3.56	0.00	--	--	--	--	--	--	--	--	--	--
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,063	286	1	g/hp-hr	58.92	0.00	--	--	--	--	--	--	--	--	--	--
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	5,755	290	1	g/hp-hr	323.58	0.02	--	--	--	--	--	--	--	--	--	--
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	24,968	80	1	g/hp-hr	114.05	0.01	--	114.03	0.01	--	114.00	0.01	--	47.89	0.00	--
5 Ton Flatbed Truck	n/a - onroad	Diesel	5,457	n/a	1	g/hr	56.05	0.00	0.00	--	--	--	--	--	--	--	--	--
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	83	n/a	1	g/hr	0.85	0.00	0.00	--	--	--	--	--	--	--	--	--
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	5,080	n/a	1	g/hr	52.18	0.00	0.00	--	--	--	--	--	--	--	--	--
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	256,985	340	6	g/hp-hr	3,001.57	0.20	--	3,006.26	0.19	--	3,009.56	0.18	--	3,008.66	0.18	--
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	43,944	680	2	g/hp-hr	1,999.88	0.13	--	2,004.56	0.13	--	2,004.85	0.12	--	19.71	0.00	--
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	12,112	783	1	g/hp-hr	1,455.14	0.12	--	959.14	0.08	--	--	--	--	--	--	--
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	2,021	4	1	g/hp-hr	1.73	0.00	--	--	--	--	--	--	--	--	--	--
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	50	120	1	g/hp-hr	1.19	0.00	--	--	--	--	--	--	--	--	--	--
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	597	145	1	g/hp-hr	17.14	0.00	--	--	--	--	--	--	--	--	--	--
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	157	145	1	g/hp-hr	4.51	0.00	--	--	--	--	--	--	--	--	--	--
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	5,391	165	1	g/hp-hr	176.02	0.01	--	--	--	--	--	--	--	--	--	--
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	55	190	1	g/hp-hr	2.07	0.00	--	--	--	--	--	--	--	--	--	--
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	23,482	315	1	g/hp-hr	457.74	0.03	--	457.04	0.03	--	456.37	0.03	--	98.87	0.01	--
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	2,210	180	1	g/hp-hr	167.27	--	--	--	--	--	--	--	--	--	--	--
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	2,210	210	1	g/hp-hr	195.15	--	--	--	--	--	--	--	--	--	--	--
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	1,105	150	1	g/hp-hr	69.71	--	--	--	--	--	--	--	--	--	--	--
Concrete Equipment																		
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	5,334	10	1	g/hp-hr	16.99	0.00	--	--	--	--	--	--	--	--	--	--
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	15,182	220	1	g/hp-hr	259.27	0.02	--	262.10	0.02	--	21.11	0.00	--	--	--	--
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	917	330	1	g/hp-hr	48.87	0.00	--	--	--	--	--	--	--	--	--	--
Grout Pump	OFF - Light Commercial - Pumps	Diesel	8,685	18	1	g/hp-hr	55.26	0.01	--	10.48	0.00	--	--	--	--	--	--	--
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	9,808	100	1	g/hp-hr	117.85	0.01	--	40.93	0.00	--	--	--	--	--	--	--
Utility Equipment																		
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	34,088	13	1	g/hp-hr	27.71	0.02	0.02	27.71	0.02	0.02	27.71	0.02	0.02	27.71	0.02	0.02
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	200	134	1	g/hp-hr	4.33	0.00	--	--	--	--	--	--	--	--	--	--
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	20,262	268	1	g/hp-hr	315.84	0.02	--	319.28	0.02	--	250.33	0.01	--	--	--	--
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	2,843	429	1	g/hp-hr	196.90	0.01	--	--	--	--	--	--	--	--	--	--
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	483,274	12	12	g/hp-hr	489.87	0.05	--	489.87	0.05	--	489.87	0.05	--	489.87	0.05	--
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	200	18	1	g/hp-hr	1.07	0.00	0.00	--	--	--	--	--	--	--	--	--
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	1,060	35	1	g/hp-hr	10.12	0.00	--	--	--	--	--	--	--	--	--	--
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	19,943	61	1	g/hp-hr	71.89	0.01	--	72.67	0.01	--	53.77	0.00	--	--	--	--
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	7,171	130	1	g/hp-hr	150.49	0.01	--	--	--	--	--	--	--	--	--	--
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	30,483	266	1	g/hp-hr	313.48	0.02	--	316.90	0.02	--	320.36	0.02	--	323.85	0.02	--
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	19,230	19	1	g/hp-hr	35.47	0.00	--	35.47	0.00	--	22.50	0.00	--	--	--	--
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	38,711	22	1	g/hp-hr	41.07	0.00	--	41.07	0.00	--	41.08	0.00	--	41.07	0.00	--
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	237	24	1	g/hp-hr	1.46	0.00	--	--	--	--	--	--	--	--	--	--
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	111	33	1	g/hp-hr	0.94	0.00	--	--	--	--	--	--	--	--	--	--
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	19,299	21	1	g/hp-hr	26.25	0.00	--	26.27	0.00	--	16.88	0.00	--	--	--	--
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	12,675	21	1	g/hp-hr	26.25	0.00	--	19.34	0.00	--	--	--	--	--	--	--
Hoisting Equipment																		
20 Ton Truck Crane	ConstMin - Cranes	Diesel	50	123	1	g/hp-hr	0.94	0.00	--	--	--	--	--	--	--	--	--	--
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	148	170	1	g/hp-hr	3.83	0.00	--	--	--	--	--	--	--	--	--	--
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	26,245	178	1	g/hp-hr	197.50	0.01	--	197.50	0.01	--	197.50	0.01	--	117.55	0.01	--
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	14,545	308	1	g/hp-hr	341.72	0.02	--	339.20	0.02	--	--	--	--	--	--	--
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	6,457	123	1	g/hp-hr	120.91	0.01	--	--	--	--	--	--	--	--	--	--
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	300	130	1	g/hp-hr	5.94	0.00	--	--	--	--	--	--	--	--	--	--
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	1,050	355	1	g/hp-hr	56.65	0.00	--	--	--	--	--	--	--	--	--	--
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	375	63	1	g/hp-hr	3.84	0.00	--	--	--	--	--	--	--	--	--	--
Drilling & Tunneling Equipment																		
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	54,435	221	2	g/hp-hr	851.10	0.03	--	852.22	0.03	--	851.90	0.03	--	620.53	0.02	--
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	4,319	221	1	g/hp-hr	251.79	0.01	--	--	--	--	--	--	--	--	--	--
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	338	44	1	g/hp-hr	4.47	0.00	--	--	--	--	--	--	--	--	--	--
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	19	63	1	g/hp-hr	0.19	0.00	--	--	--	--	--	--	--	--	--	--
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	1,585	98	1	g/hp-hr	30.33	0.00	--	--	--	--	--	--	--	--	--	--

Table A-71. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Hours per Project	Size (hp)	Quantity	Unit	Annual Emissions - 2024 (metric tons per year)			Annual Emissions - 2025 (metric tons per year)			Annual Emissions - 2026 (metric tons per year)			Annual Emissions - 2027 (metric tons per year)		
							CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O

Table A-71. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Annual Emissions - 2028 (metric tons per year)			Annual Emissions - 2029 (metric tons per year)			Annual Emissions (metric tons CO2e per year)							
			CO2	CH4	N2O	CO2	CH4	N2O	2024	2025	2026	2027	2028	2029	Annual Maximum	Project Total
Earthmoving Equipment																
110 Hsp Bulldozer (Cat D5)	ConstMin - Rubber Tired Dozers	Diesel	--	--	--	--	--	--	1.22	--	--	--	--	--	1.22	1.22
170 Hsp Bulldozer (Cat D6)	ConstMin - Rubber Tired Dozers	Diesel	448.67	0.05	--	--	--	--	519.86	519.86	519.68	519.33	449.92	--	519.86	2,528.65
305 Hsp Bulldozer (Cat D8)	ConstMin - Rubber Tired Dozers	Diesel	1,406.99	0.12	--	38.37	0.00	--	1,408.88	1,408.64	1,409.50	1,409.39	1,410.06	38.45	1,410.06	7,084.92
3.5 CY Loader (Cat 950)	ConstMin - Rubber Tired Loaders	Diesel	--	--	--	--	--	--	72.00	--	--	--	--	--	72.00	72.00
6.5 CY Loader (Cat 980)	ConstMin - Rubber Tired Loaders	Diesel	101.31	0.01	--	--	--	--	1,038.07	1,040.27	1,040.33	1,041.18	101.45	--	1,041.18	4,261.30
11.2 CY Loader (Cat 990)	ConstMin - Rubber Tired Loaders	Diesel	--	--	--	--	--	--	972.97	294.11	--	--	--	--	972.97	1,267.08
3.0 CY Track Loader (Cat 963)	ConstMin - Crawler Tractors	Diesel	--	--	--	--	--	--	40.00	--	--	--	--	--	40.00	40.00
1300LB Skid Steer Loader (Bobcat 743)	ConstMin - Skid Steer Loaders	Diesel	--	--	--	--	--	--	1.08	--	--	--	--	--	1.08	1.08
200 Hsp Grader (Cat 14G)	ConstMin - Graders	Diesel	514.42	0.03	--	--	--	--	631.09	630.81	630.76	631.06	515.17	--	631.09	3,038.89
1.7 CY Backhoe (JD 790)	ConstMin - Tractors/Loaders/Backhoes	Diesel	--	--	--	--	--	--	5.30	--	--	--	--	--	5.30	5.30
2.0 CY Backhoe (Cat 330)	ConstMin - Tractors/Loaders/Backhoes	Diesel	--	--	--	--	--	--	333.08	196.44	--	--	--	--	333.08	529.52
2.0 CY Excavator	ConstMin - Excavators	Diesel	--	--	--	--	--	--	3.56	--	--	--	--	--	3.56	3.56
2.6 CY Backhoe (Cat 350)	ConstMin - Tractors/Loaders/Backhoes	Diesel	--	--	--	--	--	--	59.00	--	--	--	--	--	59.00	59.00
2.7 CY Backhoe (Cat 345 BL)	ConstMin - Tractors/Loaders/Backhoes	Diesel	--	--	--	--	--	--	324.03	--	--	--	--	--	324.03	324.03
1.7 CY Backhoe Loader (Case680)	ConstMin - Tractors/Loaders/Backhoes	Diesel	--	--	--	--	--	--	114.28	114.25	114.21	47.98	--	--	114.28	390.73
5 Ton Flatbed Truck	n/a - onroad	Diesel	--	--	--	--	--	--	56.17	--	--	--	--	--	56.17	56.17
20 Ton (10 CY) Tandem Truck	n/a - onroad	Diesel	--	--	--	--	--	--	0.85	--	--	--	--	--	0.85	0.85
24 Ton (12 CY) Tandem Truck	n/a - onroad	Diesel	--	--	--	--	--	--	52.29	--	--	--	--	--	52.29	52.29
35 Ton Articulated Truck (Cat D350)	ConstMin - Off-Highway Trucks	Diesel	3,010.30	0.17	--	2,611.69	0.15	--	3,006.49	3,010.99	3,014.12	3,013.08	3,014.60	2,615.35	3,014.60	17,674.63
50 Ton Off Hwy Truck 680 Hsp (Cat 773)	ConstMin - Off-Highway Trucks	Diesel	--	--	--	--	--	--	2,003.16	2,007.72	2,007.90	19.74	--	--	2,007.90	6,038.52
26 CY Tandem Scraper (Cat 637)	ConstMin - Scrapers	Diesel	--	--	--	--	--	--	1,458.15	961.04	--	--	--	--	1,458.15	2,419.20
22" Smooth Drum Manual (Bomag 55)	ConstMin - Rollers	Diesel	--	--	--	--	--	--	1.73	--	--	--	--	--	1.73	1.73
10 Ton Compactor 120 hsp (Dyn CA25)	ConstMin - Rollers	Diesel	--	--	--	--	--	--	1.19	--	--	--	--	--	1.19	1.19
13 Ton Compactor 72" (Cat 553)	ConstMin - Rollers	Diesel	--	--	--	--	--	--	17.17	--	--	--	--	--	17.17	17.17
15 Ton Compactor 84" (Cat 563)	ConstMin - Rollers	Diesel	--	--	--	--	--	--	4.52	--	--	--	--	--	4.52	4.52
15 Ton Compactor 84" (Cat 663)	ConstMin - Rollers	Diesel	--	--	--	--	--	--	176.37	--	--	--	--	--	176.37	176.37
20 Ton Compactor 190 hsp (Bomag 217)	ConstMin - Rollers	Diesel	--	--	--	--	--	--	2.07	--	--	--	--	--	2.07	2.07
30 Ton Compactor 315 hsp (Cat 825)	ConstMin - Rollers	Diesel	--	--	--	--	--	--	458.47	457.73	457.03	99.00	--	--	458.47	1,472.23
180 Hsp Wheel Skidder (Cat 535)	OFF - Logging - Skidders	Diesel	--	--	--	--	--	--	167.27	--	--	--	--	--	167.27	167.27
210 Hsp Harvester (Cat 580)	OFF - Logging - Skidders	Diesel	--	--	--	--	--	--	195.15	--	--	--	--	--	195.15	195.15
150 Hsp Grapple (Cat 527)	OFF - Logging - Skidders	Diesel	--	--	--	--	--	--	69.71	--	--	--	--	--	69.71	69.71
Concrete Equipment																
Grout Mixer	OFF - ConstMin - Cement and Mortar Mixers	Diesel	--	--	--	--	--	--	17.03	--	--	--	--	--	17.03	17.03
90 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	--	--	--	--	--	--	259.71	262.51	21.15	--	--	--	262.51	543.37
124 YPH Trailer Mounted Concrete Pump	Portable Equipment - Non-Rental Pump	Diesel	--	--	--	--	--	--	48.95	--	--	--	--	--	48.95	48.95
Grout Pump	OFF - Light Commercial - Pumps	Diesel	--	--	--	--	--	--	55.42	10.51	--	--	--	--	55.42	65.93
8 YPH Wet Shotcrete Pump (Swing 750)	Portable Equipment - Non-Rental Pump	Diesel	--	--	--	--	--	--	118.17	41.04	--	--	--	--	118.17	159.21
Utility Equipment																
10 KW Generator Set (Gas)	OFF - Light Commercial - Generator Sets	Gasoline	18.56	0.01	0.02	--	--	--	34.83	34.83	34.82	34.82	23.31	--	34.83	162.62
100 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	--	--	--	--	--	--	4.34	--	--	--	--	--	4.34	4.34
200 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	--	--	--	--	--	--	316.32	319.74	250.67	--	--	--	319.74	886.73
320 KW Diesel Generator Set	Portable Equipment - Non-Rental Generator	Diesel	--	--	--	--	--	--	197.20	--	--	--	--	--	197.20	197.20
Tower 4-Lights 12 Hsp	OFF - ConstMin - Signal Boards	Diesel	489.88	0.05	--	253.18	0.03	--	491.15	491.16	491.15	491.16	491.17	253.84	491.17	2,709.64
3" Gas Water Pump 20,000 gph	OFF - Light Commercial - Pumps	Gasoline	--	--	--	--	--	--	1.32	--	--	--	--	--	1.32	1.32
150 CFM Diesel Compressor	OFF - Light Commercial - Air Compressors	Diesel	--	--	--	--	--	--	10.15	--	--	--	--	--	10.15	10.15
185 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	--	--	--	--	--	--	72.06	72.83	53.89	--	--	--	72.83	198.78
375 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	--	--	--	--	--	--	150.77	--	--	--	--	--	150.77	150.77
750 CFM Diesel Compressor	Portable Equipment - Non-Rental Compressor	Diesel	57.55	0.00	--	--	--	--	313.95	317.35	320.78	324.25	57.62	--	324.25	1,333.95
250 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	--	--	--	--	--	--	35.57	35.57	22.56	--	--	--	35.57	93.71
350 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	41.07	0.00	--	12.44	0.00	--	41.19	41.19	41.19	41.19	41.19	12.47	41.19	218.42
400 Amp Diesel Welder	OFF - Light Commercial - Welders	Diesel	--	--	--	--	--	--	1.46	--	--	--	--	--	1.46	1.46
Large Dia. Polyethylene Fusion Machine	OFF - Light Commercial - Welders	Diesel	--	--	--	--	--	--	0.94	--	--	--	--	--	0.94	0.94
2000 PSI Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	--	--	--	--	--	--	26.32	26.34	16.93	--	--	--	26.34	69.59
10 GPM Pressure Washer	OFF - Light Commercial - Pressure Washers	Diesel	--	--	--	--	--	--	26.32	19.40	--	--	--	--	26.32	45.72
Hoisting Equipment																
20 Ton Truck Crane	ConstMin - Cranes	Diesel	--	--	--	--	--	--	0.94	--	--	--	--	--	0.94	0.94
50 Ton Truck Crane (Linkbelt 108)	ConstMin - Cranes	Diesel	--	--	--	--	--	--	3.84	--	--	--	--	--	3.84	3.84
60 Ton Crawler Crane (Linkbelt118)	ConstMin - Cranes	Diesel	--	--	--	--	--	--	197.87	197.85	197.83	117.73	--	--	197.87	711.28
150 Ton Crawler Crane (American 9260)	ConstMin - Cranes	Diesel	--	--	--	--	--	--	342.34	339.79	--	--	--	--	342.34	682.13
20 Ton Hydraulic Crane (Grove58)	ConstMin - Cranes	Diesel	--	--	--	--	--	--	121.18	--	--	--	--	--	121.18	121.18
30 Ton Hydraulic Crane (Grove500)	ConstMin - Cranes	Diesel	--	--	--	--	--	--	5.95	--	--	--	--	--	5.95	5.95
60 Ton Hydraulic Crane (Grove)	ConstMin - Cranes	Diesel	--	--	--	--	--	--	56.75	--	--	--	--	--	56.75	56.75
Motorized Manlift 66 Ft	Industrial - Aerial Lifts	Diesel	--	--	--	--	--	--	3.85	--	--	--	--	--	3.85	3.85
Drilling & Tunneling Equipment																
Hydraulic Drill 3" (AC1238/Tam400)	ConstMin - Bore/Drill Rigs	Diesel	--	--	--	--	--	--	851.81	852.92	852.60	621.04	--	--	852.92	3,178.37
2.5" Air Track Rockdrill (IR100)	ConstMin - Bore/Drill Rigs	Diesel	--	--	--	--	--	--	252.00	--	--	--	--	--	252.00	252.00
Core Drill Skid Mounted 44 Hsp	ConstMin - Bore/Drill Rigs	Diesel	--	--	--	--	--	--	4.48	--	--	--	--	--	4.48	4.48
Tunnel Scissor Truck	Industrial - Aerial Lifts	Diesel	--	--	--	--	--	--	0.19	--	--	--	--	--	0.19	0.19
1/4 CY Crawler Backhoe	ConstMin - Tractors/Loaders/Backhoes	Diesel	--	--	--	--	--	--	30.40	--	--	--	--	--	30.40	30.40

Table A-71. Annual Unmitgated Emissions - Onsite Construction Equipment

Equipment Description	OFFROAD2017 Equipment Category	Fuel	Annual Emissions - 2028 (metric tons per year)			Annual Emissions - 2029 (metric tons per year)			Annual Emissions (metric tons CO2e per year)							
			CO2	CH4	N2O	CO2	CH4	N2O	2024	2025	2026	2027	2028	2029	Annual Maximum	Project Total

Service & Maintenance Equipment																		
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	1,287	n/a	1	g/hr	--	--	--	--	--	--	--	--	--	--	--	--
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	404,389	n/a	10	g/hr	#VALUE!	#VALUE!	#VALUE!	--	--	--	--	--	--	--	--	--
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	117,268	n/a	3	g/hr	20.79	0.00	0.00	20.11	0.00	0.00	19.53	0.00	0.00	19.01	0.00	0.00
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	--	--	--	--	--	--	--	--	--	--	--	--
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	300	n/a	1	g/hr	13.21	0.00	0.00	--	--	--	--	--	--	--	--	--
5 Ton Flat Bed Truck	n/a - onroad	Diesel	22,262	n/a	1	g/hr	749.76	0.01	0.01	725.13	0.01	0.01	703.79	0.01	0.01	684.58	0.01	0.01
10 Ton Flat Bed Truck	n/a - onroad	Diesel	3,158	n/a	1	g/hr	224.93	0.00	0.00	217.54	0.00	0.00	211.14	0.00	0.00	205.37	0.00	0.00
1- Ton Mechanic Truck	n/a - onroad	Diesel	3,250	n/a	1	g/hr	3.08	0.00	0.00	--	--	--	--	--	--	--	--	--
2-Ton Mechanic Truck	n/a - onroad	Diesel	116,578	n/a	3	g/hr	3.08	0.00	0.00	--	--	--	--	--	--	--	--	--
Lube Truck	n/a - onroad	Diesel	76,667	n/a	2	g/hr	74.98	0.00	0.00	72.51	0.00	0.00	70.38	0.00	0.00	3.39	0.00	0.00
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	38,333	n/a	1	g/hr	32.44	0.00	0.00	--	--	--	--	--	--	--	--	--
1000 Gallon Watertruck	n/a - onroad	Diesel	2,091	n/a	1	g/hr	33.38	0.00	0.00	--	--	--	--	--	--	--	--	--
3000 Gallon Watertruck	n/a - onroad	Diesel	26,605	n/a	1	g/hr	224.93	0.00	0.00	217.54	0.00	0.00	211.14	0.00	0.00	205.37	0.00	0.00
5000 Gallon Watertanker	n/a - onroad	Diesel	597	n/a	1	g/hr	149.95	0.00	0.00	145.03	0.00	0.00	140.76	0.00	0.00	136.92	0.00	0.00
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	74,735	500	2	g/hp-hr	836.53	0.08	--	837.16	0.08	--	837.56	0.08	--	838.34	0.07	--
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	3,803	500	1	g/hp-hr	239.60	0.02	--	--	--	--	--	--	--	--	--	--
5 Ton Boomtruck	n/a - onroad	Diesel	212	n/a	1	g/hr	74.98	0.00	0.00	72.51	0.00	0.00	70.38	0.00	0.00	44.13	0.00	0.00
10 Ton Boomtruck	n/a - onroad	Diesel	249	n/a	1	g/hr	6.13	0.00	0.00	--	--	--	--	--	--	--	--	--
20 Ton Boomtruck	n/a - onroad	Diesel	375	n/a	1	g/hr	149.95	0.00	0.00	145.03	0.00	0.00	140.76	0.00	0.00	136.92	0.00	0.00
		Total	**2,461,102**	**n/a**	**n/a**	**n/a**	**#VALUE!**	**#VALUE!**	**#VALUE!**	**18,151.21**	**2,026.07**	**2,025.03**	**15,901.99**	**2,026.88**	**2,026.03**	**12,690.51**	**2,027.68**	**2,027.03**

Service & Maintenance Equipment															
1/2 Ton Pickup Truck 2x2	n/a - onroad	Diesel	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/4 Ton Pickup Truck 2x2	n/a - onroad	Diesel	--	--	--	--	--	--	#VALUE!	--	--	--	--	--	#VALUE!	#VALUE!
3/4 Ton Pickup Truck 4x4	n/a - onroad	Diesel	18.54	0.00	0.00	18.14	0.00	0.00	20.84	20.16	19.58	19.06	18.59	18.19	20.84	116.41
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/4 Ton Crew Cab Truck	n/a - onroad	Diesel	--	--	--	--	--	--	13.24	--	--	--	--	--	13.24	13.24
5 Ton Flat Bed Truck	n/a - onroad	Diesel	667.51	0.01	0.01	352.10	0.00	0.00	751.47	726.84	705.50	686.29	669.22	353.03	751.47	3,892.33
10 Ton Flat Bed Truck	n/a - onroad	Diesel	200.25	0.00	0.00	69.44	0.00	0.00	225.44	218.05	211.65	205.89	200.77	69.62	225.44	1,131.41
1- Ton Mechanic Truck	n/a - onroad	Diesel	--	--	--	--	--	--	3.08	--	--	--	--	--	3.08	3.08
2-Ton Mechanic Truck	n/a - onroad	Diesel	--	--	--	--	--	--	3.08	--	--	--	--	--	3.08	3.08
Lube Truck	n/a - onroad	Diesel	--	--	--	--	--	--	75.15	72.68	70.55	3.40	--	--	75.15	221.78
Fuel Truck (Tandem Axle 20000 litres)	n/a - onroad	Diesel	--	--	--	--	--	--	32.51	--	--	--	--	--	32.51	32.51
1000 Gallon Watertruck	n/a - onroad	Diesel	--	--	--	--	--	--	33.46	--	--	--	--	--	33.46	33.46
3000 Gallon Watertruck	n/a - onroad	Diesel	200.25	0.00	0.00	63.27	0.00	0.00	225.44	218.05	211.65	205.89	200.77	63.43	225.44	1,125.22
5000 Gallon Watertanker	n/a - onroad	Diesel	133.50	0.00	0.00	32.78	0.00	0.00	150.29	145.37	141.10	137.26	133.84	32.86	150.29	740.72
631 WaterWagon	ConstMin - Off-Highway Tractors	Diesel	838.97	0.07	--	210.51	0.02	--	838.59	839.13	839.45	840.16	840.72	210.94	840.72	4,408.99
631 Water Wagon	ConstMin - Off-Highway Tractors	Diesel	--	--	--	--	--	--	240.19	--	--	--	--	--	240.19	240.19
5 Ton Boomtruck	n/a - onroad	Diesel	--	--	--	--	--	--	75.15	72.68	70.55	44.24	--	--	75.15	262.62
10 Ton Boomtruck	n/a - onroad	Diesel	--	--	--	--	--	--	6.15	--	--	--	--	--	6.15	6.15
20 Ton Boomtruck	n/a - onroad	Diesel	133.50	0.00	0.00	15.51	0.00	0.00	150.29	145.37	141.10	137.26	133.84	15.55	150.29	723.41
		Total	**10,309.28**	**2,028.53**	**2,028.03**	**5,706.43**	**2,029.20**	**2,029.00**	**#VALUE!**	**18,188.24**	**15,934.21**	**12,717.38**	**10,330.24**	**5,712.73**	**#VALUE!**	**#VALUE!**

Pacheco Reservoir Expansion Alternative
Offsite Construction Emissions

Table A-72. Construction Worker Commuting Emissions

Year	Annual Trips	Emission Factors, grams per mile			Annual Emissions, tons per year			
		CO2	CH4	N2O	CO2	CH4	N2O	CO2e
2024	159,250	254.53	0.18	0.08	1,621.34	1.17	0.49	1,795.59
2025	191,889	243.80	0.18	0.08	1,871.26	1.41	0.59	2,081.37
2026	291,261	234.50	0.18	0.08	2,731.98	2.14	0.89	3,051.10
2027	309,400	226.32	0.18	0.08	2,800.95	2.27	0.95	3,140.14
2028	309,400	219.16	0.18	0.08	2,712.34	2.27	0.95	3,051.72
2029	142,567	212.89	0.18	0.08	1,214.06	1.05	0.44	1,370.52
				Maximum	**2,800.95**	**2.27**	**0.95**	**3,140.14**
				Total	**12,951.93**	**10.32**	**4.30**	**14,490.43**

Table A-73. Haul Trucks Emissions

Year	Annual Trips	Emission Factors, grams per mile			Annual Emissions, tons per year			
		CO2	CH4	N2O	CO2	CH4	N2O	CO2e
2024	48,230	1,539.49	0.01	0.00	2,969.98	0.01	0.01	2,972.98
2025	132,253	1,533.94	0.01	0.00	8,114.72	0.03	0.03	8,122.96
2026	156,520	1,528.77	0.01	0.00	9,571.34	0.03	0.03	9,581.09
2027	144,387	1,523.51	0.01	0.00	8,798.98	0.03	0.03	8,807.98
2028	10,920	1,518.96	0.01	0.00	663.48	0.00	0.00	664.16
2029	4,550	1,514.70	0.01	0.00	275.67	0.00	0.00	275.96
				Maximum	**9,571.34**	**0.03**	**0.03**	**9,581.09**
				Total	**30,394.17**	**0.10**	**0.10**	**30,425.13**

One-way trip distance	
Workers	40 miles
Trucks	40 miles

Global Warming Potential	
CO2	1
CH4	25
N2O	298

Conversions

1,000,000 grams per metric ton

EMFAC2014 Emission Factors
On-Road Motor Vehicles

Table A-74. Unmitigated Emission Factors for Construction Worker Commutes and Haul Trucks (San Francisco Bay Area Air Basin

	Workers			Heavy-Duty Trucks		
Year	CO2	CH4	N2O	CO2	CH4	N2O
2024	254.5274	0.1837	0.0764	1,539.4861	0.0051	0.0048
2025	243.7953	0.1837	0.0764	1,533.9352	0.0051	0.0048
2026	234.4962	0.1837	0.0765	1,528.7722	0.0051	0.0048
2027	226.3207	0.1837	0.0766	1,523.5095	0.0051	0.0048
2028	219.1616	0.1838	0.0766	1,518.9573	0.0051	0.0048
2029	212.8932	0.1838	0.0766	1,514.6963	0.0051	0.0048

Note:
Vehicle fleet mix includes gasoline, diesel, and electric automobiles (LDA) and light-duty trucks (LDT1 and LDT2) for construction workers.

Table A-75. On-Road Medium-Duty Vehicle Diesel Emission Factors (San Francisco Bay Area Air Basin), grams per hour

Speed	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
5	5,335.24	5,190.32	5,042.84	4,891.44	4,738.47	4,585.27	4,453.02	4,333.36	4,226.99	4,134.20	4,051.88
10	9,061.54	8,815.38	8,564.04	8,305.84	8,044.73	7,783.39	7,556.62	7,352.88	7,172.74	7,014.92	6,874.88
15	11,585.95	11,266.48	10,941.40	10,607.53	10,270.71	9,933.31	9,640.98	9,377.80	9,143.99	8,939.20	8,757.65
20	12,725.83	12,379.54	12,026.54	11,663.95	11,298.07	10,931.80	10,615.58	10,331.46	10,080.08	9,860.21	9,665.16
25	13,455.78	13,089.96	12,716.94	12,333.81	11,947.09	11,559.93	11,225.43	10,924.85	10,659.01	10,426.39	10,220.02
30	13,938.32	13,559.46	13,173.55	12,777.18	12,377.30	11,976.86	11,631.74	11,320.71	11,045.15	10,804.57	10,591.21
35	14,784.54	14,379.20	13,966.55	13,542.89	13,115.40	12,687.24	12,318.41	11,985.46	11,690.32	11,433.46	11,206.00
40	15,779.91	15,348.81	14,909.89	14,458.98	14,003.72	13,548.11	13,155.84	12,801.57	12,487.59	12,214.53	11,972.77
45	17,063.49	16,603.53	16,134.97	15,653.57	15,168.04	14,681.66	14,262.38	13,884.17	13,548.71	13,255.23	12,994.54
50	19,040.69	18,523.59	17,996.69	17,455.74	16,909.48	16,362.56	15,891.68	15,467.11	15,091.43	14,764.05	14,473.93
55	22,145.35	21,544.69	20,932.70	20,304.08	19,670.03	19,034.75	18,487.21	17,992.60	17,554.13	17,171.58	16,832.19
60	26,111.76	25,403.47	24,681.94	23,941.23	23,194.31	22,446.14	21,801.74	21,222.00	20,708.94	20,260.34	19,862.33
65	31,823.18	30,948.94	30,059.10	29,145.79	28,223.56	27,300.60	26,506.23	25,790.37	25,156.66	24,605.57	24,118.01

CH4 and N2O Emission Factors

Table A-76. San Francisco Bay Area Air Basin County Emission Factors

Year	Type	Fuel	VMT	CH4 (g/mi)	N2O (g/mi)
2024	LDA	GAS	93,606,028	0.1780	0.0647
		DSL	1,166,100	0.0006	0.0012
	LDT1	GAS	6,707,310	0.2024	0.1056
		DSL	4,809	0.0011	0.0017
	LDT2	GAS	33,923,737	0.2024	0.1056
		DSL	72,319	0.0011	0.0017
	Weighted Average Emission Factor (2024), grams per mile			**0.1837**	**0.0764**
2025	LDA	GAS	93,311,764	0.1780	0.0647
		DSL	1,184,105	0.0006	0.0012
	LDT1	GAS	6,680,049	0.2024	0.1056
		DSL	4,639	0.0011	0.0017
	LDT2	GAS	34,172,007	0.2024	0.1056
		DSL	73,654	0.0011	0.0017
	Weighted Average Emission Factor (2025), grams per mile			**0.1837**	**0.0764**
2026	LDA	GAS	92,870,572	0.1780	0.0647
		DSL	1,195,720	0.0006	0.0012
	LDT1	GAS	6,646,085	0.2024	0.1056
		DSL	4,438	0.0011	0.0017
	LDT2	GAS	34,322,944	0.2024	0.1056
		DSL	74,460	0.0011	0.0017
	Weighted Average Emission Factor (2026), grams per mile			**0.1837**	**0.0765**
2027	LDA	GAS	92,720,306	0.1780	0.0647
		DSL	1,207,526	0.0006	0.0012
	LDT1	GAS	6,635,950	0.2024	0.1056
		DSL	3,976	0.0011	0.0017
	LDT2	GAS	34,549,525	0.2024	0.1056
		DSL	75,253	0.0011	0.0017
	Weighted Average Emission Factor (2027), grams per mile			**0.1837**	**0.0766**
2028	LDA	GAS	92,625,303	0.1780	0.0647
		DSL	1,217,683	0.0006	0.0012
	LDT1	GAS	6,633,341	0.2024	0.1056
		DSL	3,799	0.0011	0.0017
	LDT2	GAS	34,768,297	0.2024	0.1056
		DSL	75,916	0.0011	0.0017
	Weighted Average Emission Factor (2028), grams per mile			**0.1838**	**0.0766**
2029	LDA	GAS	92,582,004	0.1780	0.0647
		DSL	1,226,926	0.0006	0.0012
	LDT1	GAS	6,636,213	0.2024	0.1056
		DSL	3,707	0.0011	0.0017
	LDT2	GAS	34,978,472	0.2024	0.1056
		DSL	76,507	0.0011	0.0017
	Weighted Average Emission Factor (2029), grams per mile			**0.1838**	**0.0766**

Table A-77. Emission Factors for Highway Vehicles by Technology Type

Vehicle Type/ Control Technology	CH4 (g/mi)	N2O (g/mi)
Gasoline Passenger Cars		
EPA Tier 2	0.0173	0.0036
Low Emission Vehicles	0.0105	0.0150
EPA Tier 1	0.0271	0.0429
EPA Tier 0	0.0704	0.0647
Oxidation Catalyst	0.1355	0.0504
Non-Catalyst Control	0.1696	0.0197
Uncontrolled	0.1780	0.0197
Gasoline Light Trucks (Vans, Pickup Trucks, SUVs)		
EPA Tier 2	0.0163	0.0066
Low Emission Vehicles	0.0148	0.0157
EPA Tier 1	0.0452	0.0871
EPA Tier 0	0.0776	0.1056
Oxidation Catalyst	0.1516	0.0639
Non-Catalyst Control	0.1908	0.0218
Uncontrolled	0.2024	0.0220
Gasoline Medium and Heavy-Duty Vehicles (Trucks and Busses)		
EPA Tier 2	0.0333	0.0134
Low Emission Vehicles	0.0303	0.0320
EPA Tier 1	0.0655	0.1750
EPA Tier 0	0.2630	0.2135
Oxidation Catalyst	0.2356	0.1317
Non-Catalyst Control	0.4181	0.0473
Uncontrolled	0.4604	0.0497
Diesel Passenger Cars		
Advanced	0.0005	0.0010
Moderate	0.0005	0.0010
Uncontrolled	0.0006	0.0012
Diesel Light Trucks		
Advanced	0.0010	0.0015
Moderate	0.0009	0.0014
Uncontrolled	0.0011	0.0017
Diesel Medium and Heavy-Duty Vehicles (Trucks and Busses)		
Aftertreatment	0.0051	0.0048
Advanced	0.0051	0.0048
Moderate	0.0051	0.0048
Uncontrolled	0.0051	0.0048
Motorcycles		
Non-Catalyst Control	0.0672	0.0069
Uncontrolled	0.0899	0.0087

0.0765 0.072

Source:
2018 Climate Registry Default Emissions Factors
Table 13.4 Default CH4 and N2O Emission Factors for Highway Vehicles by Technology Type
https://www.theclimateregistry.org/wp-content/uploads/2018/06/The-Climate-Registry-2018-Default-Emission-Factor-Document.pdf

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San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix Q: Climate Variability Analysis

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Appendix Q
Climate Variability Analysis

This Climate Variability Appendix supplements the San Luis Low Point Improvement Project (SLLPIP) Environmental Impact Statement/Environmental Impact Report (EIS/EIR) and presents the existing and potential future climate conditions within the area of analysis. The appendix also provides an assessment of the proposed alternatives under projected future climate conditions and discusses the environmental impacts of the project alternatives described in Chapter 4, under projected future climate conditions. An evaluation of the greenhouse gas (GHG) emissions from the proposed alternatives and their potential contribution to global climate variability are presented in Section 4.8, Greenhouse Gas Emissions, and Appendix P, Greenhouse Gas Emission Calculations.

Q.1 Affected Environment/Environmental Setting

This section presents the existing climate within Merced and Santa Clara Counties along with projections of the foreseeable affected environment, the area of analysis and regulatory setting.

Q.1.1 Area of Analysis

The climate impact analysis evaluates the existing conditions and impacts across the Sacramento-San Joaquin River watershed given this areas influence on Central Valley Project (CVP) and State Water Project (SWP) operations at San Luis Reservoir. This area of analysis includes Merced and Santa Clara Counties. San Luis Reservoir is in Merced County and the San Joaquin Valley Air Basin. The Santa Teresa Water Treatment Plant is in Santa Clara County. Chapter 2, Project Description, identifies the locations of the various project components.

Q.1.2 Regulatory Setting

Response to climate variability is governed by several Federal and State laws and policies, which are listed below.

Q.1.2.1 Federal

Q.1.2.1.1 Secretarial Order No. 3289

In 2009, the Department of Interior (DOI) issued a Secretarial Order on climate variability that expands DOI bureaus' responsibilities in addressing climate variability (amended on February 22, 2010). The purpose of Secretarial Order No. 3289 is to provide guidance to bureaus and offices within the DOI on how

to provide leadership by developing timely responses to emerging climate variability issues. This Order replaces Secretarial Order No. 3226, signed on January 19, 2001, entitled "Evaluating Climate Change Impacts in Management Planning." It reaffirms efforts within DOI that are ongoing with respect to climate variability. Among the requirements of the Order is one that requires each bureau and office of DOI to "consider and analyze potential climate change impacts when undertaking long-range planning exercises, setting priorities for scientific research and investigations, and/or when making major decisions affecting DOI resources."

Q.1.2.1.2 National Environmental Policy Act Handbook

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

Q.1.2.1.3 Department of the Interior Departmental Manual 523

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

Q.1.2.1.4 Principles and Requirements for Federal Investments in Water Resources

As mentioned in Chapter 2 of the SLLPIP EIS/EIR, to meet the study objectives, the planning process follows the structured six-step planning approach outlined in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&Gs) (U.S. Water Resources Council 1983). Furthermore, Reclamation is subject to *Principles and Requirements for Federal Investments in Water Resources* (Council on Environmental Quality [CEQ] 2013). This document requires areas of risk and uncertainty to be identified, described, and considered when analyzing potential investments in water resources. It specifically requires climate variability impacts to be accounted for and addressed.

Q.1.2.1.5 Reclamation Manual Directives and Standards, Water and Related Resources Feasibility Studies

The Reclamation Directive and Standard for Water and Related Resources Feasibility Studies establishes responsibilities, requirements, and procedures for conducting a planning study for the purpose of recommending congressional authorization or funding of a water and related resources implementation plan. The potential impacts of climate variability are to be considered when developing projections of environmental conditions, water supply and demand, and operational conditions at existing facilities as part of the "without-plan future condition" (Reclamation 2015)

Q.1.2.1.6 Executive Order 13783

Section 3 of Executive Order (EO) 13783 ("Promoting Energy Independence and Economic Growth") rescinds certain energy and climate-related presidential and regulatory actions. Actions that were revoked include Executive Order 13653, Preparing the United States for the Impacts of Climate Change, and CEQ guidance entitled "Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews."

Q.1.2.1.7 Secretarial Order No. 3360

In 2017, the DOI issued a Secretarial Order that continues the implementation of EO 13783 by rescinding documents inconsistent with EO 13783. The order rescinds Departmental Manual Part 523, Chapter 1: Climate Change Policy, and directs each bureau and office to review all existing regulations, orders, guidance documents, policies, instructions, notices, and implementing actions that are inconsistent with EO 13783 and initiate a process to suspend, revise, or rescind any such actions (DOI 2017).

Q.1.2.2 State

Q.1.2.2.1 California Executive Order S-3-05

On June 1, 2005, former California Governor Arnold Schwarzenegger signed Executive Order S-3-05. The order states that increased temperature due to climate change could reduce the Sierra Nevada snowpack, further exacerbate California's air quality concerns and potentially rise sea level. This executive order established GHG emission reduction targets for California. The Secretary of the California Environmental Protection Agency (CalEPA) is also required to report about climate change impacts on water supply, public health, agriculture, the coastline, and forestry; mitigation and adaptation plans to combat these impacts must also be developed.

Q.1.3 Affected Environment/Existing Conditions

This section presents the current and future climate trends in the area of analysis for use as the basis against which the incremental effects of the alternatives are compared in Section Q.2 and to indicate the likely effect of climate variability on the alternatives.

Q.1.3.1 Historical Climate

Streamflow in the Sacramento River and San Joaquin River basins has historically varied considerably from year to year. Runoff also varies geographically; during any particular year, some portions of the basin may experience relatively greater runoff while other areas experience relatively less runoff (e.g., more abundant runoff in the northern Sacramento Valley versus relatively drier conditions in southern San Joaquin Valley). On a monthly to seasonal basis, runoff is generally greater during the winter to early summer months, with winter runoff generally originating from rainfall-runoff events and spring to early summer runoff generally supported by snowmelt from the Cascade Mountains and Sierra Nevada.

Historical changes in climate have resulted in several important effects on the hydrology of the Sacramento River and San Joaquin River basins. Although annual precipitation may have slightly increased or remained relatively unchanged, corresponding increases in mean annual runoff in the Sacramento and San Joaquin rivers did not occur (Dettinger and Cayan 1995). However, a shift in the seasonal timing of runoff has been observed in the Sacramento River Basin; a decrease of about 10 percent in the fraction of total runoff occurring between April and July has been observed over the course of the 20th century (Roos 1991). Dettinger and Cayan (1995) reported similar results for the combined Sacramento River and San Joaquin River runoff. This decline in spring runoff is contrasted against increases in winter runoff. Peterson et al. (2008) found earlier runoff trends for 18 Sierra Nevada river basins. Analyses such as Cayan et al. (2001) have indicated that increasing spring temperatures, rather than increased winter precipitation, was the primary cause of the observed shift. Studies by these researchers and others showed correlation between the magnitude of decreases in April through July runoff with the altitude of the basin watershed. High altitude basins, like the San Joaquin River Basin, exhibited less decrease in spring runoff than lower elevation watersheds, such as the Sacramento River Basin. However, it is noted that the appearance of runoff trends in the basins is dependent on location within the basin and the period of record assessed.

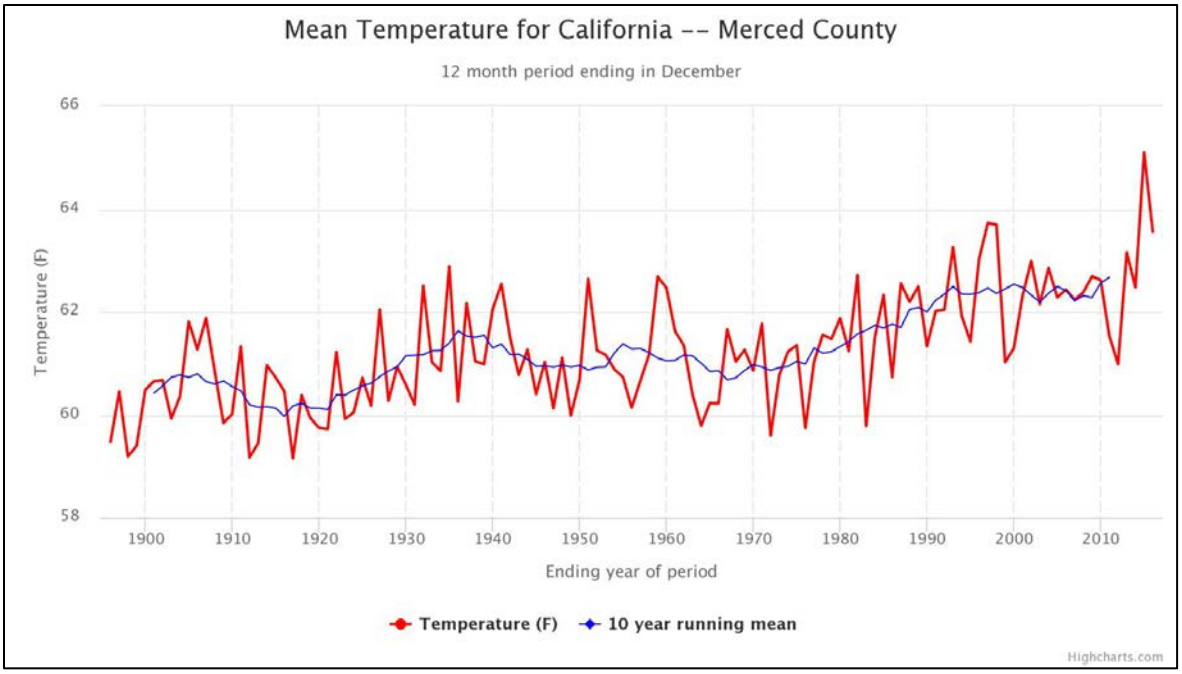
Other historical studies of 20th century spring snowpack, as measured by April 1st Snow Water Equivalent (SWE), showed a decreasing trend in the latter half of the 20th century (Mote 2005). Coincident with these trends, reduced snowpack and snowfall ratios are evidenced by analyses of SWE measurements made from 1948 through 2001 at 173 Western United States stations (Knowles et al. 2007). Additionally, Regonda et al. (2005) reported decreasing spring SWE trends in 50 percent of Western United States locations evaluated.

The historical climate of Merced County like most of the Central Valley is characterized by hot, dry summers and cool, damp winters. As shown in Figure Q-1, average summer daytime temperatures are 95 degrees Fahrenheit (°F) and average winter daytime temperatures are 55°F. Average mean-annual temperature has increased by approximately 2°F during the 20th century in

Merced County. Warming has not occurred steadily throughout the 20th century. Increases in air temperatures occurred primarily during the early part of the 20th century between 1915 and 1935. Subsequently, renewed warming began again in the mid-1970s and appears to be continuing at present, as shown in Figure Q-1. Cayan et al. (2001) reported that Western United States spring temperatures have increased 1.8 to 5.4°F since the 1970s; whereas increased winter temperature trends in the Central Valley were observed to average about 0.9°F per decade (Dettinger and Cayan 1995). In both Merced county, the overall 20th century warming has been about 3 to 4 °F.

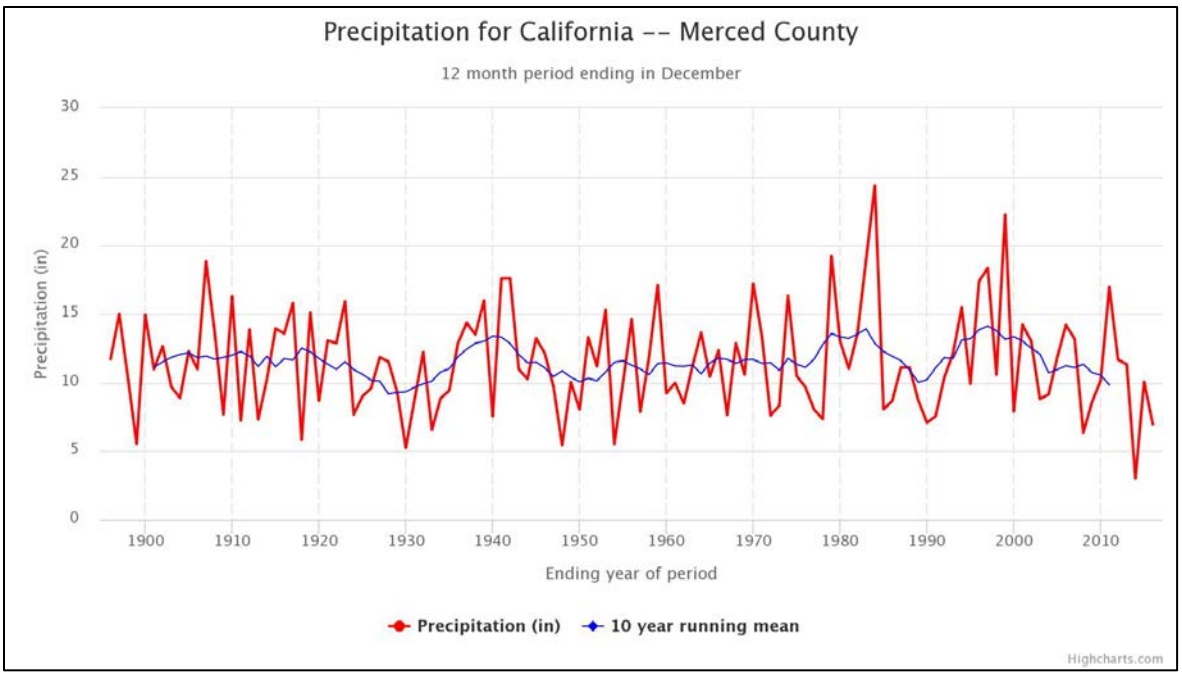
The majority of precipitation in Merced County occurs from mid-autumn to mid-spring. Snowfall is rare in Merced County, temperatures below freezing may occur in the winters but this rarely results in snowfall. Figure Q-2 shows the historic precipitation in Merced County from 1895 to 2015. The variability of annual precipitation appears to have increased in the latter part of the 20th century, as can be seen by comparing the range of differences in high and low values of the solid red line in Figures Q-2. These extremes in wet and dry years have been especially frequent since the 1980s.

Climate in Santa Clara County is heavily influenced by the strength and location of a semi-permanent, subtropical high-pressure cell. During the summer, the Pacific high pressure cell is centered over the northeastern Pacific Ocean resulting in stable meteorological conditions and a steady northwesterly wind flow. Upwelling of cold ocean water from below to the surface because of the northwesterly flow produces a band of cold water off the California coast. The cool and moisture-laden air approaching the coast from the Pacific Ocean is further cooled by the presence of the cold water band resulting in condensation and the presence of fog and stratus clouds along the Northern California coast. In the winter, the Pacific high-pressure cell weakens and shifts southward resulting in wind flow offshore, the absence of upwelling, and the occurrence of storms.



Source: WestMap 2010.

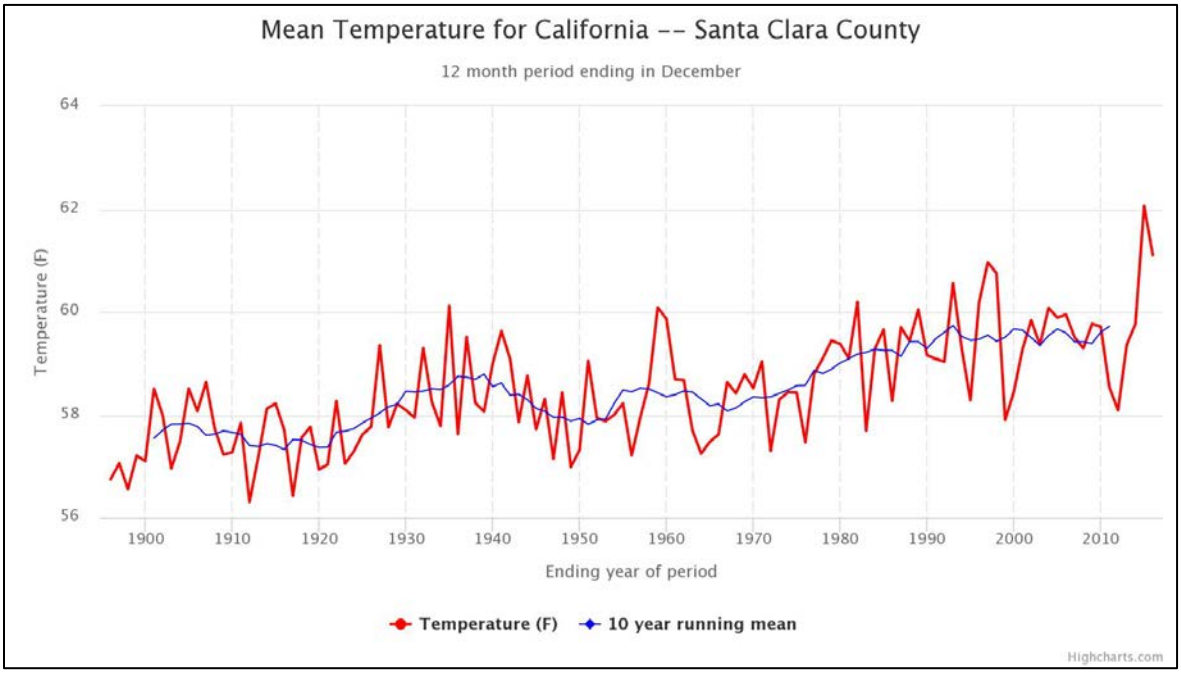
Figure Q-1. Observed Annual (red) and 10-Year Running Mean Annual (blue) Average Temperature in Merced County from 1895 to 2015



Source: WestMap 2010.

Figure Q-2. Observed Annual (red) and 10-Year Running Mean Annual (blue) Average Precipitation in Merced County from 1895 to 2015

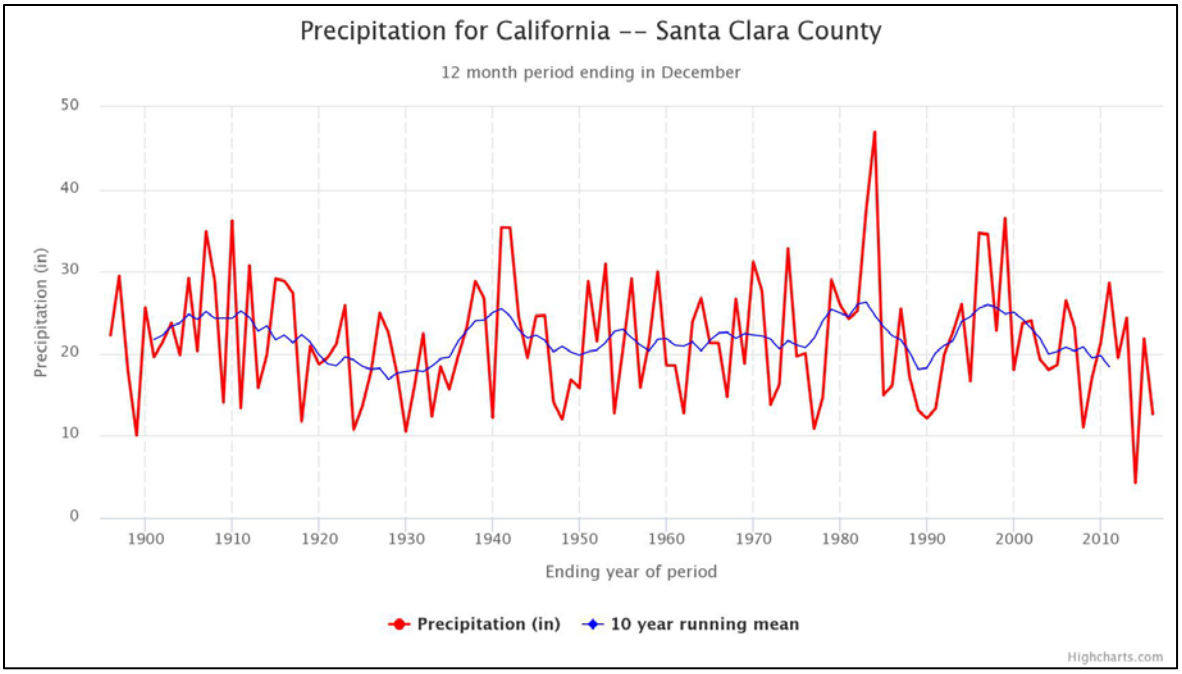
Average mean-annual temperature in Santa Clara County has risen from approximately 58°F in 1900's to 60°F in recent years. As seen in Figure Q-3, warming has not occurred steadily throughout the 20th century. Increases in air temperatures occurred primarily during the early part of the 20th century between 1915 and 1935. Subsequently, renewed warming began again in the mid-1970s and appears to be continuing at present.



Source: WestMap 2010.

Figure Q-3. Observed Annual (red) and 10-Year Running Mean Annual (blue) Average Temperature in Santa Clara County from 1895 to 2015

Precipitation in Santa Clara County is heavily influenced by the strength and location of a semi-permanent, subtropical high-pressure cell. Most of the precipitation in this area primarily occurs in the winter due to the weakening and southward shift of the subtropical high pressure cell centered over the northeastern Pacific Ocean. As shown in Figure Q-4, precipitation in Santa Clara County varies from 10 to 35 inches from 1985-2015.



Source: WestMap 2010.

Figure Q-4. Observed Annual (red) and 10-Year Running Mean Annual (blue) Average Precipitation in Santa Clara County from 1895 to 2015

Q.1.3.2 Projections of Future Climate

Q.1.3.3.1 Data Sources

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

- **"Climate Change Scenarios and Sea Level Rise Estimates for the California 2009 Climate Change Scenarios Assessment" (CCCC 2009a) –** This report provides projected climate data for California, including monthly temperature data, monthly precipitation data and snow water equivalent (the amount of water contained in snowpack). In addition to the report, the data is available through a series of interactive, web-based tools provided by the CEC. Four GCMs were used in the report; the National Center for Atmospheric Research (NCAR) Parallel Climate Model (PCM), the National Oceanic and Atmospheric Administration Geophysical Fluids Dynamics Laboratory (GFDL) model (Version 2.1), the NCAR Community Climate System Model (CCSM), and the French Centre National de Recherches Meteorologiques (CNRM) models. Two emission scenarios from the

Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment were used; a low emissions scenario involving substantial reductions in emissions after 2050 (B1) and a medium-high emissions scenario assuming continued increased in emissions (A2). Two downscaling methods were used: 1) constructed analogues and 2) bias correction and spatial downscaling.

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

- **"Draft National Climate Assessment Report" (NCADAC 2013)** – This report assesses current scientific findings about observed and projected impacts of climate variability in the United States. The report draws from a large body of scientific peer-reviewed research published or in press by July 31, 2012. The draft report is currently open for public comment and is expected to be completed in 2013 and published as "The Third National Climate Assessment."

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

- **"West-Wide Climate Risk Assessments: Bias-Corrected and Spatially Downscaled Surface Water Projections" (Reclamation 2011)** – This report summarizes climate projections developed by Reclamation consistent with Public Law 111-11, Subtitle F (the SECURE Water Act). The report was based on 112 climate variability projections developed for the IPCC Fourth Assessment report (IPCC 2007) as part of the World Climate Research Program's Coupled Model Intercomparison Project phase 3 (CMIP3). The study encompassed a western United States-wide hydrologic analysis to identify changes in temperature, precipitation and their impact on "unimpaired" flows throughout the Colorado, Columbia, Klamath, Missouri, Rio Grande, Sacramento, San Joaquin, and Truckee river basins.

- **"West-Wide Climate Risk Assessments: Sacramento and San Joaquin Basins Climate Impact Assessment" (Reclamation 2014)-** The report complements and builds on the West-Wide Climate Risk Assessments: Bias-Corrected and Spatially Downscaled Surface Water Projections (Reclamation 2011) climate change impact study. This report presents the results of the Sacramento and San Joaquin Climate Impact Assessment, which addresses climate change impacts in the Sacramento and San Joaquin Valley of California. A scenario based approach evaluating impacts of uncertainties associated with climate and socioeconomic conditions on water and related resources in the 21st century was evaluated in this report. A single socioeconomic projection representing a continuation of current population and land use trends was combined with 18 projections of future climate change (changes to temperature, precipitation and carbon dioxide). The 18 climate change projections includes: one no climate change scenario, five ensemble-informed (EI5) scenarios that were developed using downscaled GCM projections; and 12 California hydrology specific GCM projections identified by the State of California's Climate Action Team (CAT) for use in climate studies performed by the California Department of Water Resources (DWR) for the California Water Plan.

- **Sacramento and San Joaquin Rivers Basin Study: Basin Study Summary Report and Technical Report (Reclamation 2016a and 2016b) -** The Sacramento and San Joaquin Basins Study (Basins Study) was developed to address two primary questions: what is the future reliability of the Central Valley water system in meeting the needs of Basin users during the 21st century; and what are the actions and strategies that can adapt to future risks to these water and related resources? To answer these questions, the study developed an analysis approach to address uncertainties with future socioeconomic and climate conditions and to develop various scenarios with alternative views of how future conditions could change with climate change. The evaluation of these scenarios was completed using a modeling analysis

to simulate future socioeconomic and climate conditions. The results of this modeling effort were used to analyze potential changes in future water supply and demand, and then develop and evaluate the potential performance of adaptation portfolios of water management actions designed to address future vulnerabilities.

The Basin Study developed five representative climate futures were developed for use in the Basins Study using results from recent GCM simulations (Intergovernmental Panel on Climate Change [IPCC] 2013) that had been further refined for use in climate studies. From these five climate futures, the Basin Study Summary Report focused on the reporting evaluation results from three of the five scenarios - the Central Tendency, Warm-Wet, and Hot-Dry scenarios. Climate future results from this range of scenarios were then input into the Water Evaluation and Planning model of the Central Valley (WEAP-CV) hydrology model to simulate water supply and demands that were used as inputs to the CalLite-CV model to simulate how the CVP, SWP, and other water management systems operate to meet urban, agriculture, and environmental needs. Results from the CalLite-CV model were used as the basis for a supply and demand imbalance analysis and as inputs into an evaluation of the adaptation portfolios performance. The combination of models assessed the effects of climate change on the following resource categories: delivery reliability, economics, water quality, hydropower and GHG emissions, flood control, recreation, and ecological resources. Various indicator metrics were used to evaluate the effects under each category.

Q.1.3.3.2 Projected Changes in Climate

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

- Annual temperature
- Extreme heat
- Precipitation
- Sea level and storm surge
- Snowpack and streamflow

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

Annual Temperature. GCM data exhibit warming across California under both a low emission scenario and medium-high emission scenario (CCCC 2009a). While the data contain variability, there is a steady, linear increase over the 21st century (CCCC 2009a). The United States (U.S.) Climate Resilience toolkit reported a similar warming trend in Merced and Santa Clara counties (National Oceanic and Atmospheric Administration [NOAA] 2016). Table Q-1

summarizes the projected changes in temperature in the region. While there is a slight difference in the range of projected changes in temperatures between the two sources, both project a warming trend.

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

Region	Mid-21st Century	End of 21st Century
California[1]	+1.8 to 5.4°F	+3.6 to 9.0°F
Merced County, California[2]	+3.7 to 4.7	+5.1 to 9.1
Santa Clara County, California[2]	+3.6 to 4.2	+5.0 to 8.9

Source: [1] Cayan et al. 2012; [2]NOAA 2016

On a seasonal basis, the models project substantial warming in the spring and greater warming in the summer than in the winter. Summer (July to September) temperature changes range from 2.7 to 10.8 °F and winter (January to March) temperature changes range from 1.8 to 7.2 °F at the end of the 21st century when compared to the historical average (1961 to 1990) (CCCC 2009a). In addition, the models suggest that, during the summer, warming of interior land surfaces will be greater than that observed along the coast (CCCC 2009a).

Extreme Heat. The climate model results consistently show increases in frequency, magnitude, and duration of heat waves when compared to historical averages (1961 to 1990). Historically, extreme temperatures typically occur in July and August. With climate variability, these occurrences are likely to begin in June and continue through September (Cayan et al. 2012). Table Q-2 summarizes the projected number of extreme temperature days i.e. days with temperature above 95°F annually per the U.S. Climate resilience toolkit (NOAA 2016). The modeling results show more warming in interior land surfaces i.e. Merced County in comparison to the coastal areas.

Table Q-2. Projected Changes in Extreme Temperature Days in Merced and Santa Clara Counties, California

Period	Historic/ Observed	Low Emission Model	High Emissions Model
Merced County			
Historic Average (1961 to 1990)	38 days	---	---
Observed Average (2000 to 2005)	51 days	---	---
Mid-21st Century	---	71 days	85 days
End of 21st Century	---	81 days	118 days
Santa Clara County			
Historic Average (1961 to 1990)	1 day	---	---
Observed Average (2000 to 2005)	>1 day	---	---
Mid-21st Century	---	4 days	6 days
End of 21st Century	---	8 days	34 days

Source: NOAA 2016

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

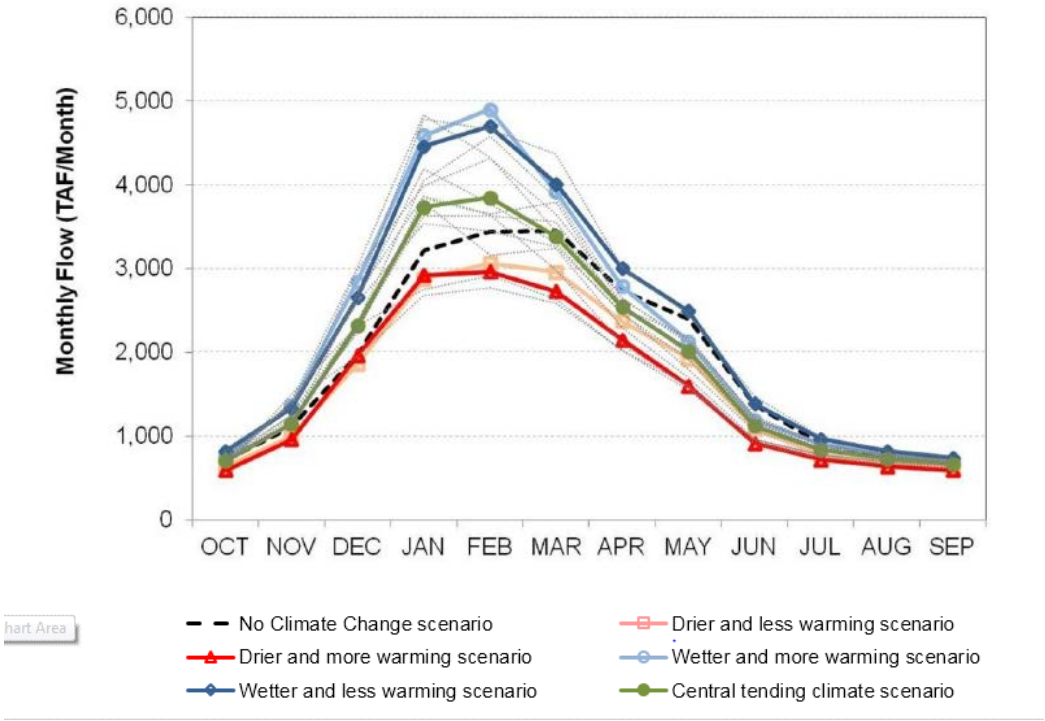
In the western San Joaquin Valley, model simulations suggest that there is a generally decreasing trend in precipitation as the 21st century progresses (CCCC 2009b). In addition, model results indicate that water shortages may be felt more acutely in the western San Joaquin Valley as Delta exports become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

Sea Level and Storm Surge. Sea level change is also an important factor in assessing the effect of climate on California's water resources, because of its effect on water quality in the Delta. Higher sea levels are associated with increasing salinity in the Delta, which influences the suitability of Delta water supplies for agricultural, urban, and environmental uses.

By 2050, sea level rise is projected to be between 30 and 45 centimeters (cm) (12 to 18 inches), compared to 2000 levels (CCCC 2009a). Global models indicate that California may see up to a 140 cm (55 inch) rise in sea level by the end of the 21st century (CEC 2011). During the 20th century, mean sea level at Golden Gate Bridge in San Francisco Bay has risen by an average of 0.2 cm/year (0.08 in/year) (Anderson et al. 2008). Rates of sea level rise in San Francisco Bay appear to be accelerating based on tidal gauges and remote sensing measurements (Church and White 2006; Beckley et al. 2007).

Snowpack and Streamflow. Snowpack and streamflow amounts are projected to decline because of less late winter precipitation falling as snow and earlier snowmelt (NCADAC 2013). In California, snow water equivalent (the amount of water held in a volume of snow) is projected to decrease by 16 percent by 2035, 34 percent by 2070, and 57 percent by 2099, as compared to measurements between 1971 and 2000 (NCADAC 2013). By the end of the century, late spring streamflow could decline by up to 30 percent (CEC 2011).

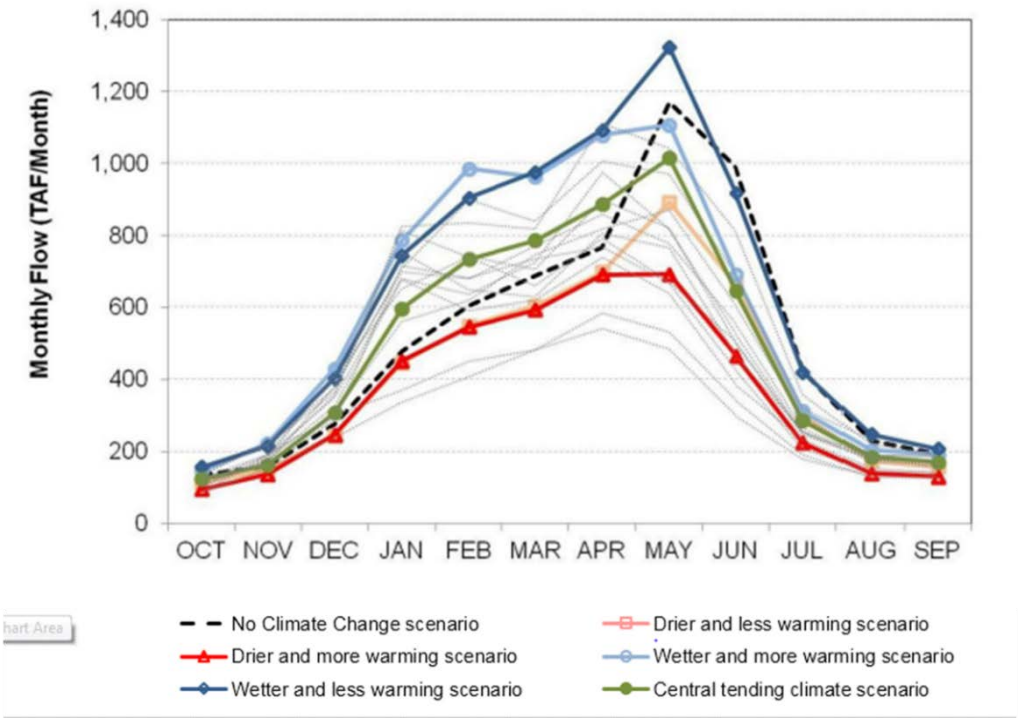
Streamflow amounts are projected to shift to more runoff in the winter and less in the spring months. This projected shift occurs because higher temperatures during winter cause more precipitation to occur as rainfall, which increases runoff and reduces snowpack. Figures Q-5 and Q-6 show the monthly runoff pattern in the Sacramento and San Joaquin River Basins under the five Ensemble-Informed Climate Change Scenarios and twelve CAT scenarios. The seasonal runoff shift in the Sacramento and San Joaquin basins are primarily due to lower elevations of these basins and their susceptibility to warming-induced changes in precipitation from snow to rain (Reclamation 2014).



Source: Reclamation 2014; Note: TAF/yr = thousand acre-feet per year

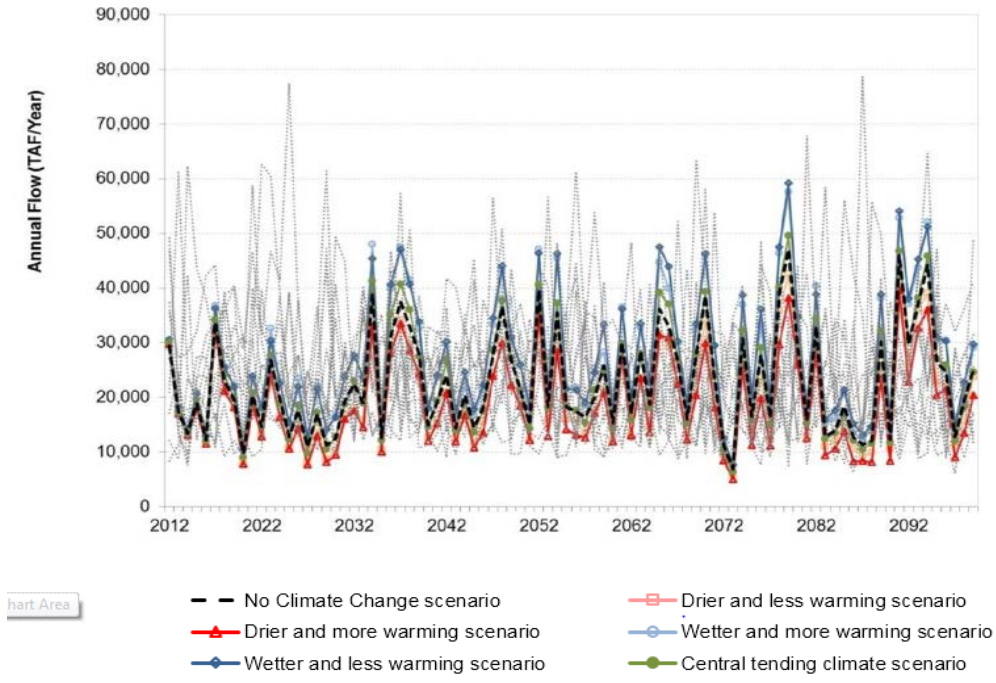
Figure Q-5. Projected Monthly Flows in the Sacramento Basin under five Ensemble-Informed Climate Change Scenarios

Figures Q-7 and Q-8 presents an estimate of the magnitude of wet and dry periods in comparison to historic climate (dashed line) in the future under the climate change scenarios in the Sacramento and San Joaquin basins. Historic observations were used to project inter-annual variability of future wet and dry periods. The extended drought periods from 2025 to 2030 correspond to the historic drought between 1929 and 1934. The magnitude of the projected unimpaired flows differs from historical flow and the climate change scenarios.



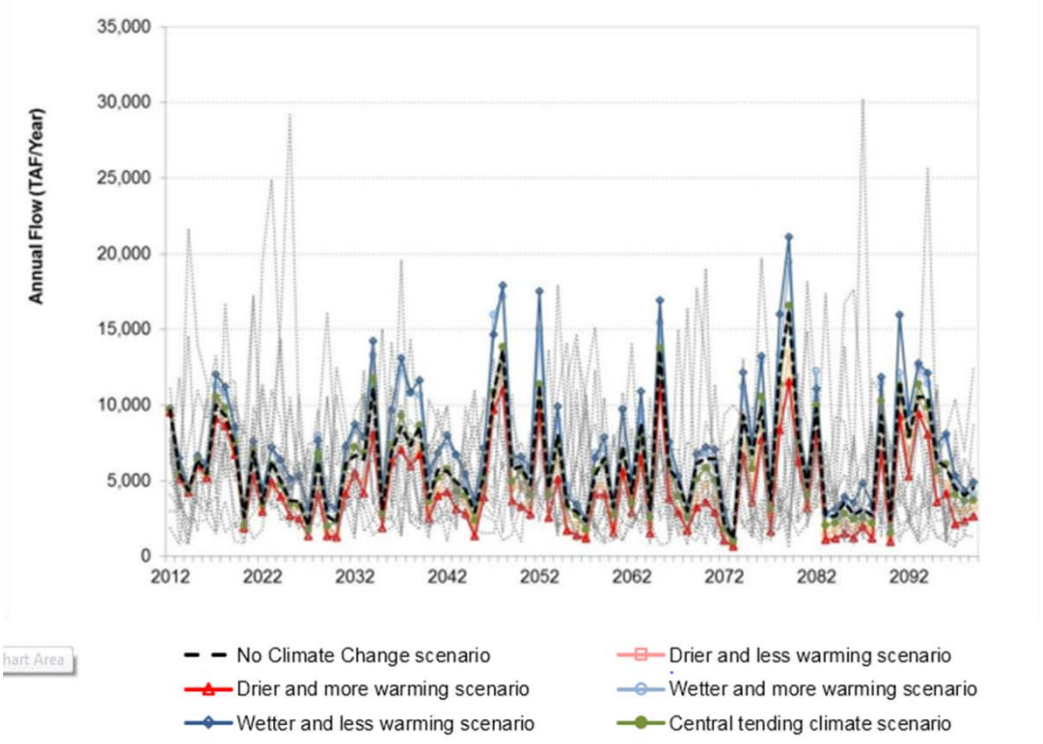
Source: Reclamation 2014; Note: TAF/yr = thousand acre-feet per year

Figure Q-6. Projected Monthly Flows in the San Joaquin Basin under five Ensemble-Informed Climate Change Scenarios



Source: Reclamation 2014; Note: TAF/year = thousand acre-feet per year

Figure Q-7. Unimpaired Flows in the Sacramento River System under five Ensemble-Informed Climate Change Scenarios



Source: Reclamation 2014; Note: TAF/year = thousand acre-feet per year

Figure Q-8. Unimpaired Flows in the San Joaquin River System under five Ensemble-Informed Climate Change Scenarios

Q.1.3.3.3 Associated Impacts

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

Wildfire Hazards. Prolonged periods of higher temperatures combined with associated drought will drive larger and more frequent wildfires in California (NCADAC 2013). The wildfires are projected to start earlier in the summer and last longer into the fall. In California, the risk of wildfire is projected to increase by up to 55 percent, depending on the level of emission reductions that can be achieved globally (CEC 2011). Changes to temperature and precipitation are also projected to change vegetation types and increase the spread of invasive species that are more fire-prone that, when coupled with more frequent and prolonged periods of drought, increase the risk of fires and reduce the capacity of native species to recover (CEC 2011).

Water Quality, Supply and Demand: The projected changes in climate will increase pressure on California's water resources, which are already fully utilized by the demands of a growing economy and population (CEC 2011). Although significant changes in annual precipitation are not projected,

increasing temperatures, decreasing snowmelt and changes to spring streamflows will decrease the reliability of water supplies and increase the likelihood of more frequent short-term and long-term droughts and water shortages (NCADAC 2013). Additionally, increasing temperatures will result in increased competition for water among agricultural, municipal, and environmental uses. Larger agricultural demands may lead to increased stress on the management of surface water resources and, potentially, the over exploitation of groundwater aquifers (CCCC 2009b). Agricultural areas could be significantly impacted, with California farmers losing as much as 25 percent of the water supply they need (CEC 2011).

Sea level change is also an important factor in assessing the effect of climate on California's water resources because of its effect on water quality in the Sacramento-San Joaquin Delta. Higher mean sea levels (msl) are associated with increasing salinity in the Delta, which influences the suitability of its water for agricultural, urban, and environmental uses. The global rate of msl change was estimated by IPCC (2007) to be 1.8 +/- 0.5 millimeters (mm)/year (0.07 +/- 0.02 inches per year (in/year)) from 1961–2003 and 3.1 +/- 0.7 mm/year (0.12+/0.03 in/year) during 1993–2003. During the 20th century, msl at Golden Gate Bridge in San Francisco Bay has risen by an average of 2 mm/year (0.08 in/year) (Anderson et al. 2008). These rates of sea level rise appear to be accelerating based on tidal gauges and remote sensing measurements (Church and White 2006; Beckley et al. 2007).

X2 is the location of the two parts per thousand (ppt) salinity concentration in the interior Delta (termed " X2"). Maintaining X2 positions of less than 74 kilometers (km) and 81 km from the Golden Gate Bridge are goals specified in the US Fish and Wildlife Service (USFWS) Biological Opinion (BiOp) for operation of the CVP and SWP, and maintaining them is identified as important for Delta smelt habitat conditions. The Sacramento and San Joaquin Basins Study evaluated potential changes to X2 and determined that in all of the climate scenarios, the average X2 position increased as the simulation moved later into the 21st century due to rising sea levels. Specifically the Basin Study identified an increase in the percentage of all of the February through June months modeled that X2 is greater than the 74 km metric on average in 31% of the months, an increase of 29%, and ranges from a minimum of 15% to a maximum of 53%. For the 81 km metric, X2 was above the metric on average in 7% of the months, an increase of 17%, and ranges from a minimum of 1% to a maximum of 16%.

SWP and CVP Delta exports is a significant water supply source for south-of-Delta water users. Given the projected changes in rainfall and snowpack, associated runoff patterns, south-of-Delta exports are likely to be impacted by climate variability. Reductions in total exports will likely lower average San Luis Reservoir storage levels and increase the occurrence of low point conditions and water supply interruptions to SCVWD. Table Q-3 summarizes projected South of Delta CVP deliveries under four climate change scenarios

and Table Q-4 summarizes projected SWP Table A deliveries under four climate change scenarios. The project deliveries presented in Table Q-3 and Q-4 summarize key results from the Sacramento and San Joaquin Basins Study CalLite-CV modeling results. These results are summarized in greater detail in the Climate Change Sensitivity Analysis presented in Appendix G of the Feasibility Report.

Table Q-3. CVP South of Delta Deliveries

Sacramento Valley Index[1]	No Climate Change	Hot-Dry		Warm-Wet		Central Tendency	
	TAF	TAF	Change (TAF)[2]	TAF	Change (TAF)[2]	TAF	Change (TAF)[2]
Wet	2716	2254	-461	2828	113	2602	-113
Above Normal	2360	1589	-771	2593	233	2220	-141
Below Normal	2265	1678	-587	2493	228	2169	-96
Dry	1919	1301	-618	2370	451	1815	-104
Critical	1441	1101	-340	1741	299	1386	-55
All Years	2134	1586	-549	2408	274	2032	-102

Source: Appendix G, Climate Change Sensitivity Analysis, Feasibility Report

[1] For the purpose of calculating average annual results by year type, the Sacramento Valley Indices for the Central Tendency were used for all climate change scenarios so that the same years and number of years of each year type were averaged for all scenarios. Sacramento Valley Indices for the Central Tendency scenario are similar to those in the No Climate Change scenario and result in a similar distribution of year types as the historical record. The distribution of year types, i.e. the number of wet, above normal, below normal etc. years, in the Hot-Dry and Warm-Wet scenarios can deviate from the historical distributions.

[2] Change calculated as difference from No Climate Change scenario

Table Q-4. SWP Table A Deliveries

Sacramento Valley Index[1]	No Climate Change	Hot-Dry		Warm-Wet		Central Tendency	
	TAF	TAF	Change (TAF)[2]	TAF	Change (TAF)[2]	TAF	Change (TAF)[2]
Wet	3265	2895	-370	3365	100	3175	-90
Above Normal	2910	2306	-604	3233	322	2770	-141
Below Normal	2635	1912	-723	2894	259	2580	-56
Dry	2329	1607	-722	2753	424	2241	-89
Critical	1652	1268	-384	2036	384	1647	-5
All Years	2557	2006	-551	2857	300	2480	-77

Source: Appendix G, Climate Change Sensitivity Analysis, Feasibility Report

[1] For the purpose of calculating average annual results by year type, the Sacramento Valley Indices for the Central Tendency were used for all climate change scenarios so that the same years and number of years of each year type were averaged for all scenarios. Sacramento Valley Indices for the Central Tendency scenario are similar to those in the No Climate Change scenario and result in a similar distribution of year types as the historical record. The distribution of year types, i.e. the number of wet, above normal, below normal etc. years, in the Hot-Dry and Warm-Wet scenarios can deviate from the historical distributions.

[2] Change calculated as difference from No Climate Change scenario

In addition to the changes water quality, supply and demand described above, the entire Delta region is now below sea level, protected by more than a thousand miles of levees and dams, and catastrophic failure of those levees and dams from an extreme high sea level event would greatly affect this resource (Karl, Melillo, and Peterson 2009). Projected changes in the timing and amount of river flow, particularly in winter and spring, is estimated to more than double the risk of Delta flooding events by mid-century, and result in an eight-fold increase before the end of the century (Karl, Melillo, and Peterson 2009). Taking into account the additional risk of a major seismic event and increases in sea level due to climate variability over this century, the California Bay–Delta Authority has concluded that the Delta and Suisun Marsh are not sustainable under current practices (Karl, Melillo, and Peterson 2009).

Natural Resources. Climate variability will continue to affect natural ecosystems, including changes to biodiversity, location of species and the capacity of ecosystems to moderate the consequences of climate disturbances such as droughts (NCADAC 2013, Reclamation 2016a, Reclamation 2016b). In particular, species and habitats that are already facing challenges will be the most impacted by climate variability (NCADAC 2013, Reclamation 2016a, Reclamation 2016b). Other impacts to natural resources include:

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

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

- Increased frequency and intensity of insect attacks due to increased temperatures and shorter winters (NCADAC 2013).

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

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

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

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

- Rare or endangered species may become less abundant or extinct (NCADAC 2013, Reclamation 2016a, Reclamation 2016b).

- Reductions in the number of months with sufficient storage for cold water pool management (Reclamation 2016a and Reclamation 2016b).

- Increased river temperatures under the Central Tendency and Hot-Dry climate future scenarios (Reclamation 2016a and Reclamation 2016b).

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

Infrastructure. Existing infrastructure were designed based on past, stable climate trends and may not have the capacity to respond to rapid changes in climate that are projected for the future (NCADAC 2013). Impacts to infrastructure include:

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

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

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

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

- Accelerated erosion when stormwater infrastructure capacity is exceeded (NCADAC 2013).

Agriculture and Livestock. Increased temperatures may lengthen the crop season of some perennial crops, although disruptions from extreme heat, drought, and changes to insects are also expected (NCADAC 2013). With adaptive actions, agriculture in the United States is expected to be resilient in the near-term, but yields of crops are expected to decline mid-century and late-century due to increased extremes in the climate (NCADAC 2013). California produces a large portion of the nation's high-value specialty crops, which are irrigation dependent and vulnerable to extreme changes in temperature and moisture (NCADAC 2013). Increased frequency and duration of heat waves would also put stress on livestock.

Table Q-5 shows projected changes in central valley crop type acreage under the Current Trends Socio-Economic Scenario that was presented in the Sacramento and San Joaquin Basins Study (Reclamation 2016b)

Human Health. Extreme heat events, increased wildfires, decreased air quality caused by rising temperatures, and diseases transmitted by insects, food and water that are impacted by climate variability are a threat to human health and well-being (NCADAC 2013).

Table Q-5. Central Valley Crop Types – Project Acreages

	Crop Acreage (Acres)			
	Period Average			
Crop Type Category	2012	2012-2039	2040-2069	2070-2099
Alfalfa	670,002	651,179	537,777	544,460
Almond/Pistachio	777,531	775,071	753,178	757,052
Other Deciduous	565,300	557,187	516,135	462,809
Pasture	259,635	258,678	209,569	142,557
Subtropical	247,333	246,980	224,105	243,875
Vineyards	591,866	587,760	529,984	484,574
Corn	654,120	623,784	509,202	426,455
Cotton	665,770	661,580	596,587	638,042
Cucurbits	91,414	91,303	87,087	90,639
Dry Beans	60,746	59,294	51,574	37,819
Grain	360,558	364,500	304,440	296,034
Onion + Garlic	44,925	44,768	39,709	43,677
Other Field	412,383	378,927	269,827	165,864
Other Truck Cucumber[1] Other TruckLettuce[2]	215,886	207,971	180,453	198,905
Potatoes	25,879	24,834	24,755	24,656
Rice	496,146	546,137	522,968	487,804
Safflower	50,213	48,936	44,838	38,556
Sugar Beets	27,306	21,026	20,016	20,136
Tomatoes	340,921	340,600	331,928	337,863
Total Perennial Crop Acreage	**3,111,667**	**3,076,855**	**2,770,748**	**2,635,326**
Total Annual Crop Acreage	**3,446,266**	**3,413,660**	**2,983,383**	**2,806,449**
Total Central Valley Crop Acreage	**6,557,933**	**6,490,515**	**5,754,131**	**5,441,775**

Source: Appendix G, Climate Change Sensitivity Analysis, Feasibility Report
Notes:
[1] Sacramento Valley only.
[2] San Joaquin and Tulare Lake Basins only.

Q.2 Environmental Consequences/Environmental Impacts

This section examines the relationship of climate variability effects to the environmental impacts and mitigation measures presented in Chapter 4. This section discusses impacts of the action alternatives and proposed mitigation measures as anticipated for a range of possible future socioeconomic-climate scenarios.

Q.2.1 Assessment Methods

The climate variability impact assessment characterizes the sensitivity of environmental effects evaluated in this EIS/EIR to uncertainties in potential future socioeconomic and climatic conditions.

This chapter presents the significance determinations made in Chapter 4 and evaluates how those significance determinations could be changed under future climate change scenarios. This sensitivity analysis does not identify new impacts that were not already analyzed in the other chapters, it instead describes how those impacts might change with future climate variability.

Q.3 Effects of Climate Variability on the Impacts Anticipated Under the Action Alternatives

This section examines the relationship of climate variability effects to the environmental impacts and mitigation measures presented in Chapter 4. This section discussions impacts after implementation of proposed mitigation measures that are anticipated under the action alternatives for a range of possible future socioeconomic-climate scenarios. This discussion relies on information provided previously in this chapter and in greater detail in the Climate Change Sensitivity Analysis completed in the Feasibility Report (Appendix G).

Q.3.1 Resources Eliminated from Further Analysis

The following resources are eliminated from further discussion because the effects of the proposed alternatives are not expected to interact with climate variability: noise and vibration; Indian Trust Assets; GHG emissions; and traffic and transportation. For these resources climate variability is not expected to alter the outcome of the impacts from the action alternatives (e.g., noise and vibration in the study area).

Q.3.2 Water Quality

As discussed in Section 4.1, Water Quality, the action alternatives could result in impacts related to the following:

- Violation of existing water quality standards or waste discharge requirements (Less than significant and significant and unavoidable)

- Substantially degrade existing water quality conditions (Less than significant)

- Result in effects on water quality related beneficial uses (Beneficial)

Surface water quality effects from the action alternatives in the study area related to short-term construction impacts would not be affected by longer-term impacts from climate variability given the timing of scheduled construction completion.

Increased surface water temperatures that could occur from higher ambient air temperatures and lower water levels at San Luis Reservoir could result in greater eutrophication (United States Environmental Protection Agency [USEPA] and DWR 2011). Climate variability induced temperature increases and associated eutrophication in the reservoir would be mitigated to some degree by the development of a lower San Felipe Intake that would allow deliveries from San Luis Reservoir from colder deeper levels longer in the year. The Treatment Alternative would increase SCVWD's capacity to treat water quality issues associated with these increased temperatures.

High turbidity could occur with climate variability as storm severity increases and wildfires become more frequent (DWR 2008). Other water quality issues that could result from climate variability include more frequent spikes in *E. coli* or Cryptosporidium, which typically accompany severe storms (Bates et al. 2008 as cited in USEPA and DWR 2011). Pollutant loads may also increase as more extreme rain events occur (DWR 2008).

Significant impacts on surface water quality within the study area could occur with implementation of the pipeline option for Alternative 2, but would not occur if the other action alternatives are implemented. Climate variability may result in additional significant surface water quality impacts in the study area, but these are not directly related to implementation of the action alternatives; consequently, there would be no changes to the impact conclusions for surface water quality in the study area.

Q.3.3 Surface Water Supply

As discussed in Section 4.2, Surface Water Supply, the action alternatives could result in impacts related to the following:

- Change deliveries to south-of-Delta CVP contractors and change storage in San Luis Reservoir (Less than significant and beneficial)

- Generate temporary CVP San Felipe Division water supply interruptions during construction (Less than significant)

- Change CVP deliveries to south-of-Delta CVP and SWP contractors via the South Bay Aqueduct and California Aqueduct (Less than significant)

- Change CVP water supply reliability for SCVWD in the long-term (Beneficial)

Under climate variability, CVP and SWP exports would be reduced as summarized in Table Q-3 and Table Q-4; SWP exports could be reduced by up to 13 percent by 2100 and CVP exports could be reduced by up to 8 percent by 2100. With implementation of the action alternatives, south-of-Delta deliveries would mostly increase (except for SWP deliveries under the San Luis Reservoir Expansion Alternative). With climate variability the magnitude of these benefits are likely to be reduced, but the alternatives would be anticipated to improve water supply conditions in comparison to a climate variability future baseline with no action. Climate variability may result in significant surface water supply impacts in the study area, but these are not directly related to implementation of the action alternatives; consequently, there would be no changes to the impact conclusions for surface water supply in the study area.

Table Q-5 summarizes the frequency of San Luis Low Point under the different climate change scenarios. San Luis storage goes below the low-point threshold of 300 thousand acre-feet (TAF) in 35 years out of 88 years simulated under the Hot-Dry scenario, nearly twice the number of years under the No Climate Change scenario. The Warm-Wet scenario results in 14 years of storage below the 300 TAF threshold, and the Central Tendency scenario results in 18 years of San Luis storage below the threshold. San Luis Reservoir storage is more likely to go below the 300 TAF threshold in drier years than in wetter years. Further detail can be found in the Climate Change Sensitivity Analysis completed in the Feasibility Report (Appendix G).

Increases in the frequency or duration of future low-point events as a result of climate variability would not affect the ability of the Lower San Felipe Intake Alternative or Treatment Alternative to continue deliveries to SCVWD uninterrupted by low point conditions. Overall, the frequency of low-point conditions does not change under San Luis Reservoir Expansion Alternative with the exception of the Hot-Dry scenario where there is one less year. The Pacheco Reservoir Expansion Alternative should be able to address more frequent or less frequent low-point conditions with climate variability through changes in operations for the volume and timing of CVP contract supply moved into and out of Pacheco Reservoir.

Table Q-5. Frequency of San Luis Reservoir Low Point Conditions (Storage < 300 TAF)

Sacramento Valley Index	No Climate Change	Hot-Dry		Warm-Wet		Central Tendency	
	Years	Years	Change[1]	Years	Change[1]	Years	Change[1]
Wet	5	7	2	5	0	3	-2
Above Normal	5	7	2	1	-4	7	2
Below Normal	1	4	3	0	-1	2	1
Dry	5	10	5	6	1	7	2
Critical	2	7	5	2	0	2	0
All Years	18	35	17	14	-4	21	3

Source: SLLPIP Feasibility Report, Appendix G, Climate Change Sensitivity Analysis,

[1] For the purpose of calculating average annual results by year type, the Sacramento Valley Indices for the Central Tendency were used for all climate change scenarios so that the same years and number of years of each year type were averaged for all scenarios. Sacramento Valley Indices for the Central Tendency scenario are similar to those in the No Climate Change scenario and result in a similar distribution of year types as the historical record. The distribution of year types, i.e. the number of wet, above normal, below normal etc. years, in the Hot-Dry and Warm-Wet scenarios can deviate from the historical distributions.

2 Change calculated as difference from No Climate Change scenario

Q.3.4 Groundwater Resources

As discussed in Section 4.3, Groundwater Resources, the action alternatives could result in impacts related to the following:

- Cause changes to imported surface water deliveries causing increases in groundwater use (Less than significant, no impact, and beneficial)
- Increased groundwater extraction pumping could affect groundwater levels (Less than significant)

Climate variability could decrease reservoir levels throughout the CVP and SWP system, which would consequently result in less CVP and SWP exports. Reduced exports could increase groundwater pumping, which would both decrease groundwater levels and could degrade groundwater quality. Climate variability may result in significant impacts to groundwater resources in the study area. Implementation of the action alternatives would, as was noted above in Section Q.3.3, provide a beneficial effect on surface water deliveries and offset to some degree the impact of climate variability on groundwater conditions. As a result, there would be no changes to the impact conclusions for groundwater resources in the study area.

Q.3.5 Flood Control

As discussed in Section 4.4, Flood Control, the action alternatives could result in impacts related to the following:

- Construction and operation of new facilities could result in the placement of structures in the 100-year flood hazard area which would impede or redirect flood flows (Less than significant)

- Construction and operations could result in the increased exposure of people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam (Less than significant, no impact, and beneficial)

- Construction and operations could result in the alteration of the existing drainage pattern and/or the creation of runoff water that would exceed the capacity of the existing or planned stormwater drainage system (Less than significant and no impact)

Climate variability could result in more frequent and severe storms and runoff could occur earlier in the year. This is anticipated to increase the frequency and severity of flood events in the area of analysis. None of the action alternatives would generate a significant impact on flood control. Changes to the frequency and severity of flood events with climate variability would not be anticipated to change these significance determinations given the Lower San Felipe Intake Alternative and Treatment Alternatives impact areas well outside of any 100-year flood zone and small increase in impervious surface. As a connected action to the B.F. Sisk Safety of Dams Corrective Action Study, the San Luis Reservoir Expansion Alternative would result in improved flood risk in the area of analysis. The Pacheco Reservoir Expansion Alternative would provide flood control benefits by reducing flows in Pacheco Creek and downstream waterways during flood events.

Q.3.6 Geology and Soils

As discussed in Section 4.5, Geology and Soils, the action alternatives could result in impacts related to the following:

- Construction activities could expose people or structures to adverse effects related to the rupture of a known earthquake fault (Less than significant)

- Construction activities on unstable soils could result in the risk of loss, injury, or death as a result of liquefaction of landslides (Less than significant and no impact)

- Construction activities could take place on expansive soils creating a substantial risk to life or property (No impact and less than significant)

- Construction activities could result in the loss of availability of a known mineral resource of regional or local importance (No impact)

- Maintenance activities during operations could expose people or structures to adverse effects related to the rupture of a known earthquake fault (Less than significant and no impact)

- Operations could result in long-term impacts to geology, soils, or mineral resources (No impact)

- Seismic-related ground failure could impact operation of alternative facilities (Less than significant and no impact)

Climate variability could result in increased storm severity and more frequent flooding, which would increase sediment erosion and transport along with increased potential for landsides from greater flows.

Under climate variability, inflow peaks could occur earlier in the water year and, therefore, delta formation at the confluence of lakes and streams would occur earlier in the water year; further, more channelization could occur from downcutting into the delta deposits during the remainder of the year. Certain climate change scenarios could also result in minor increases in inflows to San Luis Reservoir from seasonal creeks that drain to the reservoir.

Impacts from the action alternatives on geology and soils within the area of analysis are not expected to differ greatly with or without climate variability. The environmental commitments ensure that significant impacts on geology and soils are avoided and would be resilient to changes in conditions with climate variability. Given this resilience, there would be no anticipated changes to significance determinations with climate variability.

Q.3.7 Air Quality

As discussed in Section 4.7, Air Quality, the action alternatives could result in impacts related to the following:

- Construction activities could cause temporary and short-term construction-related emission of criteria pollutants or precursors that would exceed the significance thresholds (Less than significant and significant and unavoidable)

- Operational activities could cause long-term emissions of criteria pollutants or precursors that would exceed the significance thresholds (Less than significant)

- Construction activities could cause temporary and short-term construction-related emissions of toxic air contaminates that would exceed the significance thresholds (Less than significant).

- Construction activities could cause temporary and short-term construction-related emissions of criteria pollutants or precursors that would exceed the general conformity de minimis thresholds (No adverse impact)

- Construction activities could create objectionable odors affecting a substantial number of people (Less than significant)

Climate variability could result in increased ground-level ozone concentrations from warmer temperatures. Furthermore, changes in weather patterns could affect how pollutants are dispersed, which could cause localized concentrations of particulate matter to increase. Inhalation of ozone and particulate matter can cause adverse health effects including premature mortality and aggravation of cardiovascular and respiratory disease (USEPA 2015).

Climate variability may result in significant air quality impacts in the study area. These impacts from climate variability would not however change how the action alternatives would be implemented or how the action alternatives would impact air quality. As a result, there would be no changes to the impact conclusions for air quality in the study area.

Q.3.8 Visual Resources

As discussed in Section 4.9, Visual Resources, the action alternatives could result in impacts related to the following:

- Have a substantial adverse effect on a scenic vista (areas with Scenic Attractiveness Class A or Class B classifications are considered scenic vistas) (Less than significant, no impact, and significant and unavoidable)

- Substantially damage scenic resources within a State scenic highway corridor (Less than significant, no impact, and significant and unavoidable)

- Substantially degrade the existing visual character or quality of the site and its surroundings (Less than significant and no impact)

- Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area (Less than significant and no impact)

- Operational changes at the San Luis Reservoir could affect visual resources (Less than significant and no impact)

Increased temperatures could change the vegetation across the area of analysis, which could result in a substantial visual modification. The types of changes anticipated could include the shift of seasonal grasslands from active green growth to brown dormancy earlier in the year along with the potential for increases in wildfire risk and the associated charring of these grasslands.

These changes in visual quality in the area of analysis would not however be anticipated to impact the magnitude or severity of impacts on visual quality

anticipated from construction and operation of the action alternatives. The types of impacts generated by the construction actions and operation of the alternatives would be the same with and without climate variability and would not be expected to change with a shift in vegetation across the larger area of analysis.

Q.3.9 Hazards and Hazardous Materials

As discussed in Section 4.12, Hazards and Hazardous Materials, the action alternatives could result in impacts related to the following:

- During construction activities, the transport, use or disposal of hazardous materials could increase the risk of exposure from hazardous materials to the public and construction workers (Less than significant)
- Operation of new facilities could, increases the risk of exposure to hazardous materials to the public and workers within the vicinity of the sites from the routine transport, storage, use or disposal of hazardous materials (Less than significant)
- Construction would occur within ¼ mile of existing schools which could increase the potential for exposure to hazardous materials to local school children and staff (No impact)
- The project would be constructed within the vicinity of an active remediation site which could create a hazard to the public or the environment if contaminated soil and/or groundwater is encountered and released to the environment (Less than significant)
- Construction activities could conflict with activities and operations at airports near or within the project area, resulting in safety hazards for pilots or people working and residing in the area (Less than significant and no impact)
- The use of mechanical equipment during construction could increase the risk of wildfire within the vicinity of the project area (Less than significant)
- During construction activities use of local roads, construction activities along SR 152 and traffic control activities could temporarily interfere with an emergency response plan or emergency evacuation plan for the project vicinity (Less than significant)

Most impacts identified for hazards and hazardous materials under the action alternatives are related to project construction. Therefore, climate variability in the longer term would not change the effects evaluations or conclusions. This includes the potential over the long-term for climate variability to change the frequency and intensity of wildfire, impacts from the action alternatives

associated with wildfires are related to construction only, and mitigation measures would minimize these risks.

The action alternatives would not result in significant impacts from increased habitat that could contribute to the spread of and/or increase existing mosquito populations. Warming temperatures, however, are likely to further increase the abundance and active period of mosquitos and could further increase the potential for negative impacts (OEHHA 2013).

Climate variability has the potential to impact health and hazards in the area of analysis. These impacts would not however be anticipated to influence the shorter-term construction generated impacts of the action alternatives. Longer term effects from operation of the action alternatives would also not change in magnitude with climate variability.

Q.3.10 Aquatic Resources

As discussed in Section 4.13, Aquatic Resources, the action alternatives could result in impacts related to the following:

- Construction activities could destroy or adversely affect aquatic habitats for special-status fish species and/or interfere with the movement of any native resident or migratory fish species or with established native resident or migratory corridors, or impede the use of native nursery sites (No impact)

- Construction activities could interfere with the movement of any native resident or migratory fish species or with established native resident or migratory corridors, or impede the use of native nursery sites (No impact)

- Operation could result in impacts to aquatic habitats and special-status fish species in the Delta (Sacramento River Flow, Low Salinity Zone [X2], Delta Outflow, Old and Middle River Flows, and Delta Exports) (No impact and less than significant)

Climate variability could result in the south-of-Delta exports that fill San Luis Reservoir being influenced more by earlier season precipitation than from later season snowmelt across the Sacramento-San Joaquin River watershed. This change could result in as was noted previously, reductions in total Delta exports and reductions in average storage volumes in San Luis Reservoir. The reservoir elevation could refill seasonally on average to lower maximum surface elevations and potential increases in demand on supplies stored in San Luis Reservoir generated by increases in ambient air temperatures across the CVP and SWP south-of-Delta service areas.

Impacts to south-of-Delta exports would occur under the action alternatives. The proportional changes in total CVP and SWP exports with implementation

of the action alternatives, would be similar in a future with climate variability. The total availability of water for Delta exports would be reduced and the increment of additional unused export capacity available for use by the action alternatives would be expected to be similarly reduced.

Further, increases in water temperature would occur in San Luis Reservoir overall, particularly later in the year as water levels decrease. Sufficient data are not available to determine if increasing water temperatures resulting from climate variability would alter the overall survival for reservoir fish species under the action alternatives. However, because increased water temperatures would have both beneficial and detrimental effects on reservoir fishes depending on the species, it is assumed that the impact conclusions would not be substantially different with or without climate variability.

High turbidity and sedimentation have a number of potentially adverse effects on fish, including smothering eggs, injury to gills, impairment of visual feeding, and reducing food web production (Kerr 1995). Increased turbidity under the action alternatives would potentially suppress fish production in the reservoir.

Climate variability, as was noted previously, could reduce the overall water supply benefits of the alternatives, but the types and severity of effects from operation of the alternatives on fisheries in the area of analysis would not be expected to change.

Q.3.11 Terrestrial Resources

As discussed in Section 4.14, Terrestrial Resources, the action alternatives could result in impacts related to the following:

- Construction activities could destroy or adversely affect sensitive habitats including wetland and riparian vegetation communities (Less than significant and no impact)
- Construction activities could kill, harm, or disturb terrestrial wildlife, including special-status species, or their habitats (Less than significant and no impact)
- Construction activities could disturb nesting migratory birds, including raptors (Less than significant)
- Construction activities could destroy or adversely affect special-status plant species (Less than significant and no impact)
- Construction activities could adversely affect wildlife corridors (Less than significant and no impact)

- Construction activities could result in conflicts with local policies or ordinances protecting biological resources (Less than significant and no impact)

- Construction or operation could result in conflicts with Habitat Conservation Plans or Other Local Plans or Policies (No impact)

- Construction activities could reduce foraging habitat for golden eagles and California condors at the San Luis Reservoir (Less than significant and no impact)

- Operations could result in long term impacts to terrestrial resources (No impact and less than significant)

With climate variability, terrestrial habitats could be negatively affected by increased spread of invasive species (USEPA and DWR 2011). Increased temperatures and variations in precipitation (shown in the Climate Change Sensitivity Analysis completed in the Feasibility Report [Appendix G]) may also displace some native species that may not compete well under changing conditions. Optimal climate conditions for native species may shift to higher elevations; however, these areas may not always be available or suitable for colonization of plant species, depending on land use, physical separation from the existing habitat, and other physical conditions, such as substrate characteristics. Climate variability is expected to stress forested areas, making them more susceptible to pests and disease, which would further alter species composition. It is also projected that climate variability would increase the frequency and intensity of wildfires (USEPA and DWR 2011).

Climate variability may result in significant impacts to terrestrial resources in the study area, but none of these effects would influence implementation of the action alternatives in a way that magnified the effect of those alternatives on terrestrial resources.

Q.3.12 Regional Economics

As discussed in Section 4.15, Regional Economics, the action alternatives could result in impacts related to the following:

- Changes in water supply to SCVWD due to low point interruptions could affect the regional economy (Beneficial)

- Changes in water supply to CVP M&I users in the Bay Area could affect the regional economy (No impact and beneficial)

- Changes in water supply to SWP M&I users in Bay Area and Southern California could affect the regional economy (No impact and beneficial)

- Changes in water supply to agricultural users in the San Joaquin Valley could affect the regional economy (No impact and beneficial)

- Construction expenditures could increase employment, income, and output in the regional economy (Beneficial)

- Operation and maintenance activities could increase employment, income, and output in the regional economy (Beneficial)

- Changes in recreation opportunities could affect economic activity in Merced County related to San Luis Reservoir (Adverse impact)

Climate variability is likely to affect regional economics because the anticipated reduction in south-of-Delta exports amounts would affect the municipal, industrial and agricultural economies dependent on water supplies imported by the CVP and SWP. This reduction in south-of-Delta exports is likely to result in increases in the price of water as it becomes more scarce; however, the specific nature and magnitude of these effects is unknown. The action alternatives would all, as was noted above in Section 12.3.3, provide beneficial improvements in water supply conditions even in a future with climate variability. This improvement in water supply would also provide benefits to regional economics when compared to a climate variability future with no action.

Q.3.13 Land Use

As discussed in Section 4.16, Land Use and Agricultural Resources, the action alternatives could result in impacts related to the following:

- Construction activities could affect land use by physically dividing a community or conflicting with an applicable land use plan, policy, or regulation (No impact)

- Construction activities could affect land use by converting Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use (No impact)

- Operation of the expanded San Luis Reservoir could result in changes to land use that would conflict with the San Luis Reservoir State Recreation Area Resource Management Plan land use designations (Less than significant)

- Operation of Alternative 4 and 5 could result in changes to land use that would conflict with an applicable land use plan, policy, or regulation (No impact and less than significant)

- Operation of Alternative 4 and 5 could result in changes to land use and agricultural resources as a result of any changes to water supply deliveries (No impact and less than significant)

Climate variability could alter agricultural practices because of its influence on several factors related to water demand and crop performance. Increased air temperatures may increase crop evapotranspiration, but when a crop's optimum temperature range is exceeded growth and water demand would decrease. Higher levels of carbon dioxide can stimulate crop growth but can also reduce transpiration, resulting in lower water demand. Changes in crop growth rates and the timing of crop planting and harvesting due to higher early- and late-season temperatures could result in lower water demand for annuals but higher water demand for perennial crops, as discussed in the Climate Change Sensitivity Analysis completed in the Feasibility Report (Appendix G).

Climate variability effects on watershed evapotranspiration and crop water requirements and growth may also result in different crops being farmed in the region, or conversion of more land to other uses. It is unknown to what degree climate variability may affect land uses, but increases in land fallowing from climate variability could add to the temporary increases in land fallowing identified with implementation of the action alternatives.

Climate variability may result in significant impacts to land use in the study area, but these are not directly related to implementation of the action alternatives and would not increase the magnitude of any of the impacts of the action alternatives; consequently, there would be no changes to the impact conclusions for land use in the study area.

Q.3.14 Recreation

As discussed in Section 4.17, Recreation, the action alternatives could result in impacts related to the following:

- Recreational use on trails would be substantially reduced as a result of project construction (Significant and unavoidable and no impact)
- Project construction could result in temporary closure to recreation facilities, resulting in a substantial loss of recreation opportunities (Significant and unavoidable and no impact)
- Project construction could displace visitors and substantially contribute to overcrowded conditions at other local and regional recreation sites (Significant and unavoidable and no impact)
- Operational changes to water levels in recreational water bodies could affect recreational uses (No impact, less than significant, and beneficial)

Most effects on recreational resources from the action alternatives relate to the closure of recreation sites during construction, a shorter term impact considered in the context of the longer term effects of climate variability. However, the effects of climate variability on operations at San Luis Reservoir could

potentially affect water-based recreation opportunities at the lake. As was noted in Section 12.3.3, reduced south-of-Delta exports with climate variability could result in reservoir levels being lower for longer periods of time, which could affect the availability and quality of recreation activities and experiences throughout the year. Conversely, climate variability could result in warmer air temperatures, increasing demand for recreational activities associated with reservoir use.

Climate variability may result in significant impacts to recreation in the area of analysis, but these are not directly related to implementation of the action alternatives; consequently, there would be no changes to the impact conclusions for recreation in the study area.

Q.3.15 Environmental Justice

As discussed in Section 4.18, Environmental Justice, the action alternatives could result in impacts related to the following:

- Expose a minority and/or low-income population to adverse or disproportionately high effects or hazards from project construction (Potential adverse and disproportionate effect)

Increased temperatures from climate variability could negatively affect populations where temperature control is not available in the residences. Furthermore, health issues from pests, increased pollution, and increased temperatures could increase and aggravate health issues in minority and low-income populations. Potential increases in flooding could damage homes or displace residents. While climate variability could result in significant impacts to environmental justice, these impacts are not directly related to implementation of the action alternatives. Consequently, there would be no changes to the impact conclusions for environmental justice in the study area.

Q.3.16 Public Utilities, Services, and Power

As discussed in Section 4.19, Public Utilities, Services, and Power, the action alternatives could result in impacts related to the following:

- Construction activities could affect the provision of governmental services or facilities including fire and police protection, and schools (Less than significant)

- Construction activities could result in the need for new water, wastewater, or stormwater facilities (Less than significant)

- Construction activities would generate solid waste, the disposal of which could exceed the capacity of landfills designated to accommodate the project’s solid waste disposal needs (Less than significant)

- Construction activities could result in adverse impacts associated with the use and/or depletion of local or regional energy supplies (Less than significant)

- Operations could result in increases in stormwater runoff and the need for new stormwater drainage facilities (Less than significant)

- Changes in the operation of Pacheco Pumping Plant or Gianelli Pumping Plant could result in the need for additional capacity of energy supplies or the depletion of local or regional energy supplies (Less than significant)

- Long-term operations of new facilities could result in the need for additional capacity of energy supplies or the depletion of local or regional energy supplies (Less than significant)

- Construction and operation of the alternatives could result in wasteful, inefficient, or unnecessary consumption of energy (Less than significant)

- Operations could affect the provision of new governmental facilities including fire and police protection or schools (No impact)

The degree of impact from climate variability on energy generation is dependent on many factors and is not known at this time. However, the effects of climate variability are expected to increase energy demand and lower flows during high energy demand times. Climate variability may result in an increase in energy generation in the study area, but these are not directly related to implementation of the action alternatives; consequently, there would be no changes to the impact conclusions for power in the area of analysis.

Most impacts identified for public utilities, services and power under the action alternatives are shorter term construction related effects when considered in the context of the longer-term effects of climate variability. Therefore, climate variability in the longer term would not change these shorter-term constructions generated impacts. The long-term changes in energy consumption from implementation of the action alternatives were all identified to be less than significant and would not be changed in magnitude with climate variability.

Q.3.17 Cultural Resources

As discussed in Section 4.20, Cultural Resources, the action alternatives could result in impacts related to the following:

- Project construction could lead to adverse effects to known and unknown historic properties and/or historical resources (Less than significant and significant and unavoidable)

Most impacts identified for cultural resources under the action alternatives are shorter term construction related effects when considered in the context of the longer term effects of climate variability. Lower San Luis Reservoir levels from climate variability could potentially increase the potential frequency the exposure of cultural resources that are typically submerged. However, because the reservoir is currently operated annually to maximize fill and refill, climate variability would not be anticipated to substantially change the potential for this impact. Similarly, the less than significant impacts from operation of the action alternatives would not be changed in magnitude with climate variability.

Q.3.18 Population and Housing

As discussed in Section 4.21, Population and Housing, the action alternatives could result in impacts related to the following:

- Temporarily induce population growth in the area of analysis, and potentially require new housing to accommodate this growth (Less than significant)
- Construction could displace people or houses, and potentially require construction of replacement housing (No impact)
- Induce substantial population growth or housing in the area of analysis (No impact)
- Operations could displace a number of people or houses, and potentially require construction of replacement housing (No impact)

Climate variability could increase coastal special flood hazard areas (SFHA) by approximately 50 percent along the Pacific Coast due to sea level rise (Federal Emergency Management Agency [FEMA] 2013). This increase in coastal SFHA could affect housing demand or pricing particularly in coastal areas in Santa Clara County and induce population migration to lower cost communities in the Central Valley. Climate variability is likely to affect population and housing; however, the specific nature and magnitude of these effects is unknown. Climate variability may result in additional significant impacts to population and housing in the area of analysis, but these are not directly related to implementation of the action alternatives; consequently, there would be no changes to the impact conclusions for population and housing in the area of analysis.

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San Luis Low Point Improvement Project Environmental Impact Statement/Environmental Impact Report

Appendix R: Statewide Agricultural Production Model

U.S. Department of the Interior
Bureau of Reclamation
Sacramento, California

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1.0 Introduction

This technical appendix describes the agricultural economic model used in the analysis of San Luis Low Point Improvement Project (SLLPIP) alternatives. The scenarios evaluated for the feasibility study include Future No Action Alternative (NAA), and three policy alternatives: Central Valley Project (CVP) Reservoir Expansion Alternative; Increased San Luis Reservoir Carryover Storage Alternative; and Shared Reservoir Expansion Alternative. The CalSim modeling technical appendix (Appendix B) provides additional details regarding the development of the alternatives and the water supply delivered to agricultural users under each alternative.

The Statewide Agricultural Production (SWAP) model is used to evaluate the effects of changes in water supply to agriculture in Central Valley regions. As water supply conditions change within a region as a result of the SLLPIP, growers may shift the crop mix, fallow land, and adjust input use in the production of crops. The SWAP model evaluates these effects; results for each alternative are compared to the results of the NAA to quantify changes in agricultural production, irrigated acreage, and gross farm revenues.

2.0 SWAP Model Overview

The SWAP model is a regional agricultural production and economic optimization model that simulates the decisions of farmers across 97 percent of agricultural land in California. It is the most current in a series of California agricultural production models, originally developed by researchers at the University of California at Davis in collaboration with the California Department of Water Resources (DWR) with additional funding provided by the United States Bureau of Reclamation (Reclamation).

The SWAP model has been peer-reviewed (Howitt et al. 2012). The SWAP model, and its predecessor the Central Valley Production Model (CVPM), have been used for numerous policy analyses and impact studies over the past 20 years, including the impacts of the Central Valley Project Improvement Act (Reclamation and United States Fish and Wildlife Service 1999), Upper San Joaquin Basin Storage Investigation (Reclamation 2008), the State Water Project (SWP) drought impact analysis (Howitt et al. 2009a), and the economic implications of Delta conveyance options (Lund et al. 2007).

2.1 SWAP Model Mechanics

The SWAP model data coverage is most detailed in the Central Valley, but it also includes production regions in the Central Coast, South Coast, and desert areas. The model assumes that farmers maximize profit subject to resource, technical, and market constraints. Farmers sell and buy in competitive markets, and no one farmer can affect or control the price of any commodity. The model selects those crops, water supplies, and other inputs that maximize profit subject to constraints on water and land, and subject to economic conditions regarding prices, yields, and costs. The competitive market is simulated by maximizing the sum of consumer and producer surplus subject to the following characteristics of production, market conditions, and available resources:

- Constant Elasticity of Substitution (CES) production functions for every crop in every region. CES has four inputs: land; labor; water; and other supplies. CES production functions allow for limited substitution between inputs, which allows the model to estimate both total input use and input use intensity. Parameters are calculated using a combination of prior information and the method of Positive Mathematical Programming (PMP) (Howitt 1995).

- Groundwater pumping cost including depth to groundwater.

- California state-wide commodity demand functions.

- Resource constraints on land, labor, water, and other input availability by region.

The SWAP model incorporates project water supplies (SWP and CVP), other local water supplies, and groundwater. As conditions change within a SWAP region (e.g., the quantity of available project water supply increases or the cost of groundwater pumping increases), the model optimizes production by adjusting the crop mix, water sources and quantities used, and other inputs. It also fallows land when that appears to be the most cost-effective response to resource conditions.

The SWAP model is used to compare the long-term response of agriculture to potential changes in SWP and CVP irrigation water delivery, other surface or groundwater conditions, or other economic values or restrictions.

Results from Reclamation's and DWR's operations planning model, CalSim II, are used as inputs into SWAP through a standardized data linkage tool. The CalSim II data file for each alternative includes nine water year types of which five were included in the SWAP model inputs. The water year types include: wet; above normal; below normal; dry; and critical conditions. For each scenario and water year type, the CalSim II model provides the SWAP model with CVP and SWP farm-gate irrigation water deliveries for each SWAP model

region. For the SLLPIP, the Increased San Luis Reservoir Carryover Storage Alternative is post-processed from the NAA CalSim output file, and as such, the standardized data linkage tool is not applied for this alternative.

2.2 SWAP Model Theory

The SWAP model self-calibrates using a three-step procedure based on PMP (Howitt 1995) and the assumption that farmers behave as profit-maximizing agents. In a traditional optimization model, profit-maximizing farmers would simply allocate all land, up until resource constraints become binding, to the most valuable crop(s). In other words, a traditional model would have a tendency for overspecialization in production activities relative to what is observed empirically. The method of PMP incorporates information on the marginal production conditions that farmers face, allowing the model to exactly replicate a base year of observed input use and output. Marginal conditions may include inter-temporal effects of crop rotation, proximity to processing facilities, management skills, farm-level effects such as risk and input smoothing, and heterogeneity in soil and other physical capital. In the SWAP model, PMP is used to translate these unobservable marginal conditions, in addition to observed average conditions, into a cost function.

Unobserved marginal production conditions are incorporated into the SWAP model through increasing land costs. Additional land brought into production is of lower quality and, as such, requires higher production costs, captured with an exponential "PMP" cost function. The PMP cost function is both region and crop specific, reflecting differences in production across crops and heterogeneity across regions. Functions are calibrated using information from acreage response elasticities and shadow values of calibration and resource constraints. The information is incorporated in such a way that the average cost data reflected in standard crop budgets (known data) are unaffected.

PMP is fundamentally a three-step procedure for model calibration that assumes farmers optimize input use for maximization of profits. In the first step, a linear profit-maximization program is solved. In addition to basic resource availability and non-negativity constraints, a set of calibration constraints is added to restrict land use to observed values. In the second step, the dual (shadow) values from the calibration and resource constraints are used to derive the parameters for the exponential PMP cost function and CES production function. In the third step, the calibrated CES and PMP cost function are combined into a full profit maximization program. The exponential PMP cost function captures the marginal decisions of farmers through the increasing cost of bringing additional land into production (e.g., through decreasing quality). Other input costs (supplies, land, and labor) enter linearly into the objective function in both the first and third step.

The SWAP model, and calibration by PMP, is a complicated process, thus sequential testing is very useful for model validation, diagnosing problems, and debugging the model. At each stage in the SWAP model there is a corresponding model check. In other words, the calibration procedure has particular emphasis on the sequential calibration process and a parallel set of diagnostic tests to check model performance. Diagnostic tests are discussed in Howitt et al. (2012).

2.3 Constant Elasticity of Substitution Production Function

Crop production in the SWAP model is represented by a CES production function for each region and crop. In general, a production function is a mathematical specification used to capture the relationship between inputs and output. For example, land, labor, water, and other inputs are combined to produce output of any crop. CES production functions in the SWAP model are specific to each region, thus regional input use is combined to determine regional production for each crop. The calibration routine in SWAP guarantees that both input use and output exactly match a base year of observed data.

The generalized CES production function allows for limited substitution among inputs (Beattie and Taylor 1985). This is consistent with observed farmer production practices (farmers are able to substitute among inputs in order to achieve the same level of production). For example, farmers may substitute labor for chemicals by reducing herbicide application and increasing manual weed control. Or, farmers can substitute labor for water by managing an existing irrigation system more intensively in order to increase efficiency. The CES function used in the SWAP model is non-nested, thus the elasticity of substitution is the same between all inputs.

2.4 Crop Demand Functions

The SWAP model is specified with downward-sloping California state-wide demand functions. The demand curve represents willingness-to-pay for a given level of crop production. All else constant, as production of a crop increases the price of that crop is expected to fall. The extent of the price decrease depends on the elasticity of demand or, equivalently, the price flexibility. The latter refers to the percentage change in crop price due to a percent change in production. The SWAP model is specified with linear demand functions.

2.4.1 Demand Shifts

The nature of the demand function for specific commodities can change over time due to tastes and preferences, population growth, changes in income, and other factors. The SWAP model incorporates linear shifts in the demand functions over time due to growth in population and changes in real income per capita. Changes in consumer tastes and preferences are difficult to predict and

will have an indeterminate effect on demand and are consequently not considered in the model.

3.0 SWAP Model Data

The SWAP model requires a wide range of data to simulate the supply and demand for statewide agricultural production. The necessary data are not available from a single source and are instead compiled from various publicly available sources, including state and federal agencies, academic publications, and water district reports. A SWAP model data update was completed between 2009 and 2011 under contract with Reclamation. The model data and code is currently being updated under contract with the California Department of Food and Agriculture. The model update completed in 2011 is known as SWAP version 6 and this version was used for analysis of the SLLPIP alternatives. Importantly, SWAP version 6 is used in the SLLPIP analysis because it includes a National Economic Development (NED) post-processing routine which ensures benefits are consistent with federal guidelines. The NED post-processor was developed in collaboration with Reclamation concurrent with the SWAP version 6 data update.

3.1 SWAP Regions and Crop Definitions

The SWAP model has 27 base regions in the Central Valley. The current SWAP model covers agriculture in the original 21 CVPM regions (the SWAP model regions include 27 areas), the Central Coast, the Colorado River region that includes Coachella, Palo Verde and the Imperial Valley and San Diego, Santa Ana and Ventura, and the South Coast. Only the 27 regions in the Central Valley are included in the analysis of SLLPIP alternatives.

All SWAP model regions are included in the economic summaries of the SLLPIP alternatives. SWAP model regions are aggregated into the Sacramento Valley (1 - 9), San Joaquin River (10 - 13), and Tulare Lake (14a – 21c) areas for summary of the SLLPIP alternatives. Table 1 summarizes some of the major water users in each of the regions.

Table 1. SWAP Model Region Summary

Region	Major Surface Water Users
1	CVP Users: Anderson Cottonwood Irrigation District (ID), Clear Creek Community Services District, Bella Vista Water District (WD), and miscellaneous Sacramento River water users.
2	CVP Users: Corning Canal, Kirkwood WD, Tehama, and miscellaneous Sacramento River water users.
3a	CVP Users: Glenn Colusa ID, Provident ID, Princeton-Codora ID, Maxwell ID, and Colusa Basin Drain Municipal Water Company (MWC).
3b	Tehama Colusa Canal Service Area. CVP Users: Orland-Artois WD, and Westside WD.
4	CVP Users: Princeton-Codora-Glenn ID, Colusa Irrigation Company, and miscellaneous Sacramento River water users.
5	Most Feather River Region riparian and appropriative users.
6	Yolo and Solano Counties. CVP Users: Conaway Ranch and miscellaneous Sacramento River water users.
7	Sacramento County north of American River. CVP Users: Natomas Central MWC, miscellaneous Sacramento River water users, Pleasant Grove-Verona WMC, and Placer County Water Agency.
8	Sacramento County south of American River and northern San Joaquin County.
9	Direct diverters within the Delta region. CVP Users: Banta Carbona ID, West Side WD, and Plainview.
10	Delta Mendota service area. CVP Users: Panoche WD, Pacheco WD, Del Puerto WD, Hospital WD, Sunflower WD, San Joaquin River Exchange Contractors.
11	Stanislaus River water rights: Modesto ID, Oakdale ID, and South San Joaquin ID.
12	Turlock ID.
13	Merced ID. CVP Users: Madera ID, Chowchilla WD, and Gravely Ford.
14a	CVP Users: Westlands WD.
14b	Southwest corner of Kings County
15a	Tulare Lake Bed. CVP Users: Fresno Slough WD., James ID, Tranquillity ID, Traction Ranch, Laguna WD, and Reclamation District 1606.
15b	Dudley Ridge WD and Devils Den (Castaic Lake)
16	Eastern Fresno County. CVP Users: Friant-Kern Canal, Fresno ID, Garfield WD, and International WD.
17	CVP Users: Friant-Kern Canal, Hills Valley ID, Tri-Valley WD, and Orange Cove.
18	CVP Users: Friant-Kern Canal, County of Fresno, Lower Tule River ID, Pixley ID, and Tulare ID.
19a	SWP Service Area, including Belridge Water Storage District (WSD), Berrenda Mesa WD.
19b	SWP Service Area, including Semitropic WSD.
20	CVP Users: Friant-Kern Canal. Shafter-Wasco, and South San Joaquin ID.
21a	CVP Users: Cross Valley Canal and Friant-Kern Canal
21b	Arvin Edison WD.
21c	SWP service area: Wheeler Ridge-Maricopa WSD.
23-30	Central Coast, Desert, and Southern California

Note: the list above does not include all water users. It is intended only to indicate the major users or categories of users. All regions in the Central Valley also include private groundwater pumpers.

Crops are aggregated into 20 crop groups which are the same across all regions. Each crop group represents a number of individual crops, but many are dominated by a single crop. Irrigated acres represent acreage of all crops within the group, production costs and returns are represented by a single proxy crop for each group. The current 20 crop groups were defined in collaboration with DWR and were last updated in 2011. Crop group definitions and the corresponding proxy crop are shown in Table 2.

Table 2. SWAP Model Crop Groups

SWAP Definition	Proxy Crop	Other Crops
Almonds and Pistachios	Almonds	Pistachios
Alfalfa	Alfalfa Hay	
Corn	Grain Corn	Corn Silage
Cotton	Pima Cotton	Upland Cotton
Cucurbits	Summer Squash	Melons, Cucumbers, Pumpkins
Dry Beans	Dry Beans	Lima Beans
Fresh Tomatoes	Fresh Tomatoes	
Grain	Wheat	Oats, Sorghum, Barley
Onions and Garlic	Dry Onions	Fresh Onions, Garlic
Other Deciduous	Walnuts	Peaches, Plums, Apples
Other Field	Sudan Grass Hay	Other Silage
Other Truck	Broccoli	Carrots, Peppers, Lettuce, Other Vegetables
Pasture	Irrigated Pasture	
Potatoes	White Potatoes	
Processing Tomatoes	Processing Tomatoes	
Rice	Rice	
Safflower	Safflower	
Sugar Beet	Sugar Beets	
Subtropical	Oranges	Lemons, Miscellaneous Citrus, Olives
Vine	Wine Grapes	Table Grapes, Raisins

3.2 Crop Prices and Yields

The SWAP model is designed to calibrate to the actual conditions growers faced in the calibration year. Growers make current planting decisions based on expectations of prices. The SWAP model does not attempt to model how growers form their price expectations; as an approximation, SWAP uses an average of county-level crop prices. Data for county-level crop prices are obtained from the respective County Agricultural Commissioners' annual crop reports.

3.3 Crop Yields

Crop yields for each crop group in the SWAP model correspond to the proxy crops listed in Table 2 and are based on best management practices. The corresponding costs of production, discussed in Section 3.4, are based on cost studies that also reflect best management practices. Thus, crop yields in SWAP are slightly higher than those estimated by calculating county averages, but are more consistent with the production costs. Crop yield data are compiled from the University of California Cooperative Extension (UCCE) production cost budgets prepared by University of California at Davis (UC Davis) and

Extension Researchers. Yields for each region are based on the most recent proxy crop cost study available in the closest region. For example, if a cost study is not available for a particular crop in the Sacramento Valley, the North San Joaquin Valley study may be used.

3.4 Crop Cost of Production Budgets

Land, labor, and other supply costs of production are obtained from the same UCCE crop budgets used to estimate crop yields. Each UCCE budget uses interest rates for capital recovery and interest on operating capital specific to the year of the study. These range from four percent to over eight percent and, as such, require adjustment to a common base year interest rate. A common rate of six percent is used for all data.

Land costs are derived from the respective UCCE crop budget and include land-related cash overhead plus rent and land capital recovery costs. Where appropriate, interest rates are adjusted as described above.

The labor cost category in the SWAP model includes both machine and non-machine labor. Labor wages per hour differ for machine and non-machine labor and, as such, are reported separately in the UCCE budgets. Both machine and non-machine labor costs include overhead to the farmer of federal and state payroll taxes, workers' compensation, and a small percentage for other benefits which varies by budget. Additionally, a percentage premium (typically around 20 percent) is added to machine labor costs to account for equipment set-up, moving, maintenance, breaks, and field repair. The sum of these components, reported on a per acre basis, is used as input data into the SWAP model.

The supply cost category in the SWAP model includes all inputs not explicitly included in the other three input categories (land, labor, and water), including fertilizers, herbicides, insecticide, fungicide, rodenticide, seed, fuel, and custom costs. Additionally, machinery, establishment costs, buildings, and irrigation system capital recovery costs are included. Each sub-category of supply costs is broken down in detail in the respective crop budget. For example, safflower in the Sacramento Valley requires pre-plant Nitrogen as aqua ammonia at 100 pounds per acre in fertilizer costs. Application of Roundup in February and Treflan in March account for herbicide costs. The sum of these individual components, on a per acre basis, is used as base supply input cost data in the SWAP model.

3.5 Surface and Groundwater

The SWAP model includes five types of surface water: SWP delivery; three categories of CVP delivery; and local surface water delivery or direct diversion. The three categories of CVP deliveries are: water service contract, including Friant Class 1 (CVP1); Friant Class 2 (CL2); and water rights settlement and exchange delivery[1]. Water supply data in the calibration year for SWAP version 6 are derived from various sources, described below. CVP and SWP deliveries for the SLLPIP alternatives are from the CalSim II model, described in Section 2.1.

The volume of deliveries for each water source is estimated using data from DWR, Reclamation, and water district reports. CVP water deliveries were derived from Reclamation operations data. Contract deliveries were obtained from Reclamation; the difference between total and contract deliveries indicates deliveries for water rights settlements. SWP water deliveries are obtained from DWR Bulletin 132 (DWR 2008). Kern County Water Agency provides additional details on SWP deliveries to member agencies by region. Local surface water deliveries were obtained from individual district records and reports, DWR water balance estimates prepared for the California Water Plan Update (DWR 2009), and, where needed, data from the CVPM model. CVPM data were, in turn, provided by the Central Valley Ground-Surface Water Model.

A key source of irrigation water, and often the costliest, is groundwater pumping. Groundwater pumping capacity estimates are from a 2009 analysis by DWR in consultation with individual districts. Groundwater pumping capacity is intended to represent the maximum that a region can pump in a year given the aquifer characteristics and existing well capacities.

Groundwater pumping costs are broken out into fixed, energy, and operations and maintenance (O&M) components in the SWAP model. Energy and O&M components are variable. Energy costs depend on the price of electricity. The SWAP model version 6 uses the same unit cost of electricity per kilowatt-hour across all regions. Base electricity costs are derived from Pacific Gas and Electric Company (PG&E) rate books and consultation with power officials at the Fresno, California office. Energy cost is 18.9 cents per kilowatt-hour, which is an average of PG&E's AG-1B and AG-4B rates (PG&E Various Years). Overall well efficiency is assumed to be 70 percent.

[1] CVP Settlement water is delivered to districts and individuals in the Sacramento Valley based on their pre-CVP water rights on the Sacramento River, and San Joaquin River Exchange water is pumped from the Delta and delivered to four districts in the San Joaquin Valley in exchange for water rights diversion eliminated when Friant Dam was constructed. These two delivery categories are geographically distinct but for convenience are combined into one water supply category in SWAP.

3.6 Crop Water Requirements

Applied water is the amount of water applied by the irrigation system to an acre of a given crop for production in a typical year. Variation in rainfall and other climate effects will alter this requirement. Additionally, farmers may stress irrigate crops or substitute other inputs in order to reduce applied water. The latter effect is handled endogenously by the SWAP model through the respective CES production functions. Applied water per acre (base) requirements for crops in the SWAP model are derived from DWR estimates. DWR estimates are based on Detailed Analysis Units (DAU). An average of DAUs within a SWAP region is used to generate a SWAP region specific estimate of applied water per acre for SWAP crops.

3.7 Elasticities

SWAP uses a number of economic response parameters, called elasticities, to estimate rates of change in variables. An elasticity is the percent change in a variable, per unit of percent change in another variable or parameter. Acreage response elasticity is one component of supply response. It is the percentage change in acreage of a crop from a one percent change in that crop's price. The SWAP model contains both long run and short run estimates, and the analyst decides which of the elasticities to use. Long run acreage response elasticities are used for this analysis.

3.7.1 SWAP Model Data Sources

The SWAP model version 6 uses a base year of 2005 for calibration. The calibration year is used to calibrate the underlying economic parameters in the model and does not represent current conditions used in the SLLPIP alternatives analysis. The calibration year is simply intended to represent "average" production conditions in the Central Valley. The year 2005 was neither abnormally dry nor wet, and crop markets had been relatively stable. Table 3 summarizes input data and sources used in the SWAP model.

Table 3. SWAP Model Input Data Summary

Input	Source	Notes
Land Use	DWR	Base year 2005
Crop Prices	County Agricultural Commissioners	By proxy crop using 2005—2007 average prices
Crop Yields	UCCE Crop Budgets	By proxy crop for various years (most recent available)
Interest Rates	UCCE Crop Budgets	All interest rates normalized to year 2005 (6.35%)
Land Costs	UCCE Crop Budgets	By proxy crop for various years (most recent available)
Other Supply Costs	UCCE Crop Budgets	By proxy crop for various years (most recent available)

Table 3. SWAP Model Input Data Summary

Input	Source	Notes
Land Use	DWR	Base year 2005
Crop Prices	County Agricultural Commissioners	By proxy crop using 2005—2007 average prices
Crop Yields	UCCE Crop Budgets	By proxy crop for various years (most recent available)
Labor Costs	UCCE Crop Budgets	By proxy crop for various years (most recent available)
Surface Water Costs	Reclamation, DWR, Individual Districts	By SWAP model region
Groundwater Costs	PG&E, Individual Districts	Total cost per acre-foot includes fixed, O&M, and energy cost
Irrigation Water	DWR	Average crop irrigation water requirements in acre-feet per acre
Available Water	CVPM, DWR, Reclamation, Individual Districts	By SWAP model region and water supply source
Elasticities	Green et al. 2006	California estimates

3.8 Linkage to Other Models

The SWAP model has important interactions with other models. In particular, CalSim II, DWR's project operations model for the SWP and the CVP, is used to estimate SWP and CVP supplies which are inputs into SWAP. An existing linkage tool has been developed to translate CalSim II delivery output to a corresponding SWAP input (on-farm applied water) file. Changes in depth to groundwater affect pumping costs and agricultural revenues. Changes in groundwater depth and resulting changes in groundwater pumping costs can be included from other model, such as CVHM or C2VSim, output, if those models are run concurrently for the project.

4.0 Implementing the SWAP Model for the SLLPIP Alternatives

Scenario analysis using the SWAP model can focus on a single point in time or on several future points. With reasonable interpolation, this approach will create a true time sequence to calculate net present value of a stream of costs or benefits. The alternatives for the SLLPIP were evaluated at a single point in time, also called the level of development.

The SWAP model is used to compare responses to changes in irrigation water delivery under the SLLPIP alternatives. Results from the CalSim II model are used as inputs into SWAP through a standardized data linkage tool. This

linkage tool is used for the NAA, CVP Reservoir Expansion Alternative, and Shared Reservoir Expansion Alternative. The Increased San Luis Reservoir Carryover Storage Alternative is post-processed from the NAA, and this process is described below. The CalSim II data file for each scenario includes nine water year types, of which five are included in the SWAP model inputs. The water year types include wet, above normal, below normal, dry, and critical conditions. For each scenario and water year type, the CalSim II model provides the SWAP model with CVP and SWP on-farm water deliveries for each SWAP model region.

The Increased San Luis Reservoir Carryover Storage Alternative is post-processed from the CalSim II output for the NAA. Appendix B, the CalSim II modeling appendix, includes additional details about this alternative and how it was estimated from the NAA. CalSim II modelers provided the percent change in agricultural water deliveries relative to the NAA for south of Delta agricultural water service contract deliveries for each water year type. This percent change was then applied to the NAA south of Delta CVP agricultural water service contract deliveries for each of the SWAP model regions, and this is the water supply input file for the Increased San Luis Reservoir Carryover Storage Alternative.

4.1 Level of Development and Water Year Type

The SLLPIP NAA and three alternatives correspond to a 2030 level of development. Each alternative and level of development is evaluated for five water year types, including wet, above normal, below normal, dry, and critical.

4.1.1 Crop Demand Shifts

Crop demands are expected to shift in the future due to increased population, higher real incomes, changes in tastes and preferences, and related factors. The key changes that are included in the analysis of SLLPIP alternatives are population and real income. An increase in real income is expected to increase demand for agricultural products. Similarly, population increases are expected to increase crop demand. Changes in consumer tastes and preferences will have an indeterminate effect on demand and are not included in this analysis.

Increases in demand for crops produced in California may be partially offset by other production regions depending on changing export market conditions. For example, today California is the dominant producer of almonds but this may change if other regions increase production. Thus an increase in almond demand could be partially met by other regions. However, additional demand growth from markets like China may offset this effect. The net effect is indeterminate. In the absence of data or studies demonstrating which effect would dominate, California export share is assumed to remain constant for all crops in the future. This assumption is consistent with peer-reviewed publications for the California Energy Commission (CEC) and the academic

journal *Climatic Change*, in addition to the 2009 DWR Water Plan (Howitt et al. 2009a, Howitt et al. 2009b).

Crop demands are linear in the SWAP model and population and real income changes induce a parallel shift in demand. Demand shifts are included for all of the alternative scenarios evaluated for the SLLPIP, including the No Action Alternative. Consequently, comparisons of NAA to each action alternative relates identical future market conditions.

For purposes of the demand shift analysis, a distinction is made between two types of crops grown in California, California specific crops and global commodities. Global commodity crops include grain rice, and corn[2]; all other crop groups are classified as California crops. Global commodity crops are those for which there is no separate demand for California's production. For these crops, California faces a perfectly elastic demand, and is thus a price taker. For California specific crops, California faces a downward sloping demand for a market that is driven by conditions in the United States and international export markets. A routine in the SWAP model calculates the demand shift for the 2030 level of development for the SLLPIP alternatives.

4.1.2 Electricity Costs

Groundwater is typically the most expensive water supply. Real power costs are expected to increase in the future, and groundwater relies heavily on the cost of electricity for pumping. Energy pumping costs are escalated according to future marginal power cost estimates for the year 2030.

A marginal power cost escalator is determined for the year 2030 and applied to the energy cost component of groundwater costs. The cost escalator is the ratio of the expected future power cost in 2030 to the base power cost in 2005, in 2005 dollars per megawatt hour. Expected future power costs are calculated using the DWR Forward Price Projections analysis using wholesale power costs (DWR 2011). This calculates an average power cost for each month as the average of the peak (upper bound) and off-peak (lower bound) rates. An average of the monthly costs generates an average yearly cost. This cost is used to generate the power cost escalator by taking the ratio of the future year average to the current year average. The power cost escalator for 2030 is 1.54.

4.1.3 Groundwater Depth

The SWAP model can be linked to a groundwater model to estimate change in depth to groundwater, both static and dynamic, to estimate the additional lift, and therefore energy cost, for water year types. Dry years can result in groundwater levels dropping by several feet in some regions of the Central Valley, depending on local aquifer conditions. The CVHM or C2VSim models were not run for the SLLPIP alternatives. A review of existing studies using the

[2] Rice demand is very elastic, but not perfectly elastic. For purposes of the demand shifting analysis, it is assumed to be perfectly elastic.

SWAP model linked to CVHM determined that no basis was available to adjust depth to groundwater under the alternative water year types. As such, depth to groundwater is held constant at the baseline levels under all water year types and alternatives.

4.1.4 Other Factors

The SWAP model includes a number of sub-routines that are included in studies on a case-by-case basis. All of these other factors are held constant in the SLLPIP alternatives.

Climate change effects are held constant in the analysis of SLLPIP alternatives. The SWAP model has been linked to crop models, such as LAWS, to estimate the change in crop yield and crop evapotranspiration and, therefore, applied water requirements. Climate change effects on crop growth remain highly uncertain and are consequently held constant in the analysis.

Crop yields have been increasing for most crops due to technological innovations. Innovations like hybrid seeds, better chemicals and fertilizer, improved pest management, and irrigation and mechanical harvesting advances are some examples. The expected future rate of growth in crop yields remains a contentious topic among researchers. Consequently, yield changes due to technological innovations are held constant in the analysis of SLLPIP alternatives. It is important to note that the SWAP model does allow for some minor yield response to changing market conditions. This effect is referred to as endogenous yield changes. The SWAP model includes full CES production functions for each crop and region, which allow for some endogenous yield change in response to changing market conditions, but there is no exogenous technological change included in the analysis.

4.2 NED Benefits Calculations

The basic guidelines for evaluating water development projects at the federal level are specified in the “Principles, Requirements, and Guidelines for Federal Investments in Water Resources” (PR&Gs; CEQ 2014). Under the PR&Gs, the federal objective for water contributions is to maximize the contribution to NED consistent with protection of the environment. In order to adhere to the PR&Gs and determine the contribution to NED, a series of adjustments to the SWAP model and data are necessary. Adjustments fall into two categories, pre- and post-processing. Pre-processing adjustments are made prior to optimization with the SWAP model and include adjustments to SWAP input data and exogenous projections of future costs and demands. Post-processing adjustments are applied to SWAP output and include adjustments to prices and costs. They are adjustments needed in order for the results to comply with PR&Gs and Reclamation guidelines for NED analysis. In particular, guidelines require that certain prices be used for valuing changes in physical inputs and outputs. They do not explicitly affect farmers’ decisions, so they are applied

after the SWAP optimization. Post-processing adjustments include interest rates, other supply costs, fallow land costs, normalized crop prices, consumer surplus, water costs, and management charges.

All of the NED adjustments follow the SWAP NED adjustments developed in consultation with Reclamation for the North of Delta Offstream Storage (NODOS) feasibility study. The data have been updated to reflect current conditions (e.g., Current Normalized Prices are updated), but the fundamental method is unchanged. This section provides an overview of the approach.

Pre-processing adjustments include changes to the data that occur before SWAP model optimization. This includes demand shifts, energy pumping costs, interest rate adjustment, and other factors as described earlier in this section. These adjustments are made prior to SWAP optimization and are made regardless of whether the project is being evaluated under NED guidelines.

Post-processing adjustments take place after the SWAP model optimization. These include:

1. The PR&Gs require that the federal discount rate be used for all interest and capital recovery calculations. The current federal discount rate is 3.125 percent. A post-processing adjustment is applied to cost data components to adjust the interest rate to 3.125 percent.

2. Machinery capital recovery costs are removed from the NED analysis under all scenarios. Additional land coming into irrigated production (with the project versus without the project) would be quite small and is therefore unlikely to require additional machinery investment. By the same logic, buildings capital recovery costs are removed from the NED analysis under all scenarios.

3. Land rent and cash overhead and land capital recovery costs are removed from the NED analysis under all scenarios. The NED analysis is adjusted to remove land costs that are included within the SWAP data file because lands being brought into irrigated production are already considered a sunk investment. Sunk investments are irrelevant to determining the economic feasibility of new project investments.

4. Interest on operating capital and capital recovery charges for permanent crop establishment and for irrigation systems are adjusted using interest factors as noted above.

5. An annual maintenance cost of $41.88 per acre (in 2016 dollars) is used for the NED analysis to account for fallow land costs, as required by the PR&Gs.

6. Consumer surplus is the benefit (welfare gain) that consumers realize from being able to purchase crops at less than their maximum

willingness to pay. Since the changes in water supply and crop price are negligible under the SLLPIP alternatives, the change in consumer surplus is negligible and is excluded from the SLLPIP NED benefits calculations.

7. Surface water costs are excluded from the NED benefits calculation. In a NED benefit-cost analysis of a proposed project, the incremental investment and annual costs of the new water supply are accounted for on the cost side of the ledger, so including them as water costs within the benefits analysis would effectively be double-counting.

8. Reclamation guidelines for preparing NED analysis under the PR&Gs recommend including management costs at no less than six percent of variable costs. A six percent management charge is added to the variable production costs in the SWAP model.

9. The PR&Gs state that U.S. Department of Agriculture (USDA) Current Normalized Prices (CNP) must be used for benefits calculations when available. These prices have been adjusted by USDA to remove any federal subsidies because such subsidies represent an NED cost that must be accounted for in comparing project benefits and costs. For crop groups covered by USDA's CNP estimates, SWAP prices were converted to scaled CNP. For crop groups without available CNP, the SWAP-predicted prices are used. CNP reported in dollars per ton, are as follows: corn $120.36; cotton $1,413.07; dry beans $952.00; grains (wheat) $154.00; rice $312.80; and sugar beets $41.92.

5.0 Description of SLLPIP Results

This section describes the SWAP model results for NAA and the SLLPIP action alternatives. Changes in economic conditions in the Central Valley are summarized in terms of irrigated acreage, gross farm revenues, groundwater use, and groundwater cost. As described previously, the Sacramento Valley, San Joaquin River, and Tulare Lake regions are summarized. Water year types summarized in this section include wet, below normal, and critical conditions.

5.1 No Action Alternative

The NAA represents future market and production conditions for Central Valley agriculture if the SLLPIP is not implemented. The NAA is used to compare the policy alternatives. Table 4 shows the total irrigated acreage and gross value of agricultural production under the NAA. Table 5 shows the total groundwater pumping and cost under the NAA.

On average, in the Central Valley over $28 billion in gross value of production is generated on about 6.8 million irrigated acres. The wet water year conditions lead to the highest value and largest irrigated footprint. The total irrigated area and gross value decreases in below normal and critical conditions as growers shift the crop mix to lower water use crops and fallow land in response to constrained surface water supplies. For example, the Central Valley irrigates 6.87 million acres in wet years and 6.62 million acres in critically dry years and the corresponding gross value of production decreases from $28.2 million to $26.6 million. Growers are able to partially offset reduced surface water supplies by increasing the amount of groundwater pumped. Groundwater pumping increases from 5.98 million acre-feet (AF) to 8.13 million AF between wet and critically dry years.

Table 4. NAA Acreage and Value

Analysis Metric	NAA Value
	Wet Condition
Total Irrigated Acreage (thousand acres)	
Sacramento River	1,522
San Joaquin River	2,212
Tulare Lake	3,139
Total Value of Production (million $)	
Sacramento River	6,572.9
San Joaquin River	8,220.2
Tulare Lake	13,424.2
	Above Normal Condition
Total Irrigated Acreage (thousand acres)	
Sacramento River	1,522
San Joaquin River	2,211
Tulare Lake	3,139
Total Value of Production (million $)	
Sacramento River	5,428.8
San Joaquin River	8,220.1
Tulare Lake	13,423.2
	Below Normal Condition
Total Irrigated Acreage (thousand acres)	
Sacramento River	1,525
San Joaquin River	2,210
Tulare Lake	3,138
Total Value of Production (million $)	
Sacramento River	5,430.1
San Joaquin River	8,219.8
Tulare Lake	13,423.2
	Dry Condition
Total Irrigated Acreage (thousand acres)	
Sacramento River	1,507
San Joaquin River	2,210
Tulare Lake	3,068
Total Value of Production (million $)	

Table 4. NAA Acreage and Value

Analysis Metric	NAA Value
Sacramento River	5,397.3
San Joaquin River	8,225.6
Tulare Lake	13,344.8
	Critical Condition
Total Irrigated Acreage (thousand acres)	
Sacramento River	1,478
San Joaquin River	2,210
Tulare Lake	2,939
Total Value of Production (million $)	
Sacramento River	5,331.1
San Joaquin River	8,246.7
Tulare Lake	13,089.1

Table 5. NAA Groundwater Use and Cost

Analysis Metric	NAA Value
	Wet Condition
Annual Groundwater Pumped (thousand AF [TAF])	
Sacramento River	1,406.2
San Joaquin River	1,474.0
Tulare Lake	3,099.9
Annual Cost of Pumping (million $)	
Sacramento River	83.7
San Joaquin River	126.7
Tulare Lake	436.1
	Above Normal Condition
Annual Groundwater Pumped (TAF)	
Sacramento River	1,399.1
San Joaquin River	1,599.1
Tulare Lake	3,613.2
Annual Cost of Pumping (million $)	
Sacramento River	83.7
San Joaquin River	137.1
Tulare Lake	535.8
	Below Normal Condition
Annual Groundwater Pumped (TAF)	
Sacramento River	1,436.9
San Joaquin River	1,664.0
Tulare Lake	3,761.1
Annual Cost of Pumping (million $)	
Sacramento River	89.3
San Joaquin River	142.4
Tulare Lake	566.1

Table 5. NAA Groundwater Use and Cost

Analysis Metric	NAA Value
	Dry Condition
Annual Groundwater Pumped (TAF)	
Sacramento River	1,447.7
San Joaquin River	1,799.8
Tulare Lake	4,134.0
Annual Cost of Pumping (million $)	
Sacramento River	90.0
San Joaquin River	153.7
Tulare Lake	623.5
	Critical Condition
Annual Groundwater Pumped (TAF)	
Sacramento River	1,574.7
San Joaquin River	2,056.1
Tulare Lake	4,506.7
Annual Cost of Pumping (million $)	
Sacramento River	98.6
San Joaquin River	174.8
Tulare Lake	678.5

5.2 CVP Reservoir Expansion Alternative

The CVP Reservoir Expansion Alternative provides CVP agricultural water service contractors with a larger share of the additional irrigation water. Appendix B describes the water supply conditions underlying this alternative in detail.

Table 6 shows the total irrigated acreage and gross farm revenues under CVP Reservoir Expansion Alternative and the change from the NAA. Table 7 shows the total groundwater use and groundwater cost under the CVP Reservoir Expansion Alternative and the change from the NAA.

Regions that receive CVP supplies show a small increase in irrigated acreage and reduction in groundwater pumping relative to the NAA. The increases in CVP deliveries are relatively modest, less than a few TAF per year, and the corresponding change in irrigated acreage and groundwater use is small. In all water year conditions, the CVP Reservoir Expansion Alternative has a negligible effect on total irrigated acreage and value. Crop production expands by less than 100 acres and crop revenues increase by a few thousand dollars.

The additional CVP supplies result in a reduction in total groundwater pumping, which is approximately equal to the increase in CVP surface water supplies in most regions. In wet years, total groundwater pumping decreases by 22,800 AF at a cost savings of $4.5 million per year. Under progressively drier conditions

the CVP Reservoir Expansion Alternatives provides fewer incremental CVP supplies, and irrigators already rely on groundwater for a larger share of total irrigation supply, thus the groundwater pumping and cost savings attributable to the CVP Reservoir Expansion Alternative decreases. In critically dry years, the CVP Reservoir Expansion Alternative results in no groundwater pumping savings.

The effects of the CVP Reservoir Expansion Alternative are not constant across regions in the Central Valley. For example, in Below Normal, Above Normal, and Wet conditions, the San Joaquin River region receives more CVP water, expands production, and the total value of production increases relative to the NAA. As production increases, the farm-gate price of those crops decreases. In turn, the farm-gate value of production decreases in some Sacramento and Tulare Lake regions.

In general, the incremental effect of the CVP Reservoir Expansion Alternative relative to the NAA is small in most regions. Increased CVP supplies are primarily used to reduce groundwater pumping, which provides a cost-saving benefit to irrigators. This changes the average cost of irrigation water, and growers adjust the underlying crop mix in response. In addition, some regions utilize additional surface supplies to (slightly) expand production slightly under the CVP Reservoir Expansion Alternative. As production increases, the price of the crop falls, all else equal, which can cause farm-gate revenues to fall in other regions.

Table 6. CVP Reservoir Expansion Alternative Acreage and Value

Analysis Metric	CVP Reservoir Expansion Alternative	Change from NAA
	Wet Condition	
Total Irrigated Acreage (thousand acres)		
Sacramento River	1,522	0.00
San Joaquin River	2,212	0.03
Tulare Lake	3,139	0.00
Total Value of Production (million $)		
Sacramento River	5,428.6	0.00
San Joaquin River	8,220.3	0.02
Tulare Lake	13,424.2	0.00
	Above Normal Condition	
Total Irrigated Acreage (thousand acres)		
Sacramento River	1,522	0.000
San Joaquin River	2,211	0.055
Tulare Lake	3,139	-0.010
Total Value of Production (million $)		

Table 6. CVP Reservoir Expansion Alternative Acreage and Value

Analysis Metric	CVP Reservoir Expansion Alternative	Change from NAA
Sacramento River	5,428.8	-0.001
San Joaquin River	8,220.1	0.026
Tulare Lake	13,423.2	-0.015
	Below Normal Condition	
Total Irrigated Acreage (thousand acres)		
Sacramento River	1,525	0.00
San Joaquin River	2,210	0.08
Tulare Lake	3,138	-0.22
Total Value of Production (million $)		
Sacramento River	5,430.1	0.00
San Joaquin River	8,219.8	0.05
Tulare Lake	13,423.1	-0.13
	Dry Condition	
Total Irrigated Acreage (thousand acres)		
Sacramento River	1,507	-0.07
San Joaquin River	2,210	0.00
Tulare Lake	3,069	0.65
Total Value of Production (million $)		
Sacramento River	5,397.2	-0.19
San Joaquin River	8,225.6	-0.01
Tulare Lake	13,345.9	1.14
	Critical Condition	
Total Irrigated Acreage (thousand acres)		
Sacramento River	1,478	0.009
San Joaquin River	2,210	0.000
Tulare Lake	2,939	0.010
Total Value of Production (million $)		
Sacramento River	5,331.2	0.010
San Joaquin River	8,246.7	-0.006
Tulare Lake	13,089.2	0.025

Table 7. CVP Reservoir Expansion Alternative Groundwater Use and Cost

Analysis Metric	CVP Reservoir Expansion Alternative	Change from NAA
	Wet Condition	
Annual Groundwater Pumped (TAF)		
Sacramento River	1,405.0	-1.17
San Joaquin River	1,467.6	-6.40
Tulare Lake	3,084.6	-15.28
Annual Cost of Pumping (million $)		
Sacramento River	83.6	-0.12
San Joaquin River	126.1	-0.54
Tulare Lake	432.3	-3.84
	Above Normal Condition	
Annual Groundwater Pumped (TAF)		
Sacramento River	1,396.8	-2.31
San Joaquin River	1,594.8	-4.34
Tulare Lake	3,599.2	-14.01
Annual Cost of Pumping (million $)		
Sacramento River	83.4	-0.26
San Joaquin River	136.7	-0.36
Tulare Lake	532.6	-3.24
	Below Normal Condition	
Annual Groundwater Pumped (TAF)		
Sacramento River	1,433.2	-3.69
San Joaquin River	1,658.5	-5.45
Tulare Lake	3,756.1	-5.06
Annual Cost of Pumping (million $)		
Sacramento River	88.9	-0.39
San Joaquin River	142.0	-0.46
Tulare Lake	564.3	-1.75
	Dry Condition	
Annual Groundwater Pumped (TAF)		
Sacramento River	1,447.7	0.02
San Joaquin River	1,799.8	-0.05
Tulare Lake	4,133.0	-1.05
Annual Cost of Pumping (million $)		
Sacramento River	90.0	0.00
San Joaquin River	153.7	0.00
Tulare Lake	623.3	-0.16
	Critical Condition	
Annual Groundwater Pumped (TAF)		
Sacramento River	1,575.0	0.22
San Joaquin River	2,056.1	-0.01
Tulare Lake	4,506.6	-0.03

Table 7. CVP Reservoir Expansion Alternative Groundwater Use and Cost

Analysis Metric	CVP Reservoir Expansion Alternative	Change from NAA
Annual Cost of Pumping (million $)		
Sacramento River	98.7	0.02
San Joaquin River	174.8	0.00
Tulare Lake	678.5	0.00

5.3 Increased San Luis Reservoir Carryover Storage Alternative

The Increased San Luis Reservoir Carryover Storage Alternative is post-processed from the NAA, as described under Section 4. Under this alternative, south of Delta CVP water service contractors receive an additional 0.018 to 1.505 percent in surface water supplies, varying by water year type. Appendix B describes the water supply results in more detail.

Table 8 shows the total irrigated acreage and gross farm revenues under the Increased San Luis Reservoir Carryover Storage Alternative and the change from the NAA. Table 9 shows the total groundwater use and groundwater cost under the Increased San Luis Reservoir Carryover Storage Alternative and the change from the NAA.

Regions that receive CVP supplies show a small increase in irrigated acreage and reduction in groundwater pumping relative to the NAA. The increases in CVP deliveries are relatively modest, and in many years are negligible, and the corresponding change in irrigated acreage and groundwater use is small. In all water year conditions, the Increased San Luis Reservoir Carryover Storage Alternative has a negligible effect on total irrigated acreage and value. Crop production expands by less than 100 acres and crop revenues increase by a few thousand dollars.

The additional CVP supplies result in a reduction in total groundwater pumping, which is approximately equal to the increase in CVP surface water supplies in most regions. In wet years, total groundwater pumping decreases by 5,900 AF at a cost savings of $1.1 million per year. Under progressively drier conditions the Increased San Luis Reservoir Carryover Storage Alternative provides fewer incremental CVP supplies, and irrigators already rely on groundwater for a larger share of total irrigation supply, thus the groundwater pumping and cost savings attributable to the Increased San Luis Reservoir Carryover Storage Alternative decreases. In critically dry years, the Increased San Luis Reservoir Carryover Storage Alternative provides no additional CVP supplies relative to the NAA, and there is no change in groundwater pumping.

The effects of the Increased San Luis Reservoir Carryover Storage Alternative are not constant across regions in the Central Valley. In Below Normal, Above

Normal, and Wet conditions, all of the additional CVP water is used to substitute for groundwater pumping. There is no increase in the farm-gate value of production in these years. Under dry years, there is a modest increase in irrigated acreage in the Tulare Lake region. In turn, production increases and the price of the crops for which production increases falls, causing a decrease in farm-gate revenues in other region. The critical water year conditions do not provide any additional surface supplies.

In general, the incremental effect of the Increased San Luis Reservoir Carryover Storage Alternative relative to the NAA is small in most regions. The alternative provides no additional surface water under critical water year conditions. For years in which it is available, increased CVP supplies are primarily used to reduce groundwater pumping, which provides a cost-saving benefit to irrigators. This changes the average cost of irrigation water, and growers adjust the underlying crop mix in response. In addition, some regions utilize additional surface supplies to (slightly) expand production slightly under the Increased San Luis Reservoir Carryover Storage Alternative. As production increases, the price of the crop falls, all else equal, which can cause farm-gate revenues to fall in other regions.

Table 8. Increased San Luis Reservoir Carryover Storage Alternative Acreage and Value

Analysis Metric	Increased San Luis Reservoir Carryover Storage Alternative	Change from NAA
	Wet Condition	
Total Irrigated Acreage (thousand acres)		
Sacramento River	1,522	0.00
San Joaquin River	2,212	0.00
Tulare Lake	3,139	0.00
Total Value of Production (million $)		
Sacramento River	5,428.6	0.00
San Joaquin River	8,220.2	0.00
Tulare Lake	13,424.2	0.00
	Above Normal Condition	
Total Irrigated Acreage (thousand acres)		
Sacramento River	1,522	0.00
San Joaquin River	2,211	0.00
Tulare Lake	3,139	0.00
Total Value of Production (million $)		
Sacramento River	5,428.8	0.00
San Joaquin River	8,220.1	0.00
Tulare Lake	13,423.2	0.00

Analysis Metric	Increased San Luis Reservoir Carryover Storage Alternative	Change from NAA
	Below Normal Condition	
Total Irrigated Acreage (thousand acres)		
Sacramento River	1,525	0.00
San Joaquin River	2,210	0.00
Tulare Lake	3,138	0.00
Total Value of Production (million $)		
Sacramento River	5,430.1	0.00
San Joaquin River	8,219.8	0.00
Tulare Lake	13,423.2	0.00
	Dry Condition	
Total Irrigated Acreage (thousand acres)		
Sacramento River	1,507	-0.001
San Joaquin River	2,210	-0.002
Tulare Lake	3,070	2.260
Total Value of Production (million $)		
Sacramento River	5,397.3	-0.008
San Joaquin River	8,225.6	-0.044
Tulare Lake	13,348.8	4.012
	Critical Condition	
Total Irrigated Acreage (thousand acres)		
Sacramento River	1,478	0.000
San Joaquin River	2,210	0.000
Tulare Lake	2,939	0.000
Total Value of Production (million $)		
Sacramento River	5,331.1	0.000
San Joaquin River	8,246.7	0.000
Tulare Lake	13,089.1	0.000

Table 9. Increased San Luis Reservoir Carryover Storage Alternative Groundwater Use and Cost

Analysis Metric	Increased San Luis Reservoir Carryover Storage Alternative	Change from NAA
	Wet Condition	
Annual Groundwater Pumped (TAF)		
Sacramento River	1,406.2	0.000
San Joaquin River	1,472.4	-1.592
Tulare Lake	3,095.5	-4.355
Annual Cost of Pumping (million $)		
Sacramento River	83.7	0.000
San Joaquin River	126.5	-0.133
Tulare Lake	435.1	-1.057

Analysis Metric	Increased San Luis Reservoir Carryover Storage Alternative	Change from NAA
	Above Normal Condition	
Annual Groundwater Pumped (TAF)		
Sacramento River	1,399.1	0.000
San Joaquin River	1,597.9	-1.212
Tulare Lake	3,609.9	-3.318
Annual Cost of Pumping (million $)		
Sacramento River	83.7	0.000
San Joaquin River	137.0	-0.101
Tulare Lake	535.0	-0.801
	Below Normal Condition	
Annual Groundwater Pumped (TAF)		
Sacramento River	1,436.9	0.000
San Joaquin River	1,663.9	-0.038
Tulare Lake	3,761.0	-0.114
Annual Cost of Pumping (million $)		
Sacramento River	89.3	0.000
San Joaquin River	142.4	-0.003
Tulare Lake	566.0	-0.027
	Dry Condition	
Annual Groundwater Pumped (TAF)		
Sacramento River	1,447.7	-0.002
San Joaquin River	1,797.6	-2.167
Tulare Lake	4,132.7	-1.306
Annual Cost of Pumping (million $)		
Sacramento River	90.0	0.000
San Joaquin River	153.5	-0.181
Tulare Lake	623.3	-0.182
	Critical Condition	
Annual Groundwater Pumped (TAF)		
Sacramento River	1,574.7	0.000
San Joaquin River	2,056.1	0.000
Tulare Lake	4,506.7	0.000
Annual Cost of Pumping (million $)		
Sacramento River	98.6	0.000
San Joaquin River	174.8	0.000
Tulare Lake	678.5	0.000

5.4 Shared Reservoir Expansion Alternative

The Shared Reservoir Expansion Alternative provides additional surface supplies to both SWP and CVP contractors. Appendix B describes the water supply conditions underlying this alternative in detail.

Table 10 shows the total irrigated acreage and gross farm revenues under the Shared Reservoir Expansion Alternative and the change from the future NAA. Table 11 shows the total groundwater use and groundwater cost under Shared Reservoir Expansion Alternative and the change from NAA.

Regions that receive CVP or SWP irrigation water supplies show a small increase in irrigated acreage and reduction in groundwater pumping relative to NAA. Similar to the CVP Reservoir Expansion alternative, the increases in CVP and SWP deliveries are relatively modest, less than a few TAF per year, and the corresponding change in irrigated acreage and groundwater use is small. In all water year conditions, the Shared Reservoir Expansion Alternative has a negligible effect on total irrigated acreage and value. Crop production expands or contracts by fewer than 200 acres under any water year type. Crop revenues increase by less than $200,000 annually.

The additional CVP and SWP supplies result in a reduction in total groundwater pumping, which is approximately equal to the increase in surface water supplies in most regions. In wet years, total groundwater pumping decreases by 11 TAF at a cost savings of $2.1 million per year. Under progressively drier conditions the Shared Reservoir Expansion Alternative provides fewer incremental CVP and SWP supplies, and irrigators already rely on groundwater for a larger share of total irrigation supply, thus the groundwater pumping and cost savings attributable to the Shared Reservoir Expansion Alternative decreases. In dry and critically dry years, the Shared Reservoir Expansion Alternative results in no groundwater pumping savings.

The effects of the Shared Reservoir Expansion Alternative are not constant across regions in the Central Valley. In Above Normal conditions, the Tulare Lake region receives CVP and SWP supplies, expands production, and the total value of production increases relative to the NAA. As production increases, the farm-gate price of those crops decreases. In turn, the farm-gate value of production decreases in some Sacramento and San Joaquin River regions.

In general, the incremental effect of the Shared Reservoir Expansion Alternative relative to the NAA is small in most regions. Increased CVP and SWP supplies are primarily used to reduce groundwater pumping, which provides a cost-saving benefit to irrigators. This changes the average cost of irrigation water, and growers adjust the underlying crop mix in response. In addition, some regions utilize additional surface supplies to (slightly) expand production under the Shared Reservoir Expansion Alternative. As production increases, the price of the crop falls, all else equal, which can cause farm-gate revenues to fall in other regions.

Table 10. Shared Reservoir Expansion Alternative Acreage and Value

Analysis Metric	Shared Reservoir Expansion Alternative	Change from NAA
	Wet Condition	
Total Irrigated Acreage (thousand acres)		
Sacramento River	1,522	0.00
San Joaquin River	2,212	0.01
Tulare Lake	3,139	0.00
Total Value of Production (million $)		
Sacramento River	5,428.6	0.00
San Joaquin River	8,220.2	0.01
Tulare Lake	13,424.2	0.00
	Above Normal Condition	
Total Irrigated Acreage (thousand acres)		
Sacramento River	1,522	0.00
San Joaquin River	2,211	0.03
Tulare Lake	3,139	0.06
Total Value of Production (million $)		
Sacramento River	5,428.8	-0.01
San Joaquin River	8,220.0	-0.01
Tulare Lake	13,423.3	0.11
	Below Normal Condition	
Total Irrigated Acreage (thousand acres)		
Sacramento River	1,525	0.00
San Joaquin River	2,210	0.05
Tulare Lake	3,138	-0.20
Total Value of Production (million $)		
Sacramento River	5,430.1	0.00
San Joaquin River	8,219.8	0.03
Tulare Lake	13,423.1	-0.08
	Dry Condition	
Total Irrigated Acreage (thousand acres)		
Sacramento River	1,507	-0.08
San Joaquin River	2,210	0.00
Tulare Lake	3,068	0.11
Total Value of Production (million $)		
Sacramento River	5,397.1	-0.20
San Joaquin River	8,225.6	0.03
Tulare Lake	13,345.1	0.36
	Critical Condition	
Total Irrigated Acreage (thousand acres)		
Sacramento River	1,478	0.04
San Joaquin River	2,210	0.00
Tulare Lake	2,939	0.02
Total Value of Production (million $)		
Sacramento River	5,331.2	0.09
San Joaquin River	8,246.8	0.06
Tulare Lake	13,088.9	-0.20

Table 11. Shared Reservoir Expansion Alternative Groundwater Use and Cost

Analysis Metric	Shared Reservoir Expansion Alternative	Change from NAA
	Wet Condition	
Annual Groundwater Pumped (TAF)		
Sacramento River	1,405.6	-0.57
San Joaquin River	1,471.1	-2.88
Tulare Lake	3,092.3	-7.65
Annual Cost of Pumping (million $)		
Sacramento River	83.7	-0.06
San Joaquin River	126.4	-0.24
Tulare Lake	434.3	-1.86
	Above Normal Condition	
Annual Groundwater Pumped (TAF)		
Sacramento River	1,397.7	-1.44
San Joaquin River	1,597.1	-2.04
Tulare Lake	3,604.2	-8.96
Annual Cost of Pumping (million $)		
Sacramento River	83.5	-0.15
San Joaquin River	136.9	-0.17
Tulare Lake	533.9	-1.92
	Below Normal Condition	
Annual Groundwater Pumped (TAF)		
Sacramento River	1,434.7	-2.17
San Joaquin River	1,660.5	-3.43
Tulare Lake	3,760.4	-0.73
Annual Cost of Pumping (million $)		
Sacramento River	89.1	-0.23
San Joaquin River	142.1	-0.29
Tulare Lake	565.4	-0.64
	Dry Condition	
Annual Groundwater Pumped (TAF)		
Sacramento River	1,447.7	0.03
San Joaquin River	1,799.8	-0.05
Tulare Lake	4,134.6	0.60
Annual Cost of Pumping (million $)		
Sacramento River	90.0	0.00
San Joaquin River	153.7	0.00
Tulare Lake	623.5	0.01
	Critical Condition	
Annual Groundwater Pumped (TAF)		
Sacramento River	1,574.7	0.01
San Joaquin River	2,056.0	-0.05
Tulare Lake	4,506.9	0.22

Analysis Metric	Shared Reservoir Expansion Alternative	Change from NAA
Annual Cost of Pumping (million $)		
Sacramento River	98.6	0.00
San Joaquin River	174.8	0.00
Tulare Lake	678.6	0.0

6.0 SWAP Model Limitations

The SWAP model is an optimization model that makes the best (i.e., most profitable) adjustments to water supply and other changes. Constraints can be imposed to simulate restrictions on how much adjustment is possible or how fast the adjustment can realistically occur. Nevertheless, an optimization model can tend to over-adjust and minimize costs associated with detrimental changes or, similarly, maximize benefits associated with positive changes.

SWAP does not explicitly account for the dynamic nature of agricultural production; it provides a point-in-time comparison between two conditions. This is consistent with the way most economic and environmental impact analysis is conducted, but it can obscure sometimes important adjustment costs.

SWAP also does not explicitly incorporate risk or risk preferences (e.g., risk aversion) into its objective function. Risk and variability are handled in two ways. First, the calibration procedure for SWAP is designed to reproduce observed crop mix, so to the extent that crop mix incorporates risk spreading and risk aversion, the starting, calibrated SWAP base condition will also. Second, variability in water delivery, prices, yields, or other parameters can be evaluated by running the model over a sequence of conditions or over a set of conditions that characterize a distribution, such as a set of water year types.

Groundwater is an alternative source to augment SWP and CVP delivery in many subregions. The cost and availability of groundwater therefore has an important effect on how SWAP responds to changes in delivery. However, SWAP is not a groundwater model and does not include any direct way to adjust pumping lifts and unit pumping cost in response to long-run changes in pumping quantities.

Similar to other DWR water models including LCPSIM, SWAP currently does not differentiate between water delivered under the Table A, Article 21, or Article 56 provisions of the SWP water contracts, treating the supplies as equally valuable for crop production.

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San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix S: Cumulative Effects

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Appendix S
Cumulative Effects

This appendix describes, in detail, the cumulative effects analysis completed in this Environmental Impact Statement/Environmental Impact Report (EIS/EIR). Included here are descriptions of the regulatory requirements, methodology, cumulative projects considered, and resource-specific cumulative effects analyses.

Cumulative effects are those environmental effects that on their own, may not be considered adverse, but when combined with similar effects over time, result in substantial adverse effects. Cumulative effects are an important part of the environmental analysis because they allow decision makers to look not only at the impacts of an individual proposed project, but the overall impacts to a specific resource, ecosystem, or human community over time from many different projects. This section describes the cumulative effects analysis for the three action alternatives proposed in this EIS/EIR including the regulatory requirements, the methodology, the projects considered in the analysis, and the potential cumulative effects for each environmental resource.

S.1 Regulatory Requirements

This section provides an overview of the regulatory setting associated with cumulative effects.

S.1.1 Regulatory Setting

Both the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA) require consideration of cumulative effects in an EIS/EIR.

S.1.1.1 National Environmental Policy Act

Cumulative effects are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such actions (40 Code of Federal Regulations [CFR] Section 1508.7)."

NEPA regulations require an analysis of direct, indirect, and cumulative effects and define "effects" as "ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative (40 CFR Section 1508.8)." In addition, the NEPA regulations state that when determining the scope of an EIS, both connected and cumulative actions must be discussed in the same document as the proposed action (40 CFR Section 1508.25[a][1] and [2]).

S.1.1.2 California Environmental Quality Act

Cumulative effects are defined in the CEQA Guidelines as:

> "Two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts."

1. The individual effects may be changes resulting from a single project or a number of separate projects.

2. The cumulative impact from several projects is the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time (CEQA Guidelines Section 15355)."

According to the CEQA Guidelines, a Lead Agency must discuss the cumulative impacts of a project when the cumulative effect is significant and the project's incremental contribution to the cumulative effect would be "cumulatively considerable," that is, when the incremental effects of a project would be significant when viewed in connection with the effects of past, present, and probable future projects (CEQA Guidelines Section 15065[a][3]; Section 15130[a]).

If the combined cumulative impact associated with the project's incremental effect and the effects of other projects would not be significant, an EIR should briefly indicate why the cumulative impact is not significant (CEQA Guidelines Section 15130[a][2]).

Additionally, an EIR can determine that a project's contribution to a significant cumulative impact will be rendered less than cumulatively considerable and therefore not significant. A project's contribution can also be less than cumulatively considerable if the project is required to implement or fund its fair share of a mitigation measure or measures designed to alleviate the cumulative impact. The Lead Agency must identify facts supporting this conclusion (CEQA Guidelines Section 15130[a][3]).

S.2 Methodology for Assessing Cumulative Effects

This section provides an overview of the methodology used to analyze cumulative effects.

S.2.1 Area of Analysis

Table S-1 describes the specific cumulative effects area of analysis for each resource area.

Table S-1. Cumulative Effects Area of Analysis

Section	Resource	Area of Analysis
4.1	Water Quality	San Luis Reservoir; Sacramento/San Joaquin River Delta, Pacheco Reservoir; and Santa Teresa WTP in San Jose.
4.2	Surface Water Supply	Same as Water Quality with the addition of the California Aqueduct and South-of-Delta CVP Contractors (SLDMWA).
4.3	Groundwater Resources	San Joaquin Valley/Tulare Lake Hydrologic Region, San Francisco Bay Hydrologic Region, South Lohantan Hydrologic Region, Colorado River Hydrologic Region, South Coast Hydrologic Region
4.4	Flood Control	Merced, San Benito, and Santa Clara counties
4.5	Geology, Seismicity, and Soils	Merced and Santa Clara counties
4.6	Indian Trust Assets	Merced and Santa Clara counties
4.7	Air Quality	Merced County and the San Joaquin Valley Air Basin; and, Santa Clara County and the San Francisco Bay Area Air Basin.
4.8	Greenhouse Gases	Regional and Global
94.9	Visual Resources	San Luis Reservoir and O'Neill Forebay; Pacheco Reservoir; sightlines in relation to properties associated with the Santa Teresa WTP in the SCVWD Service Area.
4.10	Noise and Vibration	San Luis Reservoir, Merced County; Pacheco Reservoir and Santa Teresa WTP, Santa Clara County.
4.11	Traffic and Transportation	Roadways in Santa Clara and Merced counties as well as local roads in the cities of Gustine, Los Banos, Gilroy, San Jose, and the village of Santa Nella.
4.12	Hazards and Hazardous Materials	San Luis Reservoir and the SRA; Pacheco Reservoir; SCVWD facilities where construction is proposed.
4.13	Aquatic Resources	San Luis Reservoir and the associated SRA, SCVWD service area, Pacheco Reservoir and Pacheco Creek, Sacramento/San Joaquin River Delta.
4.14	Terrestrial Resources	Santa Clara Basin; Pacheco Reservoir; San Luis Reservoir and the SRA
4.15	Regional Economics	Santa Clara County, Merced County

Table S-1. Cumulative Effects Area of Analysis

Section	Resource	Area of Analysis
4.16	Land Use	San Luis Reservoir, Merced County, including the SRA, O'Neill Forebay, Los Banos Creek Reservoir, San Luis Wildlife Area, Pacheco State Park, and Cottonwood Creek Wildlife Area; Pacheco Reservoir; and, CVP agricultural contractors receiving water from the San Felipe Division (counties include Santa Clara, Monterey, Santa Cruz, and San Benito).
4.17	Recreation	San Luis Reservoir and the SRA; Pacheco Reservoir.
4.18	Environmental Justice	Communities close to San Luis Reservoir and the SRA including Volta, Trent, Los Banos, Ingomar, Gustine, and unincorporated Santa Nella; Santa Clara County and the City of San Jose.
4.19	Public Utilities, Services, and Power	San Luis Reservoir, Merced County; Pacheco Reservoir, Santa Clara County; SCVWD service area including Santa Teresa WTP in San Jose; and San Felipe Division Facilities.
4.20	Cultural Resources	San Luis Reservoir, Merced County, Pacheco Reservoir, Santa Clara County, San Benito County
4.21	Population and Housing	The cities of Los Banos, Newman, Gilroy, Gustine, and San Jose.

Key: CVP = Central Valley Project; SCVWD = Santa Clara Valley Water District; SLDMWA = San Luis & Delta-Mendota Water Authority; SRA = State Recreation Area; WTP = Water treatment plant

S.2.2 Timeframe for Cumulative Effects Analysis

The timeline for the cumulative effects analysis with the exception of greenhouse gasses and traffic and transportation, is 7 years for all short-term construction-related impacts. These impacts would be temporary and would only occur during construction. The timeframe for all long-term impacts is 20 years, which represents the planning horizon addressed in this EIS/EIR. The analysis in Section S.3.6 relies on a 30-year timeframe for long-term impacts consistent with the Bay Area Air Quality Management District (BAAQMD) emission amortization requirements. The analysis in Section S.3.10 utilizes a 25-year timeframe for long-term impacts consistent with the Merced County and Santa Clara Valley Transportation Authority analysis guidelines.

S.2.3 Identifying Past, Present, and Future Actions and Projects Contributing to Cumulative Effects

CEQA Section 15130(b)(1) identifies two methods that may be used to analyze cumulative impacts:

1. "A list of past, present, and probable future projects producing related or cumulative impacts, including, if necessary, those projects outside the control of the agency," and/or

2. "A summary of projections contained in an adopted local, regional, or statewide plan or related planning document, that describes or evaluates conditions contributing to the cumulative effect. Such plans may include: a general plan, regional transportation plan, or plans for the reduction of greenhouse gas emissions. A summary of projections may also be contained in an adopted or certified prior environmental document for such a plan. Such projections may be supplemented with additional information such as a regional modeling program. Any such document shall be referenced and made available to the public at a location specified by the Lead Agency."

This EIS/EIR analyzes cumulative impacts using both CEQA methods identified above. These methods are sufficient to satisfy NEPA and CEQA requirements for identifying past, present, and future actions and projects that may contribute to cumulative effects. Most EIS/EIR resources use one method or the other, but several resource areas use a combination of both methods.

A variety of Federal, State, county, and local government sources were reviewed to identify and collect information on past, present, and reasonably foreseeable actions in the project area that could contribute to cumulative effects. These include:

- City and county general plans;
- Future population, housing, traffic, and other projections found in existing city and county general plans;
- Published reports, documents, and plans;
- Biological Management Plans (Biological Opinions, Habitat Conservation Plans, etc.);
- Environmental documents (such as EIS/EIRs).
- Scoping comments; and
- Consultation with Federal, State, and local agencies.

Sections S.2.5 and S.2.6 below describe the project and projections considered for this cumulative effects analysis.

S.2.4 Mitigation

The EIS/EIR must identify potential mitigation measures if a project would result in cumulatively considerable effects.

S.2.4.1 National Environmental Policy Act

According to NEPA, a discussion on mitigation for adverse environmental effects is required in an EIS (40 Section Part 1502.16[h], 40 CFR Section 1502.14[f]); however, a final set of mitigation measures that are selected for implementation are adopted in a Record of Decision (ROD). If mitigation measures presented in the EIS are not adopted, the reasons why must be explained in the ROD (40 CFR Section 1505.2[c]). The cumulative effects analysis will identify potential feasible mitigation for significant cumulative effects; the ROD will present the final mitigation measures adopted as part of the project that will be completed with the respective alternative selected for implementation.

S.2.4.2 California Environmental Quality Act

Mitigation requirements of CEQA differ from those of NEPA. An EIR must examine reasonable, feasible options for mitigating or avoiding the project's contribution to any significant cumulative effects (CEQA Guidelines Section 15130). If there are feasible mitigation measures or alternatives that would avoid or substantially lessen the significant impacts of a project, as identified in the final EIR, such measures or alterations must in required in, or incorporated into, the project in order for it to be approved (CEQA Guidelines Section 15091). Therefore, CEQA requires each public agency to mitigate or avoid the significant effects of projects that it carries out or approves whenever it is feasible to do so (Public Resource Code § 21002.1[b]). The cumulative effects analysis will identify all feasible mitigation measures for effects of the project determined to be "cumulatively considerable" and thus significant. The approval of the EIR and subsequent CEQA findings will contain the feasible mitigation measures adopted as part of the project.

S.2.5 Cumulative Projects Considered for All Resources

This section describes the past, present, and reasonably foreseeable future cumulative actions and projects considered in this cumulative effects analysis.

S.2.5.1 Addendum to the Agreement for Coordinated Operation of the CVP and SWP

In December 2018, Reclamation and DWR amended four key elements of the Coordinated Operation Agreement as follows:

- Article 6(c) of the Agreement is amended to share the responsibility for meeting Sacramento Valley inbasin use with storage withdrawals during balanced water conditions;

- Article 10(b) of the Agreement is amended to have the State transport CVP water through the California Aqueduct and provide available capacity at the Banks Pumping Plant to the CVP;
- Article 10(i) is added to the Agreement to share the applicable export capacity when exports are constrained; and
- Article 14(a) of the Agreement is amended to have the U.S. and the State review and revise the Agreement (Reclamation 2018a).

S.2.5.2 Bay-Delta Conservation Plan/California Water Fix/Delta Conveyance

The *Bay Delta Conservation Plan* (BDCP)/California Water Fix is being prepared by the United States Department of the Interior, Bureau of Reclamation (Reclamation) and Department of Water Resources (DWR), along with Kern County Water Agency, Metropolitan Water District of Southern California, San Luis and Delta-Mendota Water Authority, Santa Clara Valley Water District (SCVWD), State and Federal Water Contractors Agency, Westlands Water District, and Zone 7 Water Agency (referred to as Potential Authorized Entities).

The BDCP/California WaterFix planning process began in 2006 when updates to the State Water Project (SWP) and coordinated operations of the Central Valley Project (CVP) were initially proposed as the BDCP. The BDCP envisioned updating the SWP by adding new points of diversion in the north Delta and by providing for large-scale species conservation through a 50- year habitat conservation plan (HCP)/natural communities conservation plan (NCCP). The HCP/NCCP was intended to comply with Section 10 of the federal Endangered Species Act and to achieve compliance with the California Endangered Species Act through the California Natural Community Conservation Planning Act. A Draft EIS/EIR was released in December 2013.

Following release of the Draft EIS/EIR, Reclamation and DWR issued a Supplemental Draft EIS/Partially Recirculated Draft EIR that included for consideration three additional alternatives that would update the SWP without the large-scale conservation efforts in an HCP/NCCP. The lead agencies proposed that one of these non-HCP alternatives, known as California WaterFix Alternative 4A, be identified as the preferred alternative in replacement of the BDCP alternative (DWR and Reclamation 2015). The preferred WaterFix alternative (4A) consists of three new diversion points in the north Delta, tunnel conveyance and ancillary facilities, operational elements, restoration measures, and an adaptive management program (DWR and Reclamation 2015). The Supplemental Draft EIS/Partially Recirculated Draft EIR also included updates to the BDCP alternative as well as other revisions and updates to the 2013 Draft EIR/EIS analyses. In addition, the state proposed as a separate program, California EcoRestore, to provide restoration efforts for species conservation independent of the SWP facility upgrades.

The Final EIS/EIR for the BDCP/California WaterFix that identified the California WaterFix for implementation was released in December 2016 (DWR and Reclamation 2016). Biological Opinions for the California WaterFix were release in June 2017 and a Notice of Determination was filed in July 2017. In July 2018, DWR released a Draft Supplemental EIR/EIS for California WaterFix, which analyzes several proposed changes designed to reduce the project's footprint and costs, and minimize impacts on environmental resources in the Delta (DWR and Reclamation 2018). In May 2019, the California Water Fix effort was halted to allow for a new environmental evaluation of a modified Delta Conveyance Project that would shift from a previously proposed two conveyance tunnels down to one tunnel (DWR 2019). That evaluation is currently underway by DWR in coordination with the Delta Conveyance Design and Construction Authority (DWR 2019).

S.2.5.3 Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta

The State Water Resources Control Board adopted Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta in December 2018, which is designed to restore water flows through the Lower San Joaquin River and its tributaries. The plan sets a starting point for increased flows but also makes allowances for reduced river flows on tributaries where stakeholders have reached voluntary agreements to pursue a combination of flow and "non-flow" measures that improve conditions for fish and wildlife, such as habitat restoration and reducing predation (SWRCB 2018). The update includes improved instream flows February through June, the critical months for migrating fish on the Stanislaus, Tuolumne and Merced rivers, and a revision of the salinity standard for the southern Delta (SWRCB 2018).

S.2.5.4 B.F. Sisk Safety of Dams Modification Project

Reclamation and DWR are evaluating alternatives for the B.F. Sisk Dam Safety of Dams (SOD) Modification Project to address dam stability and safety concerns at B.F. Sisk Dam. These concerns are associated with several sections of the B.F. Sisk Dam and select foundation materials in the event of seismic activity. The analyzed alternatives for the B.F. Sisk Dam SOD Modification Project would help prevent destabilization of the dam embankment, reduce safety concerns and maintain water supply deliveries to state and federal contractors. Reclamation and DWR released a Draft EIS/EIR for public review in May 2019 that identified a Crest Raise Alternative as the Proposed Action (Reclamation and DWR 2019). The Crest Raise Alternative would raise sections of the B.F. Sisk Dam crest by 12 feet and develop stability berms along sections of the embankment. The San Luis Reservoir Expansion Alternative evaluated in this EIS/EIR is as was noted in Chapter 2, would build upon and is a connected action under NEPA to the B.F. Sisk Dam SOD Modification Project Crest Raise Alternative. As a connected action the B.F. Sisk Dam SOD Modification Project Crest Raise Alternative to effects generated by the San

Luis Reservoir Expansion Alternative reported in this chapter already include the cumulative contribution of that connected action. The B.F. Sisk Dam SOD Modification Project Crest Raise Alternative's contribution to the other alternatives are detailed in this appendix.

S.2.5.5 California High Speed Rail Project

The California High Speed Rail Authority (CHSRA) and United States Department of Transportation Federal Railroad Administration completed a programmatic EIS/EIR for the San Francisco to Central Valley portion of an approximately 800 mile long high speed rail network connecting San Francisco to San Diego. The track alignments considered in the EIS/EIR included one configuration traversing Pacheco Pass adjacent to State Route (SR) 152 and San Luis Reservoir. The railway is being designed to support train speeds in excess of 125 miles per hour and would construct both at grade and tunnel sections through Pacheco Pass (CHSRA 2010).

The Final Partially Revised Programmatic EIS/EIR was released by the CHSRA April 6, 2012. The EIS/EIR identified the Pacheco Pass Network Alternative as the preferred alternative for consideration in future project level engineering and environmental compliance (CHSRA 2012).

The San Jose to Merced project section is part of the first phase of the California High-Speed Rail System that will provide a critical rail link between the Silicon Valley and the Central Valley. The approximately 84-mile project section would travel between stations in San Jose and Gilroy and (after passing through the Central Valley Wye) north to Merced or south to Fresno (CHSRA 2017). The Pacheco Pass tunnels and the extension to Merced will be the last link of the Silicon Valley to Central Valley Line to be constructed, with geotechnical analysis, environmental review, design, and right-of-way acquisition to be completed by 2022 (CHSRA 2018).

S.2.5.6 CVP Municipal & Industrial Water Shortage Policy

Allocation of CVP water supplies for any given water year is based upon forecasted reservoir inflows and Central Valley hydrologic conditions, amounts of storage in CVP reservoirs, regulatory requirements, and management of Section 3406(b)(2) resources and refuge water supplies in accordance with implementation of the Central Valley Project Improvement Act (CVPIA). In some cases, Municipal and Industrial (M&I) water shortage allocations may differ between CVP divisions due to regional CVP water supply availability, system capacity, or other operational constraints.

The purposes of the M&I Water Shortage Policy (WSP) are to:

- Define water shortage terms and conditions applicable to all CVP M&I contractors.

- Establish a water supply level that (a) with M&I contractors' drought water conservation measures and other water supplies will sustain urban areas during droughts, and (b) during severe or continuing droughts will, as far as possible, protect public health and safety.

- Provide information to help M&I contractors develop drought contingency plans.

The M&I WSP and implementation guidelines are intended to provide detailed, clear, and objective guidelines for the distribution of CVP water supplies during water shortage conditions, thereby allowing CVP water users to know when, and by how much, water deliveries may be reduced in drought and other low water supply conditions (Reclamation 2015a). This increased level of predictability is needed by water managers and the entities that receive CVP water to better plan for and manage available CVP water supplies, and to better integrate the use of CVP water with other available non-CVP water supplies.

While the specific future policy and shortage allocation process is currently under evaluation, it is likely that both agricultural and M&I water service contractors will received reduced allocations during shortage conditions. Reclamation will periodically reassess both the availability of CVP water supply and CVP water demand.

S.2.5.7 Los Vaqueros Reservoir Expansion Project, Phase 2

Expansion of Los Vaqueros Reservoir, owned and operated by Contra Costa Water District (CCWD), is being conducted in two phases. A Final EIS/EIR was completed in 2010 and served as the basis for Phase 1 construction, which was completed in 2012. A draft Supplement to the Final EIS/EIR (Supplement) was released to the public in July of 2017 to reflect changes since the 2010 Final EIS/EIR, including refined alternatives being considered for a Phase 2 expansion (Reclamation 2018). In 2018, a Draft Feasibility Report was release evaluating the feasibility of expanding Los Vaqueros Reservoir from the recently expanded size of 160,000 acre-feet to 275,000 acre-feet and adding new conveyance facilities. The expansion could improve water supply reliability and water quality for San Francisco Bay Area water users, including through emergency storage (Reclamation 2017).

S.2.5.8 Pacheco Reservoir Reoperation Project

The Resource Conservation District of Santa Cruz County (RCDSCC), in cooperation with the San Benito County Water District (SBCWD), Pacheco Pass Water District (PPWD), National Marine Fisheries Service (NMFS), and California Department of Parks and Recreation (CDPR), developed operational guidelines for Pacheco Reservoir to improve water supply reliability through conjunctive management of surface water and groundwater supplies and to provide in stream flows to protect all life stages of steelhead downstream of

Pacheco Reservoir (SBCWD 2013). Guidelines for Pacheco Reservoir were developed by constructing a watershed system simulation model which was used to evaluate environmental and water supply outcomes associated with alternate operation strategies. The guidelines were developed and finalized in 2015 (NOAA 2018).

S.2.5.9 San Luis Reservoir State Recreation Area Resource Management Plan/General Plan

CDPR, in partnership with Reclamation, manages the majority of the San Luis Reservoir State Recreation Area (SRA). The CDPR planning process is integrated with Reclamation's Resource Management Planning Process. The CDPR, in partnership with Reclamation, has developed and adopted the *San Luis Reservoir SRA Resource Management Plan (RMP)/General Plan (GP)* (Reclamation and CDPR 2013), in order to direct the future development, operations and maintenance of the SRA. The plan was officially adopted in 2013 and has a life expectancy of 25 years. CDPR and Reclamation continue to collaborate on the area's *San Luis Reservoir SRA RMP/GP* to guide future growth.

The plan area consists of 27,000 acres owned by Reclamation and includes the water surfaces of San Luis Reservoir, O'Neil Forebay, Los Banos Reservoir, and adjacent recreation lands in the vicinity of Los Banos, California. The project area was built as part of the water storage and delivery system of reservoirs, aqueducts, power plants, and pumping stations operated under the SWP and CVP. Lands managed by CDPR for recreation are part of the State Park system and comprise the SRA.

The plan's primary objective is to identify general areas in which future development may occur for recreation management. The plan includes an overview of existing conditions, including a summary of opportunities and constraints, a plan for future use and management of the project area, and the associated environmental analysis pursuant to NEPA and CEQA (Reclamation and CDPR 2013).

S.2.5.10 San Luis Transmission Project

The San Luis Transmission Project will develop approximately 95 miles of new transmission lines connecting the Tracy Substation and the Dos Amigos Substation with segments crossing O'Neill Forebay and connecting to the San Luis Substation. Additional components of the San Luis Transmission Project will include two new 500-kV substations, substation improvements, communication facilities, improvements to existing access roads, and new permanent access roads (Western Area Power Administration and San Luis & Delta-Mendota Water Authority 2015). The Final EIS/EIR for the San Luis Transmission Project was released in March 2016 with construction scheduled for 2018.

S.2.5.11 San Luis Solar Project

The San Luis Solar Project would allow a 30-year Land Use Authorization to access, install, operate, maintain, and remove a 26-megawatt alternating current solar facility. The project would be constructed on three sites adjacent to the San Luis Reservoir SRA, to the northwest of the SR 152/SR 33 interchange. The three sites will cover a total of 159 acres and consist of solar photovoltaic panels, racks to hold the panels, and electrical infrastructure (Reclamation 2018). The Final Environmental Assessment and Plan of Development for the San Luis Solar Project was released in May 2018, with construction scheduled for 2018.

S.2.5.12 Upper Guadalupe River Flood Control Project

The *Upper Guadalupe River Flood Control Project* follows upon the completed Downtown, and Lower Guadalupe River Projects. The project would provide flood protection along a 5.7 mile stretch of the Guadalupe River, from Interstate 280 to Blossom Hill Road in the City of San Jose. In May 2010, construction began on the portion of the project from Interstate 280 to the Union Pacific Railroad crossing just downstream of Willow Street. The project includes flood protection, habitat restoration, and fish passage components. Pending available Federal funds, remaining reaches of the Upper Guadalupe River may be completed by 2021 (SCVWD 2012).

S.2.5.13 Young Ranch Residential Project

In 2017, the Santa Clara County Planning Office prepared a Draft EIR for the Young Ranch Residential Project, a cluster subdivision consisting of 30 lots and a 4,000 square foot community center. The subdivision would be located on a 2,150 acre site southeast of downtown San Jose along Coyote Ridge, east of Highway 101. The project would develop 79 single-family homes and 16 secondary units and designate 1,947 acres as open space (Santa Clara County 2017).

S.2.5.14 Blanchard Road Warehouse/Distribution Center

An EIR is currently being prepared for the Blanchard Road Warehouse/Distribution Center, which would consist of a 415,000 square foot industrial warehouse on a 29.92 acre site on Blanchard Road in the Coyote Valley area south of San Jose. The site will be paved and would include 196 parking stalls for employee and visitors. Although the warehouse operator has not been identified, it is not anticipated that hazardous materials would be stored or distributed. Construction would take approximately nine months and would cover all site improvements as well as construction of the building. Blanchard Road would be widened to provide access to the site (City of San Jose 2016).

S.2.6 Cumulative Projections Considered for All Resources

This section describes the specific projections shown in Table S-2 that have been used for the cumulative effects analysis.

Table S-2. Summary of Projections Used in Cumulative Effects Analysis

Author	Document Title	Projections Used	Document Date
Merced County	Merced County General Plan – Revised Draft, Demographics & Economics. Background Report	Population Employment	2012
County of Santa Clara	Santa Clara County General Plan – Housing Element Update 2015-2022	Housing	2014
LAFCO Santa Clara County	Cities Service Review	Population	2015
County of Stanislaus	Stanislaus County General Plan and Airport Land Use Compatibility Plan Update Draft Program EIR	Population	2016

Source: Merced County 2013, Santa Clara County 2014, LAFCO of Santa Clara County 2015, and Stanislaus County 2016.
Notes:
LAFCO = Local Area Formation Committee

S.2.6.1 Merced County General Plan – Background Report

The Background Report for the 2030 *Merced County General Plan* was released in December 2013. This document presents population and employment projections through 2030. The projections have been developed by the California Department of Finance (DOF).

Table S-3 shows both past and projected population estimates from the General Plan's projections from 2013. The current DOF (2017) population projection for Merced County in 2030 has been revised downward, to 326,574, but the use of a higher population projection provides a more conservative cumulative impact analysis. Additionally the table also displays average annual growth rates for each time period. As indicated in Table 26-3, the county's population had an average annual growth rate of 3.1 percent from 2000 to 2005 and 2.7 percent from 2005 to 2010 and a projected growth rate of 2.6 percent from 2010 to 2030 (Merced County 2013). Utilizing these population projections, the Background Report identifies an estimated population increase from 2010 to 2030 of approximately 141,000 people that will require housing within the county (Merced County 2013).

Table S-3. Past and Projected Population Estimates Merced County and California (2000-2030)

Year	Merced County	
	Population	Average Annual Growth Rate
2000	210,544	--
2003	225,115	2.3 percent
2005	243,700	4.1 percent
2010	276,200	2.7 percent
2020	340,800	2.3 percent
2030	417,200	2.2 percent

Source: Merced County 2013

Employment growth projections presented in the Background Report identified approximately 27,600 jobs that would be added in Merced County between 2005 and 2030. Table S-4 shows these employment projections for both unincorporated and incorporated areas within the county from 2005 to 2030.

Table S-4. Past and Projected Employment Estimates Merced County (1990-2030)

Year	Observed/ Projected	Total Jobs	Average Annual Growth Rate
1990	Observed	77,300	--
2004	Observed	86,500	0.9 percent
2005	Projected	87,400	1.0 percent
2030	Projected	115,000	2.1 percent

S.2.6.2 Santa Clara County General Plan – Housing Element Update 2015-2022

The Housing Element Update 2015-2022 of the *County of Santa Clara General Plan* was adopted June 10, 2014 and certified on July 25, 2014. This document presents job growth projections through 2025. The projections have been developed by the Association of Bay Area Governments (ABAG).

Table S-5 shows job growth trends from ABAG's Projections 2009. It projects that during the 2015 to 2025 period, Santa Clara County will add 196,290 jobs, growing an average of two percent annually. The projections for the unincorporated County also forecast an increase in employment of approximately 11 percent from 2015 to 2025. However, these projections and ABAG's methodology do not adequately take into account annexation of urban islands into the cities over time. For example, most of the islands with non-residential use patterns have been annexed into San Jose over the last several decades. Annexations are expected to continue.

Table S-5. Santa Clara County Job Growth Trends

Job Growth Projections	2010	2015	2020	2025
Countywide Santa Clara County	906,270	981,230	1,071,980	1,177,520
Unincorporated Santa Clara County	50,400	53,590	56,670	59,690

Source: ABAG Projections 2009 in City of San Jose 2012

S.2.6.3 Local Area Formation Commission of Santa Clara County – Cities Service Review

The Local Area Formation Commission (LAFCO) of Santa Clara County completed a Cities Service Review that developed population, household, income, and employment projections for Santa Clara County through 2040. Table S-6 shows the population projections.

Table S-6. LAFCO Projections – Growth and Population Trends (2015-2040)

City	2015	2040	25-Year Growth	Average Annual Growth
Campbell	41,857	48,100	14.9%	0.60%
Cupertino	59,756	71,200	19.2%	0.77%
Gilroy	53,000	61,400	15.8%	0.63%
Los Altos	30,036	32,800	9.2%	0.37%
Los Altos Hills	8,341	8,600	3.1%	0.12%
Los Gatos	30,505	32,600	6.9%	0.27%
Milpitas	72,606	109,100	50.3%	2.01%
Monte Sereno	3,451	3,700	7.2%	0.29%
Morgan Hill	41,779	50,800	21.6%	0.86%
Mountain View	77,914	100,000	28.3%	1.13%
Palo Alto	66,932	84,600	26.4%	1.06%
San Jose	1,016,479	1,334,100	31.2%	1.25%
Santa Clara	120,973	156,500	29.4%	1.17%
Saratoga	30,799	32,700	6.2%	0.25%
Sunnyvale	148,028	194,300	31.3%	1.25%
Cities population and growth projections	1,802,456	2,320,500	28.7%	1.15%
Unincorporated	87,182	123,000	41.1%	1.64%
Countywide population and growth projections	1,889,638	2,443,500	29.3%	1.17%

Source: LAFCO of Santa Clara County 2015

S.2.6.4 Stanislaus County General Plan and Airport Land Use Compatibility Plan Update Draft Program EIR

The Stanislaus County General Plan and Airport Land Use Compatibility Plan Update Draft Program EIR evaluation of potential effects on population and housing presented observed and projected population estimates from 2010 through 2035 for incorporated areas, unincorporated areas and the total for all of Stanislaus County. Table S-7 shows the population projections.

Table S-7. Stanislaus County Population Projections (2010-2035)

City	2010	2015	2020	2025	2030	2035	Change
Ceres	45,417	50,069	55,379	60,689	65,999	70,127	54.4%
Hughson	6,640	7,012	7,437	7,862	8,287	8,805	32.6%
Modesto	201,165	211,813	223,966	236,119	248,272	263,802	31.1%
Newman	10,224	11,648	13,274	14,900	16,525	17,559	71.7%
Oakdale	20,675	22,908	25,457	28,005	30,555	32,466	57.0%
Patterson	20,413	25,065	30,375	35,685	40,995	43,559	113.4%
Riverbank	22,678	24,989	27,627	30,265	32,903	34,961	54.2%
Turlock	68,549	74,983	82,328	89,673	97,017	103,086	50.4%
Waterford	8,456	9,409	10,496	11,584	12,671	13,464	59.2%
Unincorporated	110,236	113,772	117,807	121,843	125,879	133,753	21.3%
Stanislaus County Total	514,453	551,668	594,146	636,625	679,103	721,582	40.3%
San Joaquin County	685,000	743,000	807,000	872,000	938,000	1,04,00	46.6%
Merced County	256,000	277,000	303,000	330,000	356,000	383,000	49.6%

Source: LAFCO of Stanislaus County 2015

S.3 Cumulative Effects Analysis

S.3.1 Water Quality

S.3.1.1 Alternative 2 - Lower San Felipe Intake Alternative

Cumulative impacts related to construction and/or operation of the Lower San Felipe Intake Alternative on the San Luis Reservoir, and cumulative impacts related to changes in south-of-Delta CVP and SWP exports and Delta outflow on the Delta Region are considered in this section.

The Lower San Felipe Intake Alternative could change Delta salinity and bromide concentrations resulting in water quality impacts. Implementation of the BDCP/ Delta Conveyance Project/California EcoRestore, 2018 Addendum to the Coordinated Operation Agreement, and 2018 Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta could result in changed Delta Region operations and habitat health with the implementation of conservation and restoration measures designed to improve the health of the Delta ecosystem alongside improving water supply and water quality conditions. Future improved conditions in the Delta Region could result in increased south-of Delta exports.

Modeling indicates that operation of the Lower San Felipe Intake Alternative would result in slight changes to Delta water quality resulting from changes in Delta ouflows compared to the No Action Alternative. Potential changes in salinity in comparison to the No Action/No Project Alternative were determined to be immeasurable. Additionally, any increases in south-of-Delta export as a result of the Delta Conveyance Project would only follow improvements in the

Delta ecosystem's health and improved water quality conditions in the Delta Region as a result of both the Delta Conveyance Project and California EcoRestore's restoration actions. **Therefore, cumulative impacts of the Lower San Felipe Intake Alternative in combination with other projects in the Delta Region, would not result in significant cumulative impacts on Delta salinity and bromide concentrations.**

The Lower San Felipe Intake Alternative could change south-of-Delta CVP and SWP exports and Delta outflow. As was noted above, implementation of the BDCP/ Delta Conveyance Project/California EcoRestore, 2018 Addendum to the Coordinated Operation Agreement, and 2018 Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta could result in changed Delta Region operations and habitat health.

Operation of the Lower San Felipe Intake Alternative would result in slight changes to average south-of-Delta exports and Delta outflow when compared to the No Action/No Project Alternative. However, these changes in south-of-Delta export of CVP and SWP water and Delta outflow as a result of the Lower San Felipe Intake Alternative would be minimal and would not impact water quality. **Therefore, cumulative impacts of the Lower San Felipe Intake Alternative in combination with other projects in the Delta Region, would not result in significant cumulative impacts on water quality.**

Construction work around San Luis Reservoir could increase run-off and could introduce pollutants into the reservoir. Construction of trails, campgrounds, and wells identified in the *San Luis SRA General Plan* would take place at the same time as the proposed project and would involve earth moving and construction near the shore of the reservoir. Construction of the B.F. Sisk Dam SOD Modification Project would involve earth moving and construction along the dam crest and across the downstream embankment. Additionally, construction activities associated with the California High Speed Rail Project could involve earth moving and construction projects upstream of the reservoir. One configuration of the railway would traverse Pacheco Pass adjacent to SR 152 and San Luis Reservoir. Together, these projects could result in significant cumulative effects associated with potential contaminants causing water quality degradation in San Luis Reservoir. Other construction is projected to occur in Merced County as a result of projected population growth; however, construction is not expected to be in the vicinity of San Luis Reservoir.

Construction of the Lower San Felipe Intake Alternative would involve earth moving activities near the shore of the reservoir that could introduce pollutants into the water and compromise water quality of the reservoir. **Therefore, the alternative's incremental contribution to the significant cumulative effect would be cumulatively considerable prior to mitigation.** However, the Lower San Felipe Intake Alternative would implement Mitigation Measure WQ-1 to avoid or reduce impacts on water quality to a less than significant level. The California High Speed Rail Project and the B.F. Sisk Dam SOD

Modification Project both include water quality mitigation strategies including implementation of Stormwater Pollution Prevention Plans (SWPPP) and best management practices (BMPs) to minimize impacts to stormwater and maintain water quality, implementation of spill prevention and emergency response plans, and incorporation of biofiltration swales (CHSRA 2012). **After implementation of Mitigation Measure WQ-1, the Lower San Felipe Intake Alternative would not result in significant cumulative impacts on water quality.**

S.3.1.2 Alternative 3 - Treatment Alternative

Cumulative impacts related to construction and/or operation of the Treatment Alternative on water bodies in Santa Clara County, and cumulative impacts related to changes in south-of-Delta CVP and SWP exports and Delta outflow on the Delta Region are considered in this section.

The Treatment Alternative could change Delta salinity and bromide concentrations resulting in water quality impacts. As was noted above, implementation of the BDCP/ Delta Conveyance Project/California EcoRestore, 2018 Addendum to the Coordinated Operation Agreement, and 2018 Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta could result in changed Delta Region operations and habitat health.

Operation of the Treatment Alternative would result in slight changes to Delta water quality resulting from changes in Delta ouflows compared to the No Action Alternative. Potential changes in salinity in comparison to the No Action/No Project Alternative were determined to be immeasurable. Additionally, any increases in south-of-Delta export as a result of the Delta Conveyance Project would only follow improvements in the Delta ecosystem's health and improved water quality conditions in the Delta Region as a result of both the Delta Conveyance Project and California EcoRestore's restoration actions. **Therefore, cumulative impacts of the Treatment Alternative in combination with other projects in the Delta Region, would not result in significant cumulative impacts on Delta salinity and bromide concentrations.**

The Treatment Alternative could change south-of-Delta CVP and SWP exports and Delta outflow. As was noted above, implementation of the BDCP/Delta Conveyance Project/California EcoRestore, 2018 Addendum to the Coordinated Operation Agreement, and 2018 Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta could result in changed Delta Region operations and habitat health.

Operation of the Treatment Alternative would result in slight changes to average south-of-Delta exports and Delta outflow when compared to the No Action/No Project Alternative. However, these changes in south-of-Delta export of CVP and SWP water and Delta outflow would be minimal and would not

impact water quality. Additionally, any increases in south-of-Delta export as a result of the BDCP/Delta Conveyance Project would only follow improvements in the Delta ecosystem's health and improved water quality conditions in the Delta Region as a result of California EcoRestore's restoration actions. **Therefore, cumulative impacts of the Treatment Alternative in combination with other projects in the Delta Region, would not result in significant cumulative impacts on water quality.**

Construction of new water treatment infrastructure at the WTP in combination with construction throughout urban/developed areas in Santa Clara County could cause significant impacts to water quality. Cumulative construction projects expected to occur in the county as a result of projected population growth could result in significant negative impacts to Santa Clara County water bodies. One cumulative project that could impact water quality in this vicinity is the Upper Guadalupe River Flood Control Project. The project could occur at the same time as the Treatment Alternative.

Construction of the Treatment Alternative could result in negative impacts to these Santa Clara County water bodies. **Therefore, the alternative's incremental contribution to the significant cumulative effect would be cumulatively considerable prior to mitigation.** However, the Treatment Alternative would implement Mitigation Measure WQ-1 to avoid or reduce impacts on water quality to a less than significant level. In addition, the Upper Guadalupe River flood control project would implement SCVWD's environmental commitments, which are used to avoid or minimize impacts on water quality in Santa Clara County (SCVWD 2012). **After implementation of Mitigation Measure WQ-1, the Treatment Alternative would not result in significant cumulative impacts on water quality.**

S.3.1.3 Alternative 4 - San Luis Reservoir Expansion Alternative

Cumulative impacts related to construction and/or operation of the – San Luis Reservoir Expansion Alternative on the San Luis Reservoir, and cumulative impacts related to changes in south-of-Delta CVP and SWP exports and Delta outflow on the Delta Region are considered in this section.

The San Luis Reservoir Expansion Alternative could change Delta salinity and bromide concentrations resulting in water quality impacts. As was noted above, implementation of the BDCP/Delta Conveyance Project/California EcoRestore, 2018 Addendum to the Coordinated Operation Agreement, and 2018 Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta could result in changed Delta Region operations and habitat health.

Operation of the San Luis Reservoir Expansion Alternative would result in slight changes to Delta water quality resulting from changes in Delta ouflows compared to the No Action Alternative. Potential changes in salinity in comparison to the No Action/No Project Alternative were determined on

average to be immeasurable. Additionally, any increases in south-of-Delta export as a result of the Delta Conveyance Project would only follow improvements in the Delta ecosystem's health and improved water quality conditions in the Delta Region as a result of both the Delta Conveyance Project and California EcoRestore's restoration actions. **Therefore, cumulative impacts of the San Luis Reservoir Expansion Alternative in combination with other projects in the Delta Region, would not result in significant cumulative impacts on Delta salinity and bromide concentrations.**

The San Luis Reservoir Expansion Alternative could change south-of-Delta CVP and SWP exports and Delta outflow. Implementation of the BDCP/Delta Conveyance Project/ California EcoRestore, 2018 Addendum to the Coordinated Operation Agreement, and 2018 Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta could result in changed Delta Region operations with the implementation of conservation and restoration measures designed to improve the health of the Delta ecosystem alongside improving water supply and water quality conditions. Future improved conditions in the Delta Region could result in increased south-of Delta exports.

Construction and operation of the San Luis Reservoir Expansion Alternative would result in an increase in the average south-of-Delta export when compared to the No Action/No Project Alternative in most years because SCVWD would be able to withdraw their full CVP water allocation from San Luis Reservoir. This would result in less carryover water stored in San Luis Reservoir and more south-of-Delta exports given the increased availability of storage capacity. These changes in south-of-Delta export of CVP and SWP water and Delta outflow as a result of the San Luis Reservoir Expansion Alternative would be minimal. Additionally, any increases in south-of-Delta export as a result of the Delta Conveyance Project would only follow improvements in the Delta ecosystem's health and improved water quality conditions in the Delta Region as a result of both the Delta Conveyance Project and California EcoRestore's restoration actions. **Therefore, cumulative impacts of the San Luis Reservoir Expansion in combination with other projects in the Delta Region, would not result in significant cumulative impacts on water quality.**

Construction work around San Luis Reservoir and the Santa Teresa WTP could increase run-off and could introduce pollutants into nearby water bodies including the reservoir. Construction of trails, campgrounds, and wells identified in the *San Luis SRA General Plan* would take place at the same time as the proposed project and would involve earth moving and construction near the shore of the reservoir. Additionally, construction activities associated with the California High Speed Rail Project could involve earth moving and construction projects upstream of the reservoir. One configuration of the railway would traverse Pacheco Pass adjacent to SR 152 and San Luis Reservoir. Together, these projects could result in significant cumulative effects associated with potential contaminants causing water quality degradation

in San Luis Reservoir. Other construction is projected to occur in Merced County as a result of projected population growth; however, construction is not expected to be in the vicinity of San Luis Reservoir.

Construction of the San Luis Reservoir Expansion Alternative would involve earth moving activities near the shore of the reservoir that could introduce pollutants into the water and compromise water quality of the reservoir. **Therefore, the alternative's incremental contribution to the significant cumulative effect would be cumulatively considerable prior to mitigation.** However, the San Luis Reservoir Expansion Alternative would implement Mitigation Measure WQ-1 to avoid or reduce impacts on water quality to a less than significant level. The California High Speed Rail Project includes water quality mitigation strategies including implementation of Stormwater Pollution Prevention Plans (SWPPP) and best management practices (BMPs) to minimize impacts to stormwater and maintain water quality, implementation of spill prevention and emergency response plans, and incorporation of biofiltration swales (CHSRA 2012). **After implementation of Mitigation Measure WQ-1, the San Luis Reservoir Expansion Alternative would not result in significant cumulative impacts on water quality.**

S.3.1.4 Alternative 5 - Pacheco Reservoir Expansion Alternative

Cumulative impacts related to construction and/or operation of the Pacheco Reservoir Expansion Alternative on the San Luis Reservoir, and cumulative impacts related to changes in south-of-Delta CVP and SWP exports and Delta outflow on the Delta Region are considered in this section.

The Pacheco Reservoir Expansion Alternative could change Delta salinity and bromide concentrations resulting in water quality impacts. As was noted above, implementation of the BDCP/Delta Conveyance Project/California EcoRestore, 2018 Addendum to the Coordinated Operation Agreement, and 2018 Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta could result in changed Delta Region operations and habitat health.

Operation of the Pacheco Reservoir Expansion Alternative would result in slight changes to Delta water quality resulting from changes in Delta ouflows compared to the No Action Alternative. Potential changes in salinity in comparison to the No Action/No Project Alternative were determined on average to be immeasurable. Additionally, any increases in south-of-Delta export as a result of the Delta Conveyance Project would only follow improvements in the Delta ecosystem's health and improved water quality conditions in the Delta Region as a result of both the Delta Conveyance Project and California EcoRestore's restoration actions. **Therefore, cumulative impacts of the Pacheco Reservoir Expansion Alternative in combination with other projects in the Delta Region, would not result in significant cumulative impacts on Delta salinity and bromide concentrations.**

The Pacheco Reservoir Expansion Alternative could change south-of-Delta CVP and SWP exports and Delta outflow. Implementation of the BDCP/Delta Conveyance Project/ California EcoRestore, 2018 Addendum to the Coordinated Operation Agreement, and 2018 Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta could result in changed Delta Region operations with the implementation of conservation and restoration measures designed to improve the health of the Delta ecosystem alongside improving water supply and water quality conditions. Future improved conditions in the Delta Region could result in increased south-of Delta exports.

Operation of the Pacheco Reservoir Expansion Alternative would result in slight changes to average south-of-Delta exports and Delta outflow when compared to the No Action/No Project Alternative. However, these changes in south-of-Delta export of CVP and SWP water and Delta outflow would be minimal and would not impact water quality. Additionally, any increases in south-of-Delta export as a result of the Delta Conveyance Project would only follow improvements in the Delta ecosystem's health and improved water quality conditions in the Delta Region as a result of both the Delta Conveyance Project and California EcoRestore's restoration actions. **Therefore, cumulative impacts of the Pacheco Reservoir Expansion Alternative in combination with other projects in the Delta Region, would not result in significant cumulative impacts on water quality.**

Construction work could increase run-off and could introduce pollutants into nearby water bodies including the reservoir and Pacheco Creek. Construction activities associated with the California High Speed Rail Project and the B.F. Sisk Dam SOD Modification Project could involve earth moving and construction projects nearby the reservoir. The current configuration of the railway would traverse Pacheco Pass adjacent to SR 152 and the SOD Modification Project would occur at San Luis Reservoir. Other construction is projected to occur in Santa Clara County as a result of projected population growth; however, construction is not expected to be in the vicinity of Pacheco Reservoir.

Construction of the Pacheco Reservoir Expansion Alternative would involve earth moving activities near Pacheco Creek that could introduce pollutants into the water and compromise water quality of the creek.

Therefore, the alternative's incremental contribution to the significant cumulative effect would be cumulatively considerable prior to mitigation. However, the Pacheco Reservoir Expansion Alternative would implement Mitigation Measure WQ-1 to avoid or reduce impacts on water quality to a less than significant level. The California High Speed Rail Project and the B.F. Sisk Dam SOD Modification Project include water quality mitigation strategies including implementation of Stormwater Pollution Prevention Plans (SWPPP) and best management practices (BMPs) to minimize impacts to stormwater and maintain water quality, implementation of spill prevention and emergency

response plans, and incorporation of biofiltration swales (CHSRA 2012, Reclamation and DWR 2019). **After implementation of Mitigation Measure WQ-1, the Pacheco Reservoir Expansion Alternative would not result in significant cumulative impacts on water quality.**

S.3.2 Surface Water Supply

Implementation of the proposed alternatives for the BDCP/Delta Conveyance Project, 2018 Addendum to the Coordinated Operation Agreement, 2018 Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta, and the B.F. Sisk Dam SOD Modification Project, CVP M&I Water Shortage Policy, Los Vaqueros Reservoir Expansion Project, and the Pacheco Reservoir Reoperation Project could result in short-term and long-term changes in water supply availability. For example, potential changes in CVP and SWP Delta export requirements as a component of the BDCP could affect water supply availability in the area of analysis. The WaterFix, the Addendum to the Coordinated Operation Agreement, and the M&I Water Shortage Policy would change the delivery patterns of CVP and SWP supplies, and population growth would increase water demands. The 2018 Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta could change the availability of exported water supply south of the Delta. The Los Vaqueros Reservoir Expansion Project would improve San Francisco Bay Area water supply reliability, along with increased Level 4 Refuge supplies. The Pacheco Reservoir Reoperation Project would improve water supply reliability for water users downstream of Pacheco Reservoir.

While cities and counties work to guide growth to appropriate areas and aim to preserve agricultural lands through land use policies, future growth and development in counties and cities as driven by expected population growth throughout California, and specifically in the area of analysis, would likely increase water demand. County general plan provisions, numerous State and local policies, and conservation efforts spearheaded by local water suppliers seek to reduce per capita water consumption and the environmental review completed alongside regular general plan updates identifies water conservation mitigation for significant impacts, as required. These conservation efforts help to reduce the cumulative contribution to increased water use in the area of analysis generated by population growth.

The population growth projections presented in Section S.2.6 along with the cumulative projects identified above would both contribute to increased pressure on the water supply system both locally and regionally to meet demands in the future. CVP and SWP water supply deliveries have decreased over time with implementation of CVPIA and the 2008 and 2009 United States Fish and Wildlife Service (USFWS) and NMFS Biological Opinions for the Long-Term Operations of the SWP and CVP. The cumulative projects and projected growth statewide and in the counties identified above are expected to

increase demand on these declining water supply deliveries and will contribute to significant cumulative water supply impacts in the future.

The Lower San Felipe Intake Alternative, the Treatment Alternative, the San Luis Reservoir Expansion Alternative, and the Pacheco Reservoir Expansion Alternative would all produce beneficial impacts on water supply reliability within the SCVWD service area. This improvement in water supply reliability would help to offset potential cumulative water supply reliability effects generated by the cumulative projects and anticipated population growth in the SCVWD service area and would help to reduce the significant cumulative water supply effects described above for SCVWD. The Lower San Felipe Intake Alternative and the Treatment Alternative would however, result in small reductions to south-of-Delta agricultural deliveries to CVP contractors and all of the action alternatives would generate small reductions in south-of-Delta SWP deliveries, contributing to the significant cumulative water supply impacts described above. These reductions would be minimal, only evident in some water years, and in the case of SWP deliveries would have functionally no difference from the No Action/No Project Alternative. **Therefore, the small reductions in south-of-Delta deliveries under the Lower San Felipe Intake Alternative, the Treatment Alternative, the San Luis Reservoir Expansion Alternative, and the Pacheco Reservoir Expansion Alternative would not have cumulatively considerable incremental contributions to a significant cumulative impact to water supply.**

Alternative 4, with the shear key option, would result in a short-term significant impact to CVP and SWP water supply deliveries due to construction. As discussed in Section 4.2.6, the temporary reduction in water supply deliveries would not be able to be replaced reliably from other sources, such as groundwater pumping or water transfers, or new surface storage. Given the environmental and technological limits and the time necessary to implement other potential options to offset this impact during the two water years that the Shear Key Option would restrict reservoir operations no feasible mitigation (California Environmental Quality Act § 21061.1) has been identified to reduce these impacts to a less than significant level. **Cumulative water supply impacts would be significant and the temporary reduction under Alternative 4 with the shear key option would be cumulatively considerable.**

S.3.3 Groundwater Resources

S.3.3.1 Alternative 2 - Lower San Felipe Intake Alternative

There would be no impacts to groundwater resources resulting from the construction and operation of the Lower San Felipe Intake Alternative in the Santa Clara subbasin or Llagas subbasin, therefore there would be no cumulative impacts SCVWD Service Area.

The Lower San Felipe Intake Alternative could change water deliveries to south-of-Delta CVP and SWP contractors and change storage in San Luis Reservoir resulting in increased groundwater use. The Lower San Felipe Intake Alternative would result in less carryover water stored in the San Luis Reservoir and potentially decrease deliveries to CVP agricultural contactors after a low point event. There would however be no change in SWP deliveries under this alternative.

The decrease in deliveries to CVP agricultural contactors as a result of the Lower San Felipe Intake Alternative's uninterrupted M&I deliveries to SCVWD during low point events could result in supply shortages to these agricultural contractors. These shortages could result in increases in groundwater pumping by these agricultural contractors in addition to existing groundwater pumping. The reductions to imported CVP agricultural deliveries will be minimal, at an annual average of approximately 2 thousand acre-feet (TAF). The Central Valley Hydrologic Model estimates groundwater pumping in the western portion of the valley to be approximately 60 TAF per year.

The cropping pattern in the South-of-Delta CVP Contractors Service Area (San Joaquin Valley Hydrologic Region) has been transitioning from annual row crops to increasingly including higher value permanent tree crops. The establishment of these permanent tree crops represents a major financial investment and in dry years irrigators with these crops have become increasingly reliant on groundwater to replace reduced surface water deliveries. This increase in groundwater use has resulted in significant pressure on the long term sustainability of the groundwater aquifers in the San Joaquin Valley Hydrologic Region. This includes multiple groundwater aquifers that have been identified by DWR as critically overdrafted (DWR 2016). These basins are required, under the Sustainable Groundwater Management Act, to be managed under a groundwater sustainability plan by January 21, 2020 (DWR 2017).

Therefore, while any potential increase in groundwater pumping even if all the deficit in delivery is made up via groundwater pumping would be less than four percent of the approximately 60 TAF per year pumping estimated for the area, given the critical overdraft of these aquifers **the Lower San Felipe Intake Alternative's incremental contribution to this significant cumulative effect would be a cumulatively considerable impact**.

S.3.3.2 Alternative 3 - Treatment Alternative

Excavation and trenching activities during construction might encounter groundwater, this groundwater would be pumped from the excavated area and contained and treated in accordance with all applicable State and federal regulations before being discharged. Impacts to groundwater levels from construction at the Santa Teresa WTP would limited given that there is no aquifer below the WTP. Any impact form implementation of the Treatment Alternative would be short-term and less than significant. **The Treatment**

Alternative's incremental contribution to any potentially significant cumulative effect on groundwater levels in the SCVWD service area would not be cumulatively considerable.

The Treatment Alternative could change water deliveries to south-of-Delta CVP and SWP contractors and change storage in San Luis Reservoir resulting in increased groundwater use. Similar to the Lower San Felipe Intake Alternative, the Treatment Alternative would result in less carryover water stored in the San Luis Reservoir and potentially decrease deliveries to CVP agricultural contactors after a low point event. There would however be no change in SWP deliveries under this alternative.

As was described for the Lower San Felipe Intake Alternative, under the Treatment Alternative decreases in deliveries to CVP agricultural contactors as a result of the alternative's uninterrupted M&I deliveries to SCVWD during low point events could result in supply shortages to these agricultural contractors. These shortages could result in increases in groundwater pumping by these agricultural contractors in addition to existing groundwater pumping.

Therefore, while any potential increase in groundwater pumping under the Treatment Alternative even if all the deficit in delivery is made up via groundwater pumping would be less than four percent of the approximately 60 TAF per year pumping estimated for the area, given the critical overdraft of the aquifers in the San Joaquin Valley Hydrologic Region, **the Treatment Alternative's incremental contribution to this significant cumulative impact would be cumulatively considerable.**

S.3.3.3 Alternative 4 - San Luis Reservoir Expansion Alternative

There would be no negative impacts to groundwater resources resulting from the construction and operation of the San Luis Reservoir Expansion Alternative in the Santa Clara subbasin or Llagas subbasin, **therefore there would be no cumulative impacts.**

S.3.3.4 Alternative 5 – Pacheco Reservoir Expansion Alternative

The Pacheco Reservoir Expansion Alternative could change water deliveries to south-of-Delta CVP and SWP contractors and change storage in San Luis Reservoir resulting in increased groundwater use. Similar to the Lower San Felipe Intake Alternative, the Pacheco Reservoir Expansion Alternative would result in less carryover water stored in the San Luis Reservoir and potentially decrease deliveries to CVP agricultural contactors after a low point event. There would however be no change in SWP deliveries under this alternative.

As was described for the Lower San Felipe Intake Alternative, under the Pacheco Reservoir Expansion Alternative decreases in deliveries to CVP agricultural contactors as a result of the alternative's uninterrupted M&I deliveries to SCVWD during low point events could result in supply shortages

to these agricultural contractors. These shortages could result in increases in groundwater pumping by these agricultural contractors in addition to existing groundwater pumping.

Therefore, while any potential increase in groundwater pumping under the Pacheco Reservoir Expansion Alternative even if all the deficit in delivery is made up via groundwater pumping would be less than four percent of the approximately 60 TAF per year pumping estimated for the area, given the critical overdraft of the aquifers in the San Joaquin Valley Hydrologic Region, **the Pacheco Reservoir Expansion Alternative's incremental contribution to this significant cumulative impact would be cumulatively considerable.**

S.3.4 Flood Control

S.3.4.1 Alternative 2 - Lower San Felipe Intake Alternative

Implementation of the Lower San Felipe Intake Alternative in combination with facilities and trail construction at San Luis Reservoir could result in the placement of structures in the 100-year flood hazard area that could impede or redirect flood flows. Areas around the shoreline of San Luis Reservoir are located in Federal Emergency Management Agency (FEMA) flood zone D, defined as areas of undetermined but possible flood hazard. The aeration facility and other facilities that would be constructed under the Lower San Felipe Intake Alternative would not be placed in the 100-year floodplain and would not impede or redirect flood flows. New structures would be constructed near existing water supply infrastructure and on already disturbed land.

The new trails and facilities at San Luis Reservoir proposed in the *San Luis Reservoir SRA RMP/GP* would involve construction at the reservoir that could be near some of the elements of the Lower San Felipe Intake Alternative. The new facilities proposed in the management plan would not be large, and none of the new facilities would be in the 100-year floodplain. The San Luis Transmission Project would construct new transmission lines near San Luis Reservoir to connect the San Luis Substation to a new transmission line that would be developed between the Tracy Substation and the Dos Amigos Substation in the potential inundation area of San Luis Reservoir. The San Luis Solar Project would develop a new 108-acre solar facility adjacent to the SR 152 crossing O'Neill Forebay also located in the potential inundation area of San Luis Reservoir.

The San Luis Transmission Project and the San Luis Solar Project would place new infrastructure in the potential inundation area of San Luis Reservoir. In the event of dam failure these new facilities could impede or redirect flood flows. The B.F. Sisk Dam SOD Modification Project would modify existing infrastructure but would not place new infrastructure in the 100-year floodplain or in the downstream inundation area of San Luis Reservoir. The Lower San Felipe Intake Alternative would also not place new infrastructure in the 100-

year floodplain or in the downstream inundation area of San Luis Reservoir. **The Lower San Felipe Intake Alternative would not contribute to any significant cumulative impacts on flood flows.**

Implementation of the Lower San Felipe Intake Alternative in combination with facilities and trail construction at San Luis Reservoir and dam safety modification construction could result in the increased exposure of people or structures to a significant risk of loss, injury or death involving flooding, including flooding because of increases in the potential for the failure of a levee or dam. While the potential for flooding exists around San Luis Reservoir, long-term operations of water supply facilities under the Lower San Felipe Intake Alternative would not differ significantly from existing water supply operations at the reservoir and would not result in increased flood hazard risks to people or structures. Construction of trails and facilities at San Luis Reservoir proposed in the *San Luis Reservoir SRA RMP/GP* would include site-specific geotechnical investigations for siting and design of permanent structures. This would minimize any potential impacts from earthquakes and dam failure at the reservoir. Construction of the B.F. Sisk Dam SOD Modification Project would be completed with safeguards against increased risk of flooding including the timing of embankment excavation during periods of normal reservoir drawdown. The construction of the San Luis Transmission Project and the San Luis Solar Project would place new infrastructure downstream of San Luis Reservoir. In the event of dam failure these new facilities could be exposed to risk of loss. However, the Lower San Felipe Intake Alternative would not result in increased flood hazard risks to people or structures. **Therefore, the Lower San Felipe Intake Alternative would not contribute to any significant cumulative impacts on flood risk.**

Implementation of the Lower San Felipe Intake Alternative in combination with facilities and trail construction at San Luis Reservoir could alter the drainage pattern and/or create runoff water that would exceed the capacity of existing or planned stormwater drainage systems. Construction of the Lower San Felipe Intake Alternative would result in temporary less than significant impacts to the drainage pattern and the creation of runoff water.

As described in the environmental analysis for the *San Luis Reservoir SRA RMP/GP* (Reclamation and CDPR 2013), earth moving and construction during facilities and trail creation projects would alter the local drainage pattern around San Luis Reservoir. When specific construction and maintenance activities are undertaken, site-specific analysis would be conducted and detailed assessment of each project's activities would take place. The environmental analysis presented in the *San Luis Reservoir SRA RMP/GP* indicates that implementation of mitigation measures designed to reduce and control stormwater runoff in the case that more detailed environmental analysis determines significant stormwater-related impacts. Similarly, construction of the the B.F. Sisk Dam SOD Modification Project and construction and operation of the San Luis Transmission Project and the San Luis Solar Project would disturb earth at and

nearby Sisk Dam and would introduce new impervious surface. The development and implementation of a SWPPP would ensure that stormwater during construction is captured and runoff volume is reduced and the incorporation of methods to minimize flood damage into the design of all new structures would reduce potential effects to drainage patters associated with all of these projects.

The long-term presence of the aeration facility would not add a significant amount of impervious surface to the shoreline and would not increase runoff. Projects developed as part of the *San Luis Reservoir SRA RMP/GP*, the B.F. Sisk Dam SOD Modification Project, the San Luis Transmission Project and the San Luis Solar Project would implement SWPPPs with BMPs to control and reduce runoff during construction and prior to the reestablishment of ground cover in disturbed areas. **Overall, the Lower San Felipe Intake Alternative in combination with other cumulative projects would not result in a significant cumulative impact related to drainage and runoff.**

S.3.4.2 Alternative 3 - Treatment Alternative

All construction and operations of the Treatment Alternative would take place on the property of the Santa Teresa WTP. No projects are identified for cumulative impacts that would take place on or near the WTP property. **Therefore, Treatment Alternative's incremental contribution to any potentially significant cumulative effect would not be cumulatively considerable given the implementation of BMPs during construction, as appropriate under the SWPPP, and the lack of other cumulative projects in at or near the WTP.**

S.3.4.3 Alternative 4 - San Luis Reservoir Expansion Alternative

Implementation of the San Luis Reservoir Expansion Alternative in combination with facilities and trail construction at San Luis Reservoir could result in the placement of structures in the 100-year flood hazard area that could impede or redirect flood flows. Areas around the shoreline of San Luis Reservoir are located in FEMA flood zone D, defined as areas of undetermined but possible flood hazard. Construction activities would occur at the dam which is within the inundation area of San Luis Reservoir.

The new trails and facilities at San Luis Reservoir proposed in the *San Luis Reservoir SRA RMP/GP* would involve construction at the reservoir that could be near some of the elements of the San Luis Reservoir expansion. The new facilities proposed in the management plan would not be large, and none of the new facilities would be in the 100-year floodplain. The San Luis Transmission Project would construct new transmission lines near San Luis Reservoir to connect the San Luis Substation to a new transmission line that would be developed between the Tracy Substation and the Dos Amigos Substation in the potential inundation area of San Luis Reservoir. The San Luis Solar Project

would develop a new 108-acre solar facility adjacent to the SR 152 crossing O'Neill Forebay also located in the potential inundation area of San Luis Reservoir.

The San Luis Transmission Project and the San Luis Solar Project would place new infrastructure in the potential inundation area of San Luis Reservoir. In the event of dam failure these new facilities could impede or redirect flood flows. The San Luis Reservoir expansion would not however place new infrastructure in the 100-year floodplain or in the downstream inundation area of San Luis Reservoir. **The San Luis Reservoir Expansion Alternative would not contribute to any significant cumulative impacts on flood flows.**

Implementation of the expansion of the San Luis Reservoir Expansion Alternative in combination with facilities and trail construction at San Luis Reservoir could result in the increased exposure of people or structures to a significant risk of loss, injury or death involving flooding, including flooding because of increases in the potential for the failure of a levee or dam. The potential for flooding exists around San Luis Reservoir. Long-term operations of water supply facilities under the San Luis Reservoir Expansion Alternative would increase the maximum allowable water storage volume in the reservoir compared to existing conditions. However, implementation of the dam modifications as a part of the connected Corrective Action Study (CAS) would reduce the potential for seismic induced dam failure from overtopping generated by embankment sloughing and/or seiche generated wave action and the associated flood risk.

Construction of trails and facilities at San Luis Reservoir proposed in the *San Luis Reservoir SRA RMP/GP* would include site-specific geotechnical investigations for siting and design of permanent structures. This would minimize any potential impacts from earthquakes and dam failure at the reservoir. The construction of the San Luis Transmission Project and the San Luis Solar Project would place new infrastructure downstream of San Luis Reservoir. In the event of dam failure these new facilities could be exposed to significant risk of loss. The San Luis Reservoir Expansion Alternative would not result in significant increases in flood hazard risks to people or structures. **Therefore, the San Luis Reservoir Expansion Alternative would not contribute to any significant cumulative impacts on flood risk and would provide a beneficial change in the cumulative risk of flooding in the study area.**

Implementation of the expansion of the San Luis Reservoir Expansion Alternative in combination with facilities and trail construction at San Luis Reservoir could alter the drainage pattern and/or create runoff water that would exceed the capacity of existing or planned stormwater drainage systems. Construction of the San Luis Reservoir expansion would result in less than significant impacts to the drainage pattern and the creation of runoff water. As described in the environmental analysis for the *San Luis Reservoir SRA*

RMP/GP (Reclamation and CDPR 2013), earth moving and construction during facilities and trail creation projects would alter the local drainage pattern around San Luis Reservoir. When specific construction and maintenance activities are undertaken, site-specific analysis would be conducted and detailed assessment of each project's activities would take place. The environmental analysis presented in the *San Luis Reservoir SRA RMP/GP* indicates that implementation of mitigation measures designed to reduce and control stormwater runoff in the case that more detailed environmental analysis determines significant stormwater-related impacts. Similarly, construction and operation of the San Luis Transmission Project and the San Luis Solar Project would disturb earth near Sisk Dam and would introduce new impervious surface. The development and implementation of a SWPPP would ensure that stormwater during construction is captured and runoff volume is reduced and the incorporation of methods to minimize flood damage into the design of all new structures would reduce potential effects to drainage patters associated with all of these projects.

The proposed permanent changes to the dam, SR 152 embankment, Dinosaur Point Boat Launch and borrow areas would not add a significant amount of impervious surface to the shoreline and would not increase runoff. Changes to the land from permanent filling and grading would alter local drainage patterns, however, methods to minimize flood damage or pollution from stormwater would be implemented as a part of the SWPPP that will be completed with BMPs to control and reduce runoff during construction and prior to the reestablishment of ground cover in disturbed areas. Projects developed as part of the *San Luis Reservoir SRA RMP/GP* and the San Luis Transmission Project and the San Luis Solar Project would implement SWPPPs with BMPs to control and reduce runoff. **Overall, the San Luis Reservoir Expansion Alternative in combination with other cumulative projects would not result in a cumulative significant impact related to drainage and runoff.**

S.3.4.4 Alternative 5 – Pacheco Reservoir Expansion Alternative

Implementation of the Pacheco Reservoir Expansion Alternative in combination with other cumulative projects at or downstream of Pacheco Reservoir could result in the placement of structures in the 100-year flood hazard area that could impede or redirect flood flows. The area around Pacheco Reservoir and along North Fork Pacheco Creek and Pacheco Creek are within Zones A and D (FEMA 2018). Areas that are susceptible to flooding include the low-lying areas along Pacheco Creek and along the banks of Pacheco Reservoir. There are no cumulative projects proposed within the 100-year flood hazard areas around Pacheco Reservoir or immediately downstream of Pacheco Reservoir. The Pacheco Reservoir Expansion Alternative would have a less than significant impact to flood flows, increased flood risk and flood control system capacity during construction; and beneficial impacts to flood risk during long-term operation. **The Pacheco Reservoir Expansion Alternative would not contribute to any significant cumulative impacts on flood flows.**

Implementation of the Pacheco Reservoir Expansion Alternative in combination with other cumulative projects at or downstream of Pacheco Reservoir could result in the increased exposure of people or structures to a significant risk of loss, injury or death involving flooding, including flooding because of increases in the potential for the failure of a levee or dam. The potential for flooding exists around and downstream of Pacheco Reservoir and downstream along Pacheco Creek. There are no cumulative projects proposed within the 100-year flood hazard areas around Pacheco Reservoir or immediately downstream of Pacheco Reservoir. Long-term operations of water supply facilities under the Pacheco Reservoir Expansion Alternative would increase the maximum allowable water storage volume in the reservoir compared to existing conditions. A new dam would also be constructed. The new dam is designed to prevent dam failure and provide some flood control benefits during major storm events by providing additional storage capacity to reduce flows within Pacheco Creek downstream of the dam reducing the risk of flooding, including flooding as a result of the failure of a levee or dam. Impacts to flood risk during operation would be beneficial and impacts during construction of the new dam would be less than significant. **Therefore, the Pacheco Reservoir Expansion Alternative would not contribute to any significant cumulative impacts on flood risk and would provide a beneficial change in the cumulative risk of flooding in the study area.**

Implementation of the expansion of the Pacheco Reservoir Expansion Alternative in combination with other cumulative projects at or downstream of Pacheco Reservoir could alter the drainage pattern and/or create runoff water that would exceed the capacity of existing or planned stormwater drainage systems. Construction of the Pacheco Reservoir Expansion Alternative would result in less than significant impacts to the drainage patterns and the creation of runoff water. No other cumulative projects are proposed around or downstream of Pacheco Reservoir. **Therefore, the Pacheco Reservoir Expansion Alternative would not result in a cumulative significant impact to drainage patterns or create runoff water that would exceed the capacity of stormwater drainage systems.**

S.3.5 Geology, Seismicity, and Soils

S.3.5.1 Alternative 2 - Lower San Felipe Intake Alternative

Construction activities during implementation of the Lower San Felipe Intake Alternative in combination with projects considered for cumulative impacts could expose people or structures to adverse effects related to the rupture of a known earthquake fault, seismically-induced ground shaking, and unstable soils. Construction of the Lower San Felipe Intake Alternative could expose workers to the risk of loss, injury, or death as a result of rupture of a known earthquake fault at or near the reservoir.

Other cumulative projects that have been identified in the area of construction around San Luis Reservoir include those described in the *San Luis Reservoir SRA RMP/GP*, the B.F. Sisk Dam SOD Modification Project, the California High Speed Rail Project, the San Luis Transmission Project and the San Luis Solar Project. Development and construction in Merced County related to projected population growth in the county would not likely occur in the vicinity of San Luis Reservoir and would not add to potential geology and soil effects related to the Lower San Felipe Intake Alternative.

Future development proposed at San Luis Reservoir includes construction of trails, campgrounds, and other recreation resources. Earth moving activities involved in these potential future projects at the reservoir could expose workers to adverse effects related to earthquake activity and unstable soils. However, the environmental analysis for the *San Luis Reservoir SRA RMP/GP* identifies geology, seismicity, and soils as a resource area that would not experience significant effects and is not considered further. The actions identified in the plan would not permit development of structures in Alquist-Priolo fault zones and would not increase the risk related to seismic events. Further, geologic studies and site-specific geotechnical investigations for siting and design of permanent structures, campgrounds, roads, and trails would minimize damage from erosion, unstable soils, landslides, and earthquakes.

The B.F. Sisk Dam SOD Modification Project similar to the Lower San Felipe Intake Alternative would be constructed at San Luis Reservoir, and the California High Speed Rail would traverse Pacheco Pass adjacent to SR 152 and San Luis Reservoir. Although construction activities under these cumulative projects could expose workers to risks associated with seismic ground shaking and unstable soils, final design of the project would require site-specific geotechnical assessments to ensure soil stability as well as short-term and long-term safety of people and structures. The San Luis Transmission Project and the San Luis Solar Project are also considered in the cumulative analysis. The San Luis Transmission Project would develop approximately 95 miles of new transmission lines connecting the Tracy Substation and the Dos Amigos Substation with segments crossing O'Neill Forebay and connecting to the San Luis Substation. The San Luis Solar Project would develop a new 108 acre solar facility adjacent to the SR 152 crossing O'Neill Forebay. Construction activities proposed for the Lower San Felipe Intake Alternative would not directly influence earthquake activity, in addition in the event of an earthquake, construction activities would follow the safety requirements of Occupational Safety and Health Administration (OSHA) to reduce the potential for harm to construction workers or equipment. Similarly construction of projects proposed in the *San Luis Reservoir SRA RMP/GP*, construction of the B.F. Sisk Dam SOD Modification Project, and construction activity propose under the California High Speed Rail Project, the San Luis Transmission Project and the San Luis Solar Project would be subject to the same safety requirements. **Therefore, construction of the Lower San Felipe Intake Alternative in**

combination with other cumulative projects would not result in a cumulative significant impact related to geology, seismicity, and soils.

Operation and maintenance of the Lower San Felipe Intake Alternative in combination with other construction and maintenance activities at San Luis Reservoir could expose people or structures to adverse effects related to the rupture of a known earthquake fault, seismically-induced ground shaking, and unstable soils. Operation and maintenance activities to support the infrastructure developed by the Lower San Felipe Intake Alternative could expose workers to risks if strong seismic ground shaking and associated ground failure, liquefaction, or landslides occurred while workers were on-site. The Lower San Felipe Intake Alternative is not however constructing structures for human habitation and would not increase the frequency of maintenance workers being onsite when compared to existing support of the Pacheco Intake. The new intake facilities would be constructed in compliance with California building codes that require protection against seismic ground shaking.

Cumulative activities that could contribute to cumulative effects during operations of the Lower San Felipe Intake include other construction projects occurring around the reservoir included in the *San Luis Reservoir SRA RMP/GP,* the California High Speed Rail, the San Luis Transmission Project and the San Luis Solar Project. These cumulative projects, similar to the Lower San Felipe Intake Alternative are not however proposing permanent structures for human habitation. The California High Speed Rail Project would be designed to include safeguards to stop train traffic in the event of seismic activities to prevent any accidents caused by impacts to the tracks. The visitor facilities proposed under the *San Luis Reservoir SRA RMP/GP* would be subject to California building codes that require protection against seismic ground shaking. **Operation and maintenance of the Lower San Felipe Intake Alternative in combination with other projects would not result in a significant cumulative impact on geology, seismicity, and soils.**

S.3.5.2 Alternative 3 - Treatment Alternative

Construction activities in combination with projects considered for cumulative impacts could expose people or structures to adverse effects related to the rupture of a known earthquake fault, seismically-induced ground shaking, and unstable soils. Construction of the Treatment Alternative could expose workers to the risk of loss, injury, or death as a result of rupture of a known earthquake fault in Santa Clara County. Other construction projected to occur in the county as a result of projected population growth could also result in similar impacts. However, construction projects related to projected growth would require individual geotechnical assessments to ensure soil stability as well as short-term and long-term safety of people and structures. The facilities constructed under the Treatment Alternative would not include homes or other structures of human residence. Additionally, construction would not increase the risk of seismic activity or risks associated with strong ground shaking and unstable

soils. **Construction of the Treatment Alternative in combination with other projects would not result in a significant cumulative impact ongeology, seismicity, and soils.**

Maintenance activities in combination with projects considered for cumulative impacts could expose people or structures to adverse effects related to the rupture of a known earthquake fault, seismically-induced ground shaking, and unstable soils. No other cumulative activities or projects have been identified that would contribute to effects associated with the potential exposure of workers to risks associated with seismic activity at the Santa Teresa WTP. **Operations of the Treatment Alternative in combination with other projects would not result in a significant cumulative impact on geology, seismicity, and soils.**

S.3.5.3 Alternative 4 - San Luis Reservoir Expansion Alternative

Construction activities during the expansion of the San Luis Reservoir Expansion Alternative in combination with projects considered for cumulative impacts could expose people or structures to adverse effects related to the rupture of a known earthquake fault, seismically-induced ground shaking, and unstable soils. Construction of the San Luis Reservoir expansion could expose workers to the risk of loss, injury, or death as a result of rupture of a known earthquake fault at or near the reservoir. Other cumulative projects that have been identified in the area of construction around San Luis Reservoir include those described in the *San Luis Reservoir SRA RMP/GP*, the California High Speed Rail Project, the San Luis Transmission Project and the San Luis Solar Project. Development and construction in Merced County related to projected population growth in the county would not likely occur in the vicinity of San Luis Reservoir and would not add to potential geology and soil effects related to the San Luis Reservoir Expansion Alternative.

Future development proposed at San Luis Reservoir includes construction of trails, campgrounds, and other recreation resources. Earth moving activities involved in these potential future projects at the reservoir could expose workers to adverse effects related to earthquake activity and unstable soils. However, the environmental analysis for the *San Luis Reservoir SRA RMP/GP* identifies geology, seismicity, and soils as a resource area that would not experience significant effects and is not considered further. The actions identified in the plan would not permit development of structures in Alquist-Priolo fault zones and would not increase the risk related to seismic events. Further, geologic studies and site-specific geotechnical investigations for siting and design of permanent structures, campgrounds, roads, and trails would minimize damage from erosion, unstable soils, landslides, and earthquakes.

The California High Speed Rail would traverse Pacheco Pass adjacent to SR 152 and San Luis Reservoir. Although construction activities could expose workers to risks associated with seismic ground shaking and unstable soils, final

design of the project would require site-specific geotechnical assessments to ensure soil stability as well as short-term and long-term safety of people and structures. The San Luis Transmission Project and the San Luis Solar Project are also considered in the cumulative analysis. The San Luis Transmission Project would develop approximately 95 miles of new transmission lines connecting the Tracy Substation and the Dos Amigos Substation with segments crossing O'Neill Forebay and connecting to the San Luis Substation. The San Luis Solar Project would develop a new 108-acre solar facility adjacent to the SR 152 crossing O'Neill Forebay.

Construction activities proposed for the San Luis Reservoir expansion would not directly influence earthquake activity, in addition in the event of an earthquake, construction activities would follow the safety requirements of OSHA to reduce the potential for harm to construction workers or equipment. Similarly construction of projects proposed in the *San Luis Reservoir SRA RMP/GP*, and construction activity propose under the California High Speed Rail Project, the San Luis Transmission Project and the San Luis Solar Project would be subject to the same safety requirements. **Therefore, construction of the San Luis Reservoir Expansion Alternative in combination with other cumulative projects would not result in a significant cumulative impact on geology, seismicity, and soils.**

Operation and maintenance of the expanded San Luis Reservoir in combination with other construction and maintenance activities at San Luis Reservoir could expose people or structures to adverse effects related to the rupture of a known earthquake fault, seismically-induced ground shaking, and unstable soils. Operation and maintenance activities to support the infrastructure developed by the San Luis Reservoir Expansion Alternative could expose workers to risks if strong seismic ground shaking and associated ground failure, liquefaction, or landslides occurred while workers were on-site. The San Luis Reservoir expansion is not however constructing structures for human habitation and would not increase the frequency of maintenance workers being onsite when compared to existing support of B.F. Sisk Dam.

Cumulative activities that could contribute to cumulative effects during operations of the San Luis Reservoir Expansion Alternative include other construction projects occurring around the reservoir included in the *San Luis Reservoir SRA RMP/GP*, the California High Speed Rail, the San Luis Transmission Project and the San Luis Solar Project. These cumulative projects, similar to the Lower San Felipe Intake Alternative are not however proposing permanent structures for human habitation. The California High Speed Rail Project would be designed to include safeguards to stop train traffic in the event of seismic activities to prevent any accidents caused by impacts to the tracks. The visitor facilities proposed under the *San Luis Reservoir SRA RMP/GP* would be subject to California building codes that require protection against seismic ground shaking. **Operation and maintenance of the San Luis Reservoir Expansion Alternative in combination with other projects would**

not result in a significant cumulative impact on geology, seismicity, and soils.

S.3.5.4 Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction activities during the expansion of the Pacheco Reservoir Expansion Alternative in combination with projects considered for cumulative impacts could expose people or structures to adverse effects related to the rupture of a known earthquake fault, seismically-induced ground shaking, and unstable soils. Construction of the expanded Pacheco Reservoir could expose workers to the risk of loss, injury, or death as a result of rupture of a known earthquake fault in Santa Clara County. Other construction projected to occur in the county as a result of projected population growth could also result in similar impacts. However, construction projects related to projected growth would require individual geotechnical assessments to ensure soil stability as well as short-term and long-term safety of people and structures. Construction would not increase the risk of seismic activity or risks associated with strong ground shaking and unstable soils. **Construction of the Pacheco Reservoir Expansion Alternative in combination with other projects would not result in a significant cumulative impact ongeology, seismicity, and soils.**

Operation and maintenance of the Pacheco Reservoir Expansion in combination with other construction and maintenance activities could expose people or structures to adverse effects related to the rupture of a known earthquake fault, seismically-induced ground shaking, and unstable soils. Operation and maintenance activities to support the infrastructure developed by the Pacheco Reservoir Expansion Alternative could expose workers to risks if strong seismic ground shaking and associated ground failure, liquefaction, or landslides occurred while workers were on-site. The Pacheco Reservoir Expansion Alternative is not however constructing structures for human habitation and would not increase the frequency of maintenance workers being onsite when compared to existing support of North Fork Dam.

No other cumulative activities or projects have been identified that would contribute to effects associated with the potential exposure of workers to risks associated with seismic activity at Pacheco Reservoir. **Operations of the Pacheco Alternative in combination with other projects would not result in a significant cumulative impact on geology, seismicity, and soils.**

S.3.6 Air Quality

S.3.6.1 Alternative 2 - Lower San Felipe Intake Alternative

Construction activities associated with the Lower San Felipe Intake Alternative could cause temporary and short-term construction-related emissions of criteria pollutants or precursors that would exceed the San Joaquin Valley Air Pollution Control District's (SJVAPCD's) significance thresholds. The population in

Merced County is expected to increase in the future. Increases in population and housing could increase traffic, utility demands, and construction projects, which would all result in increased air pollution. Additionally, air pollutant emissions associated with past and present development and activities have contributed to local and regional air pollution. Potential projects that could contribute to cumulative effects when considered with this alternative include the B.F. Sisk Dam SOD Modification Project, the California High Speed Rail Project, the *San Luis Reservoir SRA RMP/GP*, the San Luis Transmission Project, and the San Luis Solar Project because short-term construction activities associated with these projects would occur in Merced County near San Luis Reservoir.

Air pollution, by definition, is a cumulative impact because no single project determines the California Ambient Air Quality Standards (CAAQS) or National Ambient Air Quality Standards (NAAQS) attainment status of a region. As a result, this alternative, when considered with past, present, and future development, would result in a significant cumulative impact.

The significance thresholds developed by the SJVAPCD serve to evaluate if a proposed project could either 1) cause or contribute to a new violation of a CAAQS or NAAQS in the study area or 2) increase the frequency or severity of any existing violation of any standard in the area. Therefore, if an alternative would produce air quality impacts that are individually significant, then the alternative would also be cumulatively considerable. This approach is consistent with the CEQA Guidance documents developed by both the BAAQMD (2017) and the SJVAPCD (2015).

Construction of the tunnel option would not individually exceed the SJVAPCD's significance thresholds and mitigation would not be required. **Therefore, the tunnel option's incremental contribution to the significant cumulative effect would not be cumulatively considerable.**

Construction of the pipeline option would result in individually significant air quality impacts and NOx emissions would be cumulatively considerable prior to mitigation. Implementation of Mitigation Measures AQ-1 and AQ-2 would be sufficient to reduce impacts to less than significant. **Therefore, with inclusion of Mitigation Measures AQ-1 and AQ-2, the pipeline option's incremental contribution to the significant cumulative effect would not be cumulatively considerable after mitigation.**

Operational activities associated with the Lower San Felipe Intake Alternative could cause long-term emissions of criteria pollutants or precursors that would exceed the SJVAPCD's significance thresholds. As described previously, both the expected population growth in the region combined with past and present development projects contribute to local and regional air pollution. Potential projects that could contribute to cumulative effects when considered with this alternative include the California High Speed Rail Project, the *San Luis*

Reservoir SRA RMP/GP, the San Luis Transmission Project, and the San Luis Solar Project because long-term operational activities associated with these projects would occur in Merced County.

Air pollution is largely a cumulative impact because the attainment status of the region is a result of past and present development. While a single project would not determine the region's attainment status, it would continue to add to any existing air quality issues and would have a significant cumulative effect. Because the SJVAPCD's significance thresholds are intended to both attain and maintain the CAAQS and NAAQS, they are sufficient to determine if a project's individual air quality impacts would also be cumulatively considerable. Operation of this project would not individually exceed the SJVAPCD's significance thresholds and mitigation would not be required. **Therefore, this alternative's incremental contribution to the significant cumulative effect would not be cumulatively considerable.**

Construction activities associated with the Lower San Felipe Intake Alternative could cause temporary and short-term construction-related emissions of toxic air contaminants (TACs) that would exceed the SJVAPCD's significance thresholds. As described previously, both the expected population growth in the region combined with past and present development projects contribute to local and regional air pollution. Impacts from TACs are largely localized impacts. Because of this, significant cumulative TAC effects associated with this alternative would be driven by the projection method of assessing cumulative impacts.

The SJVAPCD's significance thresholds for TACs are highly conservative and protective of health impacts on sensitive receptors. As a result, the SJVAPCD's Guidance for Assessing and Mitigating Air Quality Impacts (GAMAQI) (see page 110) states that if project-specific TAC emissions would have a less than significant impact, then the project would not be expected to result in a cumulatively considerable net increase in health impacts. The proposed construction of the tunnel or pipeline would have a less than significant impact on sensitive receptors and mitigation would not be required. **Therefore, this alternative's incremental contribution to the cumulative effect would not be cumulatively considerable.**

S.3.6.2 Alternative 3 - Treatment Alternative

Construction activities associated with the Treatment Alternative could cause temporary and short-term construction-related emissions of criteria pollutants or precursors that would exceed the BAAQMD's significance thresholds. The population in Santa Clara County is expected to increase in the future. Increases in population and housing could increase traffic, utility demands, and construction projects, which would all result in increased air pollution. Additionally, air pollutant emissions associated with past and present development and activities have contributed to local and regional air pollution.

Potential projects that could contribute to cumulative effects when considered with this alternative include the Young Ranch Residential Project and Blanchard Road Warehouse/Distribution Center because short-term construction activities associated with these projects would occur in Santa Clara County near the Santa Teresa WTP.

Air pollution, by definition, is a cumulative impact because no single project determines the CAAQS or NAAQS attainment status of a region. As a result, this alternative, when considered with past, present, and future development, would result in a significant cumulative impact. The significance thresholds developed by the BAAQMD serve to evaluate if a proposed project could either 1) cause or contribute to a new violation of a CAAQS or NAAQS in the study area or 2) increase the frequency or severity of any existing violation of any standard in the area. Therefore, if an alternative would produce air quality impacts that are individually significant, then the alternative would also be cumulatively considerable.

Construction of this alternative would not individually exceed the BAAQMD's significance thresholds and mitigation would not be required. **Therefore, this alternative's incremental contribution to the significant cumulative effect would not be cumulatively considerable.**

Operation of the Santa Teresa WTP associated with the Treatment Alternative could cause long-term emissions of criteria pollutants or precursors that would exceed the BAAQMD's significance thresholds. As described previously, both the expected population growth in the region combined with past and present development projects contribute to local and regional air pollution. Potential projects that could contribute to cumulative effects when considered with this alternative include the Young Ranch Residential Project and Blanchard Road Warehouse/Distribution Center because long-term operational activities associated with these projects would occur in Santa Clara County.

Air pollution is largely a cumulative impact because the attainment status of the region is a result of past and present development. While a single project would not determine the region's attainment status, it would continue to add to any existing air quality issues and would have a significant cumulative effect. Because the BAAQMD's significance thresholds are intended to both attain and maintain the CAAQS and NAAQS, they are sufficient to determine if a project's individual air quality impacts would also be cumulatively considerable.

Operation of this alternative would not individually exceed the BAAQMD's significance thresholds and mitigation would not be required. **Therefore, this alternative's incremental contribution to the significant cumulative effect would not be cumulatively considerable.**

Construction activities associated with the Treatment Alternative could cause temporary and short-term construction-related emissions of TACs that would exceed the BAAQMD's significance thresholds. Cumulative impacts from TACs were evaluated using the BAAQMD Risk and Hazard Screening Analysis Process Flow Chart (2012). No permitted sources, highways, or major roadways were located within 1,000 feet of the property line for the Santa Teresa WTP. **Because no sources would be within the zone of influence of the water treatment plants, the alternative's incremental contribution to TAC emissions would not be cumulatively significant.**

S.3.6.3 Alternative 4 - San Luis Reservoir Expansion Alternative

Construction activities associated with the San Luis Reservoir Expansion Alternative could cause temporary and short-term construction-related emissions of criteria pollutants or precursors that would exceed the SJVAPCD's significance thresholds. The population in Merced County is expected to increase in the future. Increases in population and housing could increase traffic, utility demands, and construction projects, which would all result in increased air pollution. Additionally, air pollutant emissions associated with past and present development and activities have contributed to local and regional air pollution. Potential projects that could contribute to cumulative effects when considered with this alternative include the California High Speed Rail Project, the *San Luis Reservoir SRA RMP/GP*, the San Luis Transmission Project, and the San Luis Solar Project because short-term construction activities associated with these projects would occur in Merced County near San Luis Reservoir.

Air pollution, by definition, is a cumulative impact because no single project determines the CAAQS or NAAQS attainment status of a region. As a result, this alternative, when considered with past, present, and future development, would result in a significant cumulative impact.

The significance thresholds developed by the SJVAPCD serve to evaluate if a proposed project could either 1) cause or contribute to a new violation of a CAAQS or NAAQS in the study area or 2) increase the frequency or severity of any existing violation of any standard in the area. Therefore, if an alternative would produce air quality impacts that are individually significant, then the alternative would also be cumulatively considerable. This approach is consistent with the CEQA Guidance documents developed by both the BAAQMD (2017) and the SJVAPCD (2015).

Construction of the enlarged reservoir would result in individually significant air quality impacts because PM_{10} and $PM_{2.5}$ emissions would be cumulatively considerable prior to mitigation. Implementation of Mitigation Measure AQ-3 would be sufficient to reduce impacts from $PM_{2.5}$ to less than significant, but PM_{10} emissions would remain significant. **Therefore, the**

enlarged reservoir's incremental contribution to the significant cumulative effect would be cumulatively considerable after mitigation.

Operational activities associated with the San Luis Reservoir Expansion Alternative could cause long-term emissions of criteria pollutants or precursors that would exceed the SJVAPCD's significance thresholds. As described previously, both the expected population growth in the region combined with past and present development projects contribute to local and regional air pollution. Potential projects that could contribute to cumulative effects when considered with this alternative include the California High Speed Rail Project, *San Luis Reservoir SRA RMP/GP*, the San Luis Transmission Project, and the San Luis Solar Project because long-term operational activities associated with these projects would occur in Merced County.

Air pollution is largely a cumulative impact because the attainment status of the region is a result of past and present development. While a single project would not determine the region's attainment status, it would continue to add to any existing air quality issues and would have a significant cumulative effect. Because the SJVAPCD's significance thresholds are intended to both attain and maintain the CAAQS and NAAQS, they are sufficient to determine if a project's individual air quality impacts would also be cumulatively considerable. Operation of this project would not individually exceed the SJVAPCD's significance thresholds and mitigation would not be required. **Therefore, this alternative's incremental contribution to the significant cumulative effect would not be cumulatively considerable.**

Construction activities associated with the San Luis Reservoir Expansion Alternative could cause temporary and short-term construction-related emissions of TACs that would exceed the SJVAPCD's significance thresholds. As described previously, both the expected population growth in the region combined with past and present development projects contribute to local and regional air pollution. Impacts from TACs are largely localized impacts. Because of this, significant cumulative TAC effects associated with this alternative would be driven by the projection method of assessing cumulative impacts.

The SJVAPCD's significance thresholds for TACs are highly conservative and protective of health impacts on sensitive receptors. As a result, the SJVAPCD's GAMAQI (see page 110) states that if project-specific TAC emissions would have a less than significant impact, then the project would not be expected to result in a cumulatively considerable net increase in health impacts. The proposed construction of the tunnel or pipeline would have a less than significant impact on sensitive receptors and mitigation would not be required. **Therefore, this alternative's incremental contribution to the cumulative effect would not be cumulatively considerable.**

S.3.6.4 Alternative 5 - Pacheco Reservoir Expansion Alternative

Construction activities associated with the Pacheco Reservoir Expansion Alternative could cause temporary and short-term construction-related emissions of criteria pollutants or precursors that would exceed the BAAQMD's significance thresholds. The population in Santa Clara County is expected to increase in the future. Increases in population and housing could increase traffic, utility demands, and construction projects, which would all result in increased air pollution. Additionally, air pollutant emissions associated with past and present development and activities have contributed to local and regional air pollution. Potential projects that could contribute to cumulative effects when considered with this alternative would be the B.F. Sisk Dam SOD Modification Project and the California High Speed Rail Project because term construction activities associated with this project would occur in Merced County and Santa Clara County near Pacheco Reservoir.

Air pollution, by definition, is a cumulative impact because no single project determines the CAAQS or NAAQS attainment status of a region. As a result, this alternative, when considered with past, present, and future development, would result in a significant cumulative impact. As previously discussed, the significance thresholds developed by the BAAQMD serve to evaluate if a proposed project could either 1) cause or contribute to a new violation of a CAAQS or NAAQS in the study area or 2) increase the frequency or severity of any existing violation of any standard in the area. **Construction of the expanded Pacheco reservoir would result in individually significant air quality impacts because PM_{10} and $PM_{2.5}$ emissions would be cumulatively considerable prior to mitigation.** Implementation of Mitigation Measure AQ-3 would be sufficient to reduce impacts from $PM_{2.5}$ to less than significant, but PM_{10} emissions would remain significant. **Therefore, the new reservoir's incremental contribution to the significant cumulative effect would be cumulatively considerable after mitigation.**

Operational activities associated with the Pacheco Reservoir Expansion Alternative could cause long-term emissions of criteria pollutants or precursors that would exceed the BAAQMD's significance thresholds. As described previously, both the expected population growth in the region combined with past and present development projects contribute to local and regional air pollution. A potential project that could contribute to cumulative effects when considered with this alternative would be the California High Speed Rail Project because long-term operational activities associated with this project would occur in Santa Clara County near Pacheco Reservoir.

Air pollution is largely a cumulative impact because the attainment status of the region is a result of past and present development. While a single project would not determine the region's attainment status, it would continue to add to any existing air quality issues and would have a significant cumulative effect. Because the BAAQMD's significance thresholds are intended to both attain and maintain the CAAQS and NAAQS, they are sufficient to determine if a

project's individual air quality impacts would also be cumulatively considerable. Operation of this project would not individually exceed the BAAQMD's significance thresholds and mitigation would not be required. **Therefore, this alternative's incremental contribution to the significant cumulative effect would not be cumulatively considerable.**

Construction activities associated with the Pacheco Reservoir Expansion Alternative could cause temporary and short-term construction-related emissions of TACs that would exceed the BAAQMD's significance thresholds. Cumulative impacts from TACs were evaluated using the BAAQMD Risk and Hazard Screening Analysis Process Flow Chart (2012). No permitted sources, highways, or major roadways were located within 1,000 feet of the property line for the expanded Pacheco Reservoir. **Because no sources would be within the zone of influence of the new reservoir, the alternative's incremental contribution to TAC emissions would not be cumulatively significant.**

S.3.7 Greenhouse Gas Emissions

S.3.7.1 Alternative 2 - Lower San Felipe Intake Alternative

Construction activities associated with the Lower San Felipe Intake Alternative could generate Greenhouse Gas (GHG) emissions, either directly or indirectly, that could have a significant impact on the environment. The population in Merced County is expected to increase in the future. Increases in population and housing could increase traffic, utility demands, and construction projects, which would all result in increased GHG emissions. Additionally, GHG emissions associated with past and present development and activities have contributed to global climate change. Potential projects that could contribute to cumulative effects when considered with this alternative include the B.F. Sisk Dam SOD Modification Project, the California High Speed Rail Project, the *San Luis Reservoir SRA RMP/GP*, the San Luis Transmission Project, and the San Luis Solar Project because short-term construction activities and long-term operational activities associated with these projects could potentially occur in Merced County.

In its 2012 GAMAQI, the SJVAPCD states that no single project could generate enough GHG emissions to noticeably change the global climate temperature; therefore, climate change is a result of the combination of past, present, and future projects. Thus, this alternative would create a significant cumulative effect on climate change by adding additional GHG emissions to the atmosphere.

The California Air Pollution Control Officers Association (CAPCOA) document *CEQA & Climate Change* (2008) provides guidance to lead agencies for evaluating and addressing GHG emissions under CEQA. The CAPCOA document recognizes that a non-zero significance threshold could be construed as setting a de minimis threshold for cumulative impacts. In other words, a non-

zero threshold would provide a point at which a project's contribution would not contribute considerably to climate change. Therefore, if an alternative would produce GHG emission impacts that are individually significant, then the alternative would also be cumulatively considerable. Construction and operation of this alternative would not individually exceed the quantitative GHG emissions threshold. **Therefore, this alternative's incremental contribution to the significant cumulative effect would not be cumulatively considerable.**

Construction activities associated with the Lower San Felipe Intake Alternative could conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs. As described previously, both the expected population growth in the region combined with past and present development projects contribute to global climate change. Potential projects that could contribute to cumulative effects when considered with this alternative include the B.F. Sisk Dam SOD Modification Project, the California High Speed Rail Project, the *San Luis Reservoir SRA RMP/GP*, the San Luis Transmission Project, and the San Luis Solar Project because long-term operational activities associated with these projects could occur in Merced County.

Because no single project can noticeably change the global climate temperature, this alternative, when considered in relationship to all past, present, and future development, would result in a significant cumulative impact. As described previously, the significance criterion used to assess an alternative's individual significance is sufficient to determine if a project would conflict with an applicable plan, policy, or regulation adopted for reducing GHG emissions for which project-specific thresholds have been set by BAAQMD. Therefore, if an alternative would produce GHG emission impacts that are individually significant, then the alternative would also be cumulatively considerable. Construction and operation of this alternative would not individually exceed the quantitative GHG emissions threshold. **Therefore, this alternative's incremental contribution to the significant cumulative effect would not be cumulatively considerable.**

S.3.7.2 Alternative 3 - Treatment Alternative

Construction activities associated with the Treatment Alternative could generate GHG emissions, either directly or indirectly, that could have a significant impact on the environment. The population in Santa Clara County is expected to increase in the future. Increases in population and housing could increase traffic, utility demands, and construction projects, which would all result in increased GHG emissions. Additionally, GHG emissions associated with past and present development and activities have contributed to global climate change. Potential projects that could contribute to cumulative effects when considered with this alternative include the Young Ranch Residential Project and Blanchard Road Warehouse/Distribution Center because

construction and operational activities associated with these projects would occur in Santa Clara County.

As previously stated, no single project could generate enough GHG emissions to noticeably change the global climate temperature; therefore, climate change is a result of the combination of past, present, and future projects. Thus, this alternative would create a significant cumulative effect on climate change by adding additional GHG emissions to the atmosphere. Additionally, the non-zero significance threshold used in this analysis provides a point at which a project's contribution would not contribute considerably to climate change. Therefore, if an alternative would produce GHG emission impacts that are individually significant, then the alternative would also be cumulatively considerable. Construction and operation of this alternative would not individually exceed the quantitative GHG emissions thresholds. **Therefore, this alternative's incremental contribution to the significant cumulative effect would not be cumulatively considerable.**

Construction activities associated with the Treatment Alternative could conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs. As described previously, both the expected population growth in the region combined with past and present development projects contribute to global climate change. Potential projects that could contribute to cumulative effects when considered with this alternative include the Upper Guadalupe River Flood Control Project, Young Ranch Residential Project, and the Blanchard Road Warehouse/Distribution Center because long-term operational activities associated with these projects could occur in Santa Clara County.

Because no single project can noticeably change the global climate temperature, this alternative, when considered in relationship to all past, present, and future development, would result in a significant cumulative impact. As described previously, the significance criterion used to assess an alternative's individual significance is sufficient to determine if a project would conflict with an applicable plan, policy, or regulation adopted for reducing GHG emissions for which project-specific thresholds have been set by BAAQMD. Therefore, if an alternative would produce GHG emission impacts that are individually significant, then the alternative would also be cumulatively considerable. Construction and operation of this alternative would not individually exceed the quantitative GHG emissions thresholds. **Therefore, this alternative's incremental contribution to the significant cumulative effect would not be cumulatively considerable.**

S.3.7.3 Alternative 4 – San Luis Reservoir Expansion Alternative

Construction activities associated with the San Luis Reservoir Expansion Alternative could generate GHG emissions, either directly or indirectly, that could have a significant impact on the environment. The population in Merced

County is expected to increase in the future. Increases in population and housing could increase traffic, utility demands, and construction projects, which would all result in increased GHG emissions. Additionally, GHG emissions associated with past and present development and activities have contributed to global climate change. Potential projects that could contribute to cumulative effects when considered with this alternative include the California High Speed Rail Project, the *San Luis Reservoir SRA RMP/GP*, the San Luis Transmission Project, and the San Luis Solar Project because short-term construction activities and long-term operational activities associated with these projects could potentially occur in Merced County.

In its 2012 GAMAQI, the SJVAPCD states that no single project could generate enough GHG emissions to noticeably change the global climate temperature; therefore, climate change is a result of the combination of past, present, and future projects. Thus, this alternative would create a significant cumulative effect on climate change by adding additional GHG emissions to the atmosphere.

The CAPCOA document *CEQA & Climate Change* (2008) provides guidance to lead agencies for evaluating and addressing GHG emissions under CEQA. The CAPCOA document recognizes that a non-zero significance threshold could be construed as setting a de minimis threshold for cumulative impacts. In other words, a non-zero threshold would provide a point at which a project's contribution would not contribute considerably to climate change. Therefore, if an alternative would produce GHG emission impacts that are individually significant, then the alternative would also be cumulatively considerable. **Construction and operation of this alternative would exceed the quantitative GHG emissions threshold and the alternative's incremental contribution to the significant cumulative effect would be cumulatively considerable.** Implementation of Mitigation Measure GHG-1 would reduce emissions to less than significant levels. **Therefore, this alternative's incremental contribution to the significant cumulative effect would not be cumulatively considerable with mitigation.**

Construction activities associated with the San Luis Reservoir Expansion Alternative could conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs. As described previously, both the expected population growth in the region combined with past and present development projects contribute to global climate change. Potential projects that could contribute to cumulative effects when considered with this alternative include the California High Speed Rail Project, the *San Luis Reservoir SRA RMP/GP,* the San Luis Transmission Project, and the San Luis Solar Project because long-term operational activities associated with these projects could occur in Merced County.

Because no single project can noticeably change the global climate temperature, this alternative, when considered in relationship to all past, present, and future

development, would result in a significant cumulative impact. As described previously, the significance criterion used to assess an alternative's individual significance is sufficient to determine if a project would conflict with an applicable plan, policy, or regulation adopted for reducing GHG emissions for which project-specific thresholds have been set by BAAQMD. Therefore, if an alternative would produce GHG emission impacts that are individually significant, then the alternative would also be cumulatively considerable. Construction and operation of this alternative would not individually exceed the quantitative GHG emissions threshold with implementation of Mitigation Measure GHG-1. **Therefore, this alternative's incremental contribution to the significant cumulative effect would be cumulatively considerable pre-mitigation, but would not be cumulatively considerable with mitigation.**

S.3.7.4 Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction activities associated with the Pacheco Reservoir Expansion Alternative could generate GHG emissions, either directly or indirectly, that could have a significant impact on the environment. The population in Santa Clara County is expected to increase in the future. Increases in population and housing could increase traffic, utility demands, and construction projects, which would all result in increased GHG emissions. Additionally, GHG emissions associated with past and present development and activities have contributed to global climate change. A potential project that could contribute to cumulative effects when considered with this alternative would be the California High Speed Rail Project because construction and operational activities associated with this project would occur in Santa Clara County.

As previously stated, no single project could generate enough GHG emissions to noticeably change the global climate temperature; therefore, climate change is a result of the combination of past, present, and future projects. Thus, this alternative would create a significant cumulative effect on climate change by adding additional GHG emissions to the atmosphere. Additionally, the non-zero significance threshold used in this analysis provides a point at which a project's contribution would not contribute considerably to climate change. Therefore, if an alternative would produce GHG emission impacts that are individually significant, then the alternative would also be cumulatively considerable. Construction and operation of this alternative would not individually exceed the quantitative GHG emissions thresholds. **Therefore, this alternative's incremental contribution to the significant cumulative effect would not be cumulatively considerable.**

Construction activities associated with the Pacheco Reservoir Expansion Alternative could conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs. As described previously, both the expected population growth in the region combined with past and present development projects contribute to global climate change. A potential project that could contribute to cumulative effects when considered with this

alternative would be the California High Speed Rail Project because long-term operational activities associated with this project would occur in Santa Clara County near Pacheco Reservoir.

Because no single project can noticeably change the global climate temperature, this alternative, when considered in relationship to all past, present, and future development, would result in a significant cumulative impact. As described previously, the significance criterion used to assess an alternative's individual significance is sufficient to determine if a project would conflict with an applicable plan, policy, or regulation adopted for reducing GHG emissions for which project-specific thresholds have been set by BAAQMD. Therefore, if an alternative would produce GHG emission impacts that are individually significant, then the alternative would also be cumulatively considerable. Construction and operation of this alternative would not individually exceed the quantitative GHG emissions thresholds. **Therefore, this alternative's incremental contribution to the significant cumulative effect would not be cumulatively considerable.**

S.3.8 Visual Resources

S.3.8.1 Alternative 2 - Lower San Felipe Intake Alternative

Implementation of the Lower San Felipe Intake Alternative in combination with other cumulative actions could have short-term adverse effects on Class A and Class B visual resources. The Lower San Felipe Intake Alternative would create construction and stockpile areas at B. F. Sisk Dam, Basalt Use Area, and Dinosaur Point Use Area that could affect views from scenic vistas and overall visual character in the study area.

The B.F. Sisk Dam SOD Modification Project, the *San Luis Reservoir SRA RMP/GP* and the California High Speed Rail Project have been identified as cumulative plans that could contribute to visual resource effects during the construction of the Lower San Felipe Intake. The proposed improvements at San Luis Reservoir SRA, the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could result in cumulative effects associated with visual resources.

The B.F. Sisk Dam SOD Modification Project would modify the dam with raises along sections of the dam crest and embankment. During construction, the introduction of construction equipment and the placement of new material along the embankment are also forecast to be visually apparent for a period following construction.

The *San Luis Reservoir SRA RMP/GP* includes a Park Plan, which outlines various alternatives for future park expansion and new facility development including new trails. It is typical for park expansion projects to be phased; thus,

associated construction actions could take place prior to or congruently with SLLPIP construction actions.

A multi-modal trail system is proposed to connect both use areas to the Pacheco State Park. The Dinosaur Point Use Area trail would also connect to the San Luis Wildlife Area (Reclamation and CDPR 2013). An additional trail is proposed to connect the Basalt and Los Banos Creek Trail use areas. Construction of these trails would be expected to require small scale construction equipment and hand labor and would not be anticipated to generate substantial visual impacts.

The California High Speed Rail Project would develop a new railway traversing the Pacheco Pass adjacent to the San Luis Reservoir and SR 152. The railway would support train speeds in excess of 125 miles per hour and would likely have sections visible to both San Luis Reservoir and SR 152. The project construction schedule for this section of railway is currently unknown but, if funding is secured in the near future, development of the high speed railway could take place prior to or congruently with SLLPIP construction actions.

Development of the California High Speed Rail Project would establish new railway and railway tunnels across Pacheco Pass parallel to SR 152 near San Luis Reservoir. Construction of this railway would likely require large scale equipment that would be visible from San Luis Reservoir, public roadways (including SR 152), the Romero Outlook Visitors Center, and open space areas, such as the Cottonwood Creek Wildlife Area and portions of Pacheco State Park, would generate a temporary degradation of the areas visual character and the quality of scenic vistas.

The San Luis Transmission Project and the San Luis Solar Project would both construct new facilities downstream of B. F. Sisk Dam. The San Luis Transmission Project would develop new transmission lines connecting the Tracy Substation to the Dos Amigos Substation with a side connection the San Luis Substation at B. F. Sisk Dam. This project would develop new transmission towers in the near the construction staging area for the Lower San Felipe Intake Alternative. The San Luis Solar Project would develop a new 108-acre solar power generation facility in the area between the O'Neill Forebay and SR 152. Construction of these projects would likely require large scale equipment that would be visible from public roadways (including SR 152), the Romero Outlook Visitors Center, and open space areas, such as the Cottonwood Creek Wildlife Area and portions of Pacheco State Park, would generate a temporary degradation of the areas visual character and the quality of scenic vistas.

If construction of these projects was completed concurrently with the Lower San Felipe Intake Alternative, the Dinosaur Point and Basalt use areas would be closed as would recreational boat use on the reservoir limiting impacts to prolonged visual resource impacts to foreground views from the reservoir.

Construction and material staging would affect views from public roadways (including SR 152), the Romero Outlook Visitors Center, and open space areas, however impacts would be short-term (approximately 33 to 47 months). In addition, the panoramic nature of background views from distant static viewing locations and the speed of motorists passing the site from adjacent roadways reduce the overall impact generated by construction activities from Alternative 2. **Therefore, the Lower San Felipe Intake Alternative's incremental contribution to any significant cumulative impact on visual quality in the area of analysis would not be cumulatively considerable.**

Implementation of the Lower San Felipe Intake Alternative in combination with other cumulative actions could have short-term adverse effects scenic resources within a designated State scenic highway, existing visual character of the area, and may create light glare in the reservoir region. Under the tunnel option, construction activities could take place after day-light hours, in which case lights in the construction staging areas and at Gate Shaft Island could have a negative impact on nighttime views in the project area. The tunnel option would generate excavated material that would need to be disposed at a spoil site at Dinosaur Point Use Area. This deposit of soils material at Dinosaur Point would change the existing visual character of the spoil site by covering existing vegetation until new vegetation is established which is inconsistent with the aesthetics resource goals outlined in the San Luis Reservoir SRA RMP/GP. In addition, to complete construction operations, the two existing intersections along SR 152 (at Dinosaur Point Road and at Basalt Road) would be improved to accommodate the high volume of trucks and other heavy equipment anticipated during construction.

The aeration system would consist of a new facility near Romero Outlook Visitors Center and would permanently change the visual experience of viewers from the Visitor Center, watercraft on the reservoir, and shoreline areas (from a distance) around the reservoir, which is inconsistent with the aesthetics resource goals as outlined in the San Luis Reservoir SRA RMP/GP.

If construction of the B.F. Sisk Dam SOD Modification Project, the San Luis Transmission Project and the San Luis Solar Project were completed concurrently with the Lower San Felipe Intake Alternative, there could be a cumulative short-term impact on visual resources given the introduction of construction equipment, construction traffic and construction lighting. However, implementation of Mitigation Measures VIS-1, VIS-2, VIS-3, and VIS-4 would reduce effects to a less than significant level. **Therefore, although the Lower San Felipe Intake Alternative may combine with other projects to create a cumulatively considerable contribution to significant cumulative visual impacts pre-mitigation, impacts would not be cumulatively considerable post-mitigation.**

S.3.8.2 Alternative 3 - Treatment Alternative

The Treatment Alternative proposes treatment technology and facility upgrades, requiring construction, at the Santa Teresa WTP. New treatment facilities and processes would replace existing processes and all improvements would occur on site. Because the visual character of the sites is that of a WTP and improvements are within the character of the site, there are no long term impacts to visual resources expected. Therefore, no cumulative activities or projects have been identified that in combination with project construction would affect visual resources. **The Treatment Alternative would have no significant cumulative effects on visual resources.**

S.3.8.3 Alternative 4 - San Luis Reservoir Expansion Alternative

Implementation of the San Luis Reservoir Expansion Alternative in combination with other cumulative actions could have short-term adverse effects on Class A and Class B visual resources, scenic resources within a designated State scenic highway, existing visual character of the area, and may create light glare in the reservoir region. The San Luis Reservoir expansion would create construction and stockpile areas at B. F. Sisk Dam, Basalt Use Area, and Dinosaur Point Use Area that could affect views from scenic vistas and overall visual character in the study area.

The *San Luis Reservoir SRA RMP/GP* and the California High Speed Rail Project have been identified as cumulative plans that could contribute to visual resource effects during the construction of the San Luis Reservoir Expansion Alternative. The proposed improvements at San Luis Reservoir SRA, the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could result in cumulative effects associated with visual resources.

The *San Luis Reservoir SRA RMP/GP* includes a Park Plan, which outlines various alternatives for future park expansion and new facility development including new trails. It is typical for park expansion projects to be phased; thus, associated construction actions could take place prior to or congruently with SLLPIP construction actions.

A multi-modal trail system is proposed to connect both use areas to the Pacheco State Park. The Dinosaur Point Use Area trail would also connect to the San Luis Wildlife Area (Reclamation and CDPR 2013). An additional trail is proposed to connect the Basalt and Los Banos Creek Trail use areas. Construction of these trails would be expected to require small scale construction equipment and hand labor and would not be anticipated to generate substantial visual impacts.

The California High Speed Rail Project would develop a new railway traversing the Pacheco Pass adjacent to the San Luis Reservoir and SR 152. The railway would support train speeds in excess of 125 miles per hour and would likely

have sections visible to both San Luis Reservoir and SR 152. The project construction schedule for this section of railway is currently unknown but, if funding is secured in the near future, development of the high speed railway could take place prior to or congruently with SLLPIP construction actions.

Development of the California High Speed Rail Project would establish new railway and railway tunnels across Pacheco Pass parallel to SR 152 near San Luis Reservoir. Construction of this railway would likely require large scale equipment that would be visible from San Luis Reservoir, public roadways (including SR 152), the Romero Outlook Visitors Center, and open space areas, such as the Cottonwood Creek Wildlife Area and portions of Pacheco State Park, would generate a temporary degradation of the areas visual character and the quality of scenic vistas.

The San Luis Transmission Project and the San Luis Solar Project would both construct new facilities downstream of B.F. Sisk Dam. The San Luis Transmission Project would develop new transmission lines connecting the Tracy Substation to the Dos Amigos Substation with a side connection the San Luis Substation at B.F. Sisk Dam. This project would develop new transmission towers in the near the construction staging area for the San Luis Reservoir Expansion Alternative. The San Luis Solar Project would develop a new 108-acre solar power generation facility in the area between the O'Neill Forebay and SR 152. Construction of these projects would likely require large scale equipment that would be visible from public roadways (including SR 152), the Romero Outlook Visitors Center, and open space areas, such as the Cottonwood Creek Wildlife Area and portions of Pacheco State Park, would generate a temporary degradation of the areas visual character and the quality of scenic vistas.

If construction of these projects was completed concurrently with the San Luis Reservoir expansion, the Basalt Use Area for the full construction schedule and Dinosaur Point would be closed for one year limiting impacts to prolonged visual resource impacts to foreground views from the reservoir. Background views of the reservoir from more distant locations like public roadways (including SR 152), the Romero Outlook Visitors Center, and open space areas, such as the Cottonwood Creek Wildlife Area and portions of Pacheco State Park could be adversely impacted in the short-term given the introduction of construction equipment, construction traffic and construction lighting. Implementation of Mitigation Measures VIS-1 and VIS-4 would reduce effects of the San Luis Reservoir Expansion Alternative. **Therefore, although the San Luis Reservoir Expansion Alternative may combine with other projects to create a cumulatively considerable contribution to significant cumulative visual impacts pre-mitigation, impacts would not be cumulatively considerable post-mitigation.**

Under the San Luis Reservoir Expansion Alternative, operational changes at the San Luis Reservoir could affect visual resources. In the long-term, following completion of the San Luis Reservoir Expansion Alternative, in combination with the other cumulative projects in the area of analysis, scenic values in the foreground for recreation users at San Luis Reservoir and in the background from vistas along public roadways (including SR 152), at the Romero Outlook Visitors Center, and open space areas, such as the Cottonwood Creek Wildlife Area and portions of Pacheco State Park would return to their current quality level. **Therefore, the San Luis Reservoir Expansion Alternative in combination with the other cumulative projects would not result in a significant cumulative impact.**

S.3.8.4 Alternative 5 – Pacheco Reservoir Expansion Alternative

Implementation of the Pacheco Reservoir Expansion Alternative in combination with other cumulative actions could have short-term adverse effects on Class A and Class B visual resources, scenic resources within a designated State scenic highway, existing visual character of the area, and may create light glare in the reservoir region. The Pacheco Reservoir Expansion Alternative would create construction and stockpile areas along Pacheco that could temporarily affect the overall visual character in the study area during the 5-year construction period.

The California High Speed Rail Project has been identified as a cumulative project that could contribute to visual resource effects during the construction of the Pacheco Reservoir Expansion Alternative. The California High Speed Rail Project would develop a new railway traversing the Pacheco Pass near Pacheco Reservoir and SR 152. The railway would support train speeds in excess of 125 miles per hour and would likely have sections visible to SR 152. The project construction schedule for this section of railway is currently unknown but, if funding is secured in the near future, development of the high speed railway could take place prior to or congruently with SLLPIP construction actions.

Development of the California High Speed Rail Project would establish new railway and railway tunnels across Pacheco Pass parallel to SR 152. Construction of this railway would likely require large scale equipment that would be visible from public roadways (including SR 152) and could cause temporary degradation of the areas visual character and the quality of scenic vistas.

If construction of this project was completed concurrently with the Pacheco Reservoir Expansion Alternative, views from public roadways (including SR 152) could be adversely affected in the short-term given the introduction of construction equipment, construction traffic and construction lighting. The Pacheco Reservoir Expansion Alternative is not immediately adjacent to SR 152, and the effects would be reduced through Mitigation Measure VIS-1, as described in Section 4.9.8. **Therefore, although the Pacheco Reservoir Expansion Alternative may combine with other projects to create a**

cumulatively considerable contribution to significant cumulative visual impacts pre-mitigation, impacts would not be cumulatively considerable post-mitigation.

Under the Pacheco Reservoir Expansion Alternative, operational changes could affect visual resources. The expanded Pacheco Reservoir would only be visible from the neighboring properties; no views exist from scenic overlooks, trails, or roads. Therefore, it would not result in cumulative impacts in conjunction with other cumulative projects. **The Pacheco Reservoir Expansion Alternative in combination with the other cumulative projects would not result in a significant cumulative impact.**

S.3.9 Noise and Vibration

S.3.9.1 Alternative 2 - Lower San Felipe Intake Alternative

Construction activities associated with the Lower San Felipe Intake Alternative could expose sensitive receptors to noise levels in excess of standards established in the local general plan or noise ordinance. Construction is projected to occur in Merced County as a result of projected population growth; however, construction is not expected to be in the vicinity of San Luis Reservoir. Construction of the B.F. Sisk Dam SOD Modification Project, the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could potentially occur at the same time as construction activities near San Luis Reservoir for the Lower San Felipe Intake Alternative and would involve a substantial amount of construction equipment and vehicle traffic that could contribute to noise impacts. The B.F. Sisk Dam SOD Modification Project, the proposed alignment of the California High Speed Rail Project the San Luis Transmission Project, and the San Luis Solar Project would all be along SR 152. The Lower San Felipe Intake Alternative would not exceed standards established in the local general plan or noise ordinance and would have a less than significant incremental contribution. **Therefore, the Lower San Felipe Intake Alternative's incremental contribution to the significant cumulative effect would not be cumulatively considerable.**

Construction activities associated with the Lower San Felipe Intake Alternative could expose sensitive receptors to excessive groundborne vibration or groundborne noise. Construction is projected to occur in Merced County as a result of projected population growth; however, construction is not expected to be in the vicinity of San Luis Reservoir. Construction of the B.F. Sisk Dam SOD Modification Project, the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could potentially occur at the same time as construction activities at or near San Luis Reservoir for the Lower San Felipe Intake Alternative. Construction and operation of these projects could result in significant cumulative vibration effects. The Lower San Felipe Intake Alternative's incremental contribution to this significant cumulative vibration and ground borne noise effect would be minimal given the

Lower San Felipe Intake Alternative's less than significant, minor individual effect and the cumulative project's distance from the Dinosaur Point construction area – approximately 1.5 miles for the California High Speed Rail Project (CHSRA 2016), 3.5 miles from the B.F. Sisk Dam SOD Modification Project (Reclamation and DWR 2019) and 6 miles for the San Luis Transmission Project and the San Luis Solar Project. **Therefore, the Lower San Felipe Intake Alternative's incremental contribution to the significant cumulative effect would not be cumulatively considerable.**

Operational sources located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would not expose people residing or working in the project area to excessive noise levels. Operation of the California High Speed Rail Project, the San Luis Transmission Project, the San Luis Solar Project and the lower San Felipe intake would occur within the San Luis Reservoir Seaplane Base Airport Land Use Plan. The seaplane base allows water landings of planes on the reservoir. Because of the high sound levels associated with construction equipment, construction workers would be wearing hearing protection in compliance with California OSHA regulations, and no workers would be exposed to excessive noise levels associated with either project. Additionally, neither of the proposed projects would cause new residents or offsite workers to be located within the airport land use plan. **Therefore, the Lower San Felipe Intake Alternative would not contribute to any cumulative effect.**

Construction activities associated with and operation of the Lower San Felipe Intake Alternative could cause a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project. Noise from construction equipment and construction traffic would occur throughout the construction phase of this alternative. Noise levels at the sensitive receptors closest to Dinosaur Point and the Gianelli Pumping Plant would exceed the significance criteria, which would contribute to a substantial temporary increase in ambient noise levels in the project vicinity.

Construction of the B.F. Sisk Dam SOD Modification Project, the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could potentially occur at the same time as construction activities near San Luis Reservoir for the Lower San Felipe Intake Alternative and would involve a substantial amount of construction equipment and vehicle traffic that would cause an increase in ambient noise levels in the project vicinity. The cumulative impact of Lower San Felipe Intake Alternative's incremental contribution to this ambient noise level increase would be significant.

The long term operation of the California High Speed Rail Project would produce substantial periodic ambient noise level effects with regular passing trains. The Lower San Felipe Intake Alternative would require the long-term operation of an aeration facility near the Romero Visitor's Center which would not generate a substantial temporary or periodic ambient noise level effects.

Operation of the San Luis Transmission Project and the San Luis Solar Project would not produce permanent ambient noise level effects. Therefore, cumulative periodic ambient noise level increases would not be a significant cumulative impact.

Implementation of Mitigation Measure NOISE-1 would reduce construction impacts from the Lower San Felipe Intake Alternative, but it would not be sufficient to reduce the alternative's construction impacts to a less than significant level. **Therefore, the Lower San Felipe Intake Alternative's incremental contribution to the significant cumulative increase in short-term ambient noise levels during construction would remain cumulatively considerable, while the Lower San Felipe Intake Alternative's incremental contribution to any cumulative increase in ambient noise levels during long-term operation would not be cumulatively considerable.**

S.3.9.2 Alternative 3 - Treatment Alternative

Construction activities associated with the Treatment Alternative could expose sensitive receptors to noise levels in excess of standards established in the local general plan or noise ordinance. Projects that could occur in the same place and time as this alternative and expose sensitive receptors to noise levels in excess of both the City of San Jose and Santa Clara County's noise ordinances include the Upper Guadalupe River Flood Control Project and could cause a significant cumulative impact. Other cumulative construction projects expected to occur in the county as a result of projected population growth could result in significant negative impacts to Santa Clara County noise levels.

Construction activities at the Santa Teresa WTP would not exceed the noise limits for the City of San Jose and the Treatment Alternative's incremental contribution to any substantial noise effects would be minimal. **Therefore, the Treatment Alternative's incremental contribution to any significant cumulative effect would not be cumulatively considerable.**

Construction activities associated with and operation of the Treatment Alternative could expose sensitive receptors to excessive groundborne vibration or groundborne noise. Projects that could occur in the same place and time as this alternative and expose sensitive receptors to groundborne vibration or noise include the Upper Guadalupe River Flood Control Project and could cause a significant cumulative impact. Other cumulative construction projects expected to occur in the county as a result of projected population growth could result in significant cumulative impact.

The Treatment Alternative's incremental contribution to any significant cumulative groundborne vibration or groundborne noise effect would be minimal. The Treatment Alternative's generation of groundborne vibration was less than significant. Long term operation of the Treatment Alternative would not generate vibrations or groundborne noise, or otherwise expose persons to

such impact. **Therefore, the Treatment Alternative's incremental contribution to any significant cumulative effect would not be cumulatively considerable.**

Construction activities associated with and operation of the Treatment Alternative could cause a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project. Projects could occur in the same place and time as this alternative and increase temporary or periodic ambient noise levels. Noise from construction equipment would occur throughout the construction phase of this alternative. The 1-hour L_{eq} during construction would be greater than 10 dBA when compared to the No Action/No Alternative conditions, and therefore the cumulative impact would be significant. The Treatment Alternative's incremental contribution to this significant cumulative noise effect would be cumulatively considerable.

No perceptible change in offsite plant noise levels during operation of the Treatment Alternative would occur because the modifications would occur within the existing process area.

Implementation of Mitigation Measure NOISE-1 would reduce construction impacts from the Treatment Alternative, but it would not be sufficient to reduce the alternative's construction impacts to a less than significant level.**Therefore, the Treatment Alternative's incremental contribution to the significant cumulative increase in short-term ambient noise levels during construction would remain cumulatively considerable, while the Treatment Alternative's incremental contribution to any cumulative increase in ambient noise levels during long-term operation would not be cumulatively considerable.**

Operational sources located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would not expose people residing or working in the project area to excessive noise levels. Operation of the Treatment Alternative would not occur within an airport land use plan. **The Treatment Alternative would not contribute to any cumulative effect.**

S.3.9.3 Alternative 4 - San Luis Reservoir Expansion Alternative

Construction activities associated with the San Luis Reservoir Expansion Alternative could expose sensitive receptors to noise levels in excess of standards established in the local general plan or noise ordinance. All construction activities associated with reservoir expansion component of the San Luis Reservoir Expansion Alternative would occur within Merced County. While the Merced County Code (Section 10.60.030) sets specific sound level limitations for the county, the noise ordinance specifically exempts construction activities between 7:00 a.m. and 6:00 p.m. Operation of construction equipment between 6:00 p.m. and 7:00 a.m. is prohibited unless it does not result in noise

levels exceeding the background level by 10 dBA between 6:00 p.m. and 10:00 p.m. and by 5 dBA between 10:00 p.m. and 7:00 a.m. Construction activities, including the operation of off-road construction equipment to spread excavated soil at Dinosaur Point, would occur over two 10-hour shifts. This would exceed the Merced County limits.

Construction projects expected to occur in the county as a result of projected population growth could result in significant cumulative noise levels. Construction of the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could potentially occur at the same time as construction activities near San Luis Reservoir for the San Luis Reservoir expansion and would involve a substantial amount of construction equipment and vehicle traffic that could contribute to noise impacts. The proposed alignment of the California High Speed Rail Project the San Luis Transmission Project, and the San Luis Solar Project would all be along SR 152. The San Luis Reservoir expansion's cumulative noise effect would be significant given the proposed rail alignment's crossing of SR 152 via aerial structure and beneath Dinosaur Point Road via tunnel (CHSRA 2016) and the San Luis Transmission Project and San Luis Solar Project location along SR 152 adjacent to O'Neill Forebay, all important construction traffic routes for the San Luis Reservoir expansion. Implementation of Mitigation Measure NOISE-1 would reduce impacts from the San Luis Reservoir Expansion Alternative, but it would not be sufficient to reduce the alternative's construction impacts to a less than significant level. **Therefore, with the Implementation of Mitigation Measure NOISE-1, the San Luis Reservoir Expansion Alternative's incremental contribution to the significant cumulative effect would remain cumulatively considerable.**

Construction activities associated with the San Luis Reservoir Expansion Alternative could expose sensitive receptors to excessive groundborne vibration or groundborne noise. Construction projects expected to occur in the county as a result of projected population growth could result in significant negative impacts. Construction of the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could potentially occur at the same time as construction activities near San Luis Reservoir for the San Luis Reservoir expansion. Construction and operation of these cumulative projects could result in significant cumulative vibration effects. The San Luis Reservoir Expansion Alternative's effect on vibration and ground borne would be less than significant but given the close proximity of alternative's construction area to the cumulative project's construction areas the San Luis Reservoir expansion could contribute to a significant cumulative vibration and ground borne noise impact. This significant cumulative effect would be limited to the borrow area east of Sisk Dam where excavation and transport of borrow materials for placement on the dam could occur adjacent to construction actions for the San Luis Transmission Project and the San Luis Solar Project and the SR 152 construction areas near Cottonwood Bay adjacent to the California High Speed Rail Project alignment. Other construction areas including Sisk Dam, the

Basalt Borrow Area and Dinosaur Point would not contribute to this cumulative effect given their distance from the cumulative projects. **The San Luis Reservoir Expansion Alternative's incremental contribution to the significant cumulative effect would be cumulatively considerable.**

Construction activities associated with and operation of the San Luis Reservoir Expansion Alternative could cause a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project. Noise from construction equipment and construction traffic would occur throughout the construction phase of this alternative. Noise levels at the sensitive receptors would exceed the significance criteria, which would contribute to a substantial temporary increase in ambient noise levels in the project vicinity.

Construction projects expected to occur in the county as a result of projected population growth could result in significant negative impacts. Construction of the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could occur at the same time as construction activities near San Luis Reservoir for the San Luis Reservoir expansion and would involve a substantial amount of construction equipment and vehicle traffic that would cause an increase in ambient noise levels in the project vicinity. The San Luis Reservoir expansion's incremental contribution to cumulativeambient noise levels would be significant. The long term operation of the California High Speed Rail Project would produce substantial periodic ambient noise level effects with regular passing trains. Operation of the San Luis Transmission Project and the San Luis Solar Project would not produce permanent ambient noise level effects. Operation of the San Luis Reservoir Expansion Alternative would not change operations at San Luis Reservoir in a way that would introduce a new noise source. Therefore, cumulative periodic ambient noise level increases would not be a significant cumulative impact.

Implementation of Mitigation Measure NOISE-1 would reduce construction impacts from the San Luis Reservoir expansion, but it would not be sufficient to reduce the alternative's construction impacts to a less than significant level. **Therefore, the San Luis Reservoir Expansion Alternative's incremental contribution to the significant cumulative increase in temporary ambient noise levels during construction would be cumulatively considerable pre-mitigation and remain cumulatively considerable post mitigation. Operation of the San Luis Reservoir Expansion Alternative would not contribute to any cumulative temporary or periodic ambient noise effect.**

Operational sources located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would not expose people residing or working in the project area to excessive noise levels. Operation of the California High Speed Rail Project, the San Luis Transmission Project, the San Luis Solar Project and the enlarged reservoir would occur within the San Luis Reservoir Seaplane Base Airport

Land Use Plan. The seaplane base allows water landings of planes on the reservoir. Because of the high sound levels associated with construction equipment, construction workers would be wearing hearing protection in compliance with California OSHA regulations, and no workers would be exposed to excessive noise levels associated with either project. Additionally, neither of the proposed projects would cause new residents or offsite workers to be located within the airport land use plan. **Therefore, the San Luis Reservoir Expansion Alternative would not contribute to any cumulative effect.**

S.3.9.4 Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction activities associated with the Pacheco Reservoir Expansion Alternative could expose sensitive receptors to noise levels in excess of standards established in the local general plan or noise ordinance. Projects that could occur in the same place and time as this alternative and expose sensitive receptors to noise levels in excess of Santa Clara County's noise ordinances include the California High Speed Rail Project and could cause a significant cumulative impact. Other cumulative construction projects expected to occur in the county as a result of projected population growth could result in significant negative impacts to Santa Clara County noise levels.

Construction activities at Pacheco Reservoir would exceed the noise limits for the County of Santa Clara. Implementation of Mitigation Measure NOISE-1 would reduce impacts from the Pacheco Reservoir Expansion Alternative, but it would not be sufficient to reduce the alternative's construction impacts to a less than significant level. **Therefore, with the Implementation of Mitigation Measure NOISE-1, the Pacheco Reservoir Expansion Alternative's incremental contribution to the significant cumulative effect would remain cumulatively considerable.**

Construction activities associated with and operation of the Pacheco Reservoir Expansion Alternative could expose sensitive receptors to excessive groundborne vibration or groundborne noise. Construction projects expected to occur in the county as a result of projected population growth could result in significant negative impacts. Construction of the California High Speed Rail Project could potentially occur at the same time as construction activities near Pacheco Reservoir. Construction and operation of these cumulative projects could result in significant cumulative vibration effects. The Pacheco Reservoir Expansion Alternative's effect on vibration and ground borne would be less than significant, but given the close proximity of alternative's construction area to the cumulative project's construction areas the Pacheco Reservoir construction could contribute to a significant cumulative vibration and ground borne noise impact. This significant cumulative effect would be limited to activities associated with constructing the conveyance tunnel that would connect the new reservoir to the Pacheco Conduit, which could occur adjacent to construction activities associated with the proposed San Jose to Merced alignment of the California High Speed Rail Project. **Pacheco Reservoir**

Expansion Alternative's incremental contribution to the significant cumulative effect would be cumulatively considerable.

Construction activities associated with and operation of the Pacheco Reservoir Expansion Alternative could cause a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project. Noise from construction equipment and construction traffic would occur throughout the construction phase of this alternative. Noise levels at the sensitive receptors would exceed the significance criteria, which would contribute to a substantial temporary increase in ambient noise levels in the project vicinity.

Construction projects expected to occur in the county as a result of projected population growth could result in significant negative impacts. Construction of the California High Speed Rail Project could occur at the same time as construction activities near Pacheco Reservoir and would involve a substantial amount of construction equipment and vehicle traffic that would cause an increase in ambient noise levels in the project vicinity. The Pacheco Reservoir Expansion Alternative's incremental contribution to cumulative ambient noise levels would be significant. Implementation of Mitigation Measure NOISE-1 would reduce construction impacts, but it would not be sufficient to reduce the alternative's construction impacts to a less than significant level. **Therefore, the Pacheco Reservoir Expansion Alternative's incremental contribution to the significant cumulative increase in temporary ambient noise levels during construction would be cumulatively considerable pre-mitigation and remain cumulatively considerable post mitigation.**

The long term operation of the California High Speed Rail Project would produce substantial periodic ambient noise level effects with regular passing trains. Long-term operation of the pump station under Alternative 5 would have a significant impact to noise and vibration that would be **cumulatively considerable pre-mitigation,** although the impact would be reduced through Mitigation Measure NOISE-3 and **therefore would not be cumulatively considerable post-mitigation.**

Operational sources located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would not expose people residing or working in the project area to excessive noise levels. Operation of the Pacheco Reservoir Expansion Alternative would not occur within an airport land use plan. **The operation of the Pacheco Reservoir Expansion Alternative would not contribute to any cumulative effect.**

S.3.10 Traffic and Transportation

S.3.10.1 Alternative 2 - Lower San Felipe Intake Alternative

Construction activities for the Lower San Felipe Intake Alternative (tunnel and pipeline options) in combination with construction activities considered for cumulative impacts could result in degradation of roadway Level of Service (LOS) in the area of analysis. Construction of projects considered for cumulative impacts in Merced County including the B.F. Sisk Dam SOD Modification Project, the California High Speed Rail project, the *San Luis Reservoir SRA RMP/GP* and development projects related to projected growth in the county could create additional construction traffic in the area of analysis during the same time period.

The *San Luis Reservoir SRA RMP/GP* describes that traffic on SR 152 currently exceeds capacity during peak hours and additional development in the region related to the projects proposed at the SRA and development projects related to projected growth in the county would further add to this significant cumulative condition.

The *San Luis Reservoir SRA RMP/GP* notes that as specific projects at the SRA are developed, site-specific environmental analyses would be conducted and mitigation measures would be implemented to reduce impacts to visitor access or circulation on local roads.

Construction truck and worker trips associated with the Lower San Felipe Intake Alternative would not result in a short-term degradation of roadway LOS values. **Given that construction-related traffic increases would be temporary and would not degrade the LOS values of roads in the area of analysis, the alternative's incremental contribution to significant cumulative impacts on traffic flow in the area of analysis would not be cumulatively considerable.**

Construction activities for the Lower San Felipe Intake Alternative (tunnel and pipeline options) in combination with construction activities considered for cumulative impacts could result in temporary traffic safety effects. The presence of additional heavy construction equipment and slower moving traffic on regional and local roads around San Luis Reservoir related to the B.F. Sisk Dam SOD Modification Project, the California High Speed Rail project, the *San Luis Reservoir SRA Draft RMP/GP* and development projects related to projected growth in the county would increase risks related to traffic safety. Some of the alternatives considered in the *San Luis Reservoir SRA RMP/GP* include signage improvements to address existing turning conflicts. Additionally, agencies with jurisdiction over nearby signage and roadways are expected to continue to incorporate roadway improvements over time (Reclamation and CDPR 2013), these would have a beneficial effect on the cumulative condition in the study area but would not reduce the magnitude of

the other cumulative construction actions effect on traffic safety to a less that significant cumulative level.

Construction of the Lower San Felipe Intake Alternative in combination with cumulative construction actions and their associated construction traffic could generate a significant cumulative impact on traffic safety, and this Alternative's incremental contribution to this impact would be cumulatively considerable. Implementation of Mitigation Measure TR-1 would install caution signs at intersections immediately adjacent to construction zones as well as the first transition intersections from residential roadways to arterials and collectors along construction routes warning motorists of slow moving construction traffic, lane closures, implement dust control measures to maintain visibility near the dangerous intersections, and implement construction traffic management actions documented in a Transportation, Community, & System Preservation (TCSP) Program to reduce conflicts during periods of high traffic volume on impacted roadways. Added vehicle trips due to construction of the Lower San Felipe Intake Alternative would be temporary and would not contribute to traffic safety risks once construction is complete. **Thus, with implementation of Mitigation Measure TR-1, the Lower San Felipe Intake Alternative's incremental contribution to significant cumulative impacts on traffic safety would not be cumulatively considerable.**

Construction activities for the Lower San Felipe Intake Alternative (tunnel and pipeline options) in combination with construction activities considered for cumulative impacts could result in reductions of public transit capacity, availability, or performance. There would be no public transit impacts from operation of this alternative; therefore there would be no cumulative effects.

Maintenance of the Lower San Felipe Intake Alternative in combination with projects considered for cumulative impact could result in negative cumulative effects to roadway LOS, traffic safety, and the availability of public transit. The development of new projects related to projected growth in the county could create additional long-term traffic in the area of analysis. The *San Luis Reservoir SRA RMP/GP* describes that traffic on SR 152 currently exceeds capacity during peak hours and **additional development in the region related to the projects proposed at the SRA and development projects related to projected growth in the county would further add to these significant conditions.**

Long-term operation of the Lower San Felipe Intake Alternative would require a maximum of two delivery truck trips per day to provide supplies to the aeration facility. Any other required maintenance would occur on an as-needed basis and would not be expected to result in any large increases in traffic. Maintenance under the Lower San Felipe Intake Alternative would not individually result in long-term increases in traffic. **Therefore, the Lower San Felipe Intake Alternative's incremental contribution to significant**

cumulative impacts on traffic in the area of analysis would not be cumulatively considerable.

S.3.10.2 Alternative 3 - Treatment Alternative

Construction activities for the Treatment Alternative in combination with construction activities considered for cumulative impacts could result in degradation of roadway LOS in the area of analysis. Other development and projected growth in population and associated housing and commercial buildings would generate additional traffic in the area of analysis. The addition of construction-related vehicles associated with development of the Treatment Alternative would not degrade roadway LOS for regional and local roads in the area of analysis. Potential roadway effects would be temporary and less than the Valley Transportation Authority's (VTA's) threshold of one percent of freeway segment's capacity to evaluate freeway segments. **The incremental contribution of construction vehicle trips resulting from the Treatment Alternative on significant cumulative traffic effects would not be cumulatively considerable.**

Construction activities for the Treatment Alternative in combination with construction activities considered for cumulative impacts could result in temporary traffic safety effects. **The presence of slow moving vehicles during construction of the Treatment Alternative could result in significant adverse impacts related to traffic safety, and this Alternative's incremental contribution to this impact would be cumulatively considerable**. Implementation of Mitigation Measure TR-1 would reduce impacts to less than significant. Other construction projects related to residential and commercial growth in the City of San Jose and other urban areas could contribute to adverse traffic safety effects but they would however also be analyzed for impacts at a site-specific level, and significant impacts would be mitigated as a part of local permitting. **Therefore, with implementation of Mitigation Measure TR-1, the Treatment Alternative's contribution to traffic safety impacts in Santa Clara County would be a less than significant cumulative impact.**

Construction activities for the Treatment Alternative in combination with construction activities considered for cumulative impacts could result in reductions of public transit capacity, availability, or performance. Other development and projected growth in population and associated housing and commercial buildings could create congestion that could significantly reduce the performance of public transit in the study area.

Construction equipment and vehicles would be kept off local roads and on SCVWD-owned lands when they are not in transit; therefore, construction activities would not interfere with the public transit facilities and services. Additionally, construction of the Treatment Alternative would not be expected to generate any new demands on public transit services in the study area that would cause reductions in service levels. There are no public transit, bicycle, or

pedestrian facility programs in the area that the Treatment Alternative would conflict with. **Therefore, the alternative's incremental contribution to potentially significant cumulative public transit capacity, availability, or performance impacts would not be cumulatively considerable.**

Maintenance activities under the Treatment Alternative in combination with operations of other projects considered for long-term cumulative impacts could result in negative cumulative effects to roadway LOS, traffic safety, and the availability of public transit. County-wide growth over the next 20 to 25 years would likely cause congestion problems on regional and local roadways. However, VTA, in coordination with local jurisdictions, is simultaneously planning roadway improvements throughout the county. In addition, local growth in the City of San Jose is directed towards pre-determined growth areas in an attempt to create compact development close to public transit (City of San Jose 2011).

Long-term maintenance of new facilities installed at the WTP under the Treatment Alternative would require a maximum traffic increase of one worker per day, and one solid waste disposal truck per day and would have minimal effect on the amount of traffic on roadways in the area of analysis. **The Treatment Alternative's incremental contribution to long-term cumulative traffic and transportation effects would not be cumulatively considerable.**

S.3.10.3 Alternative 4 - San Luis Reservoir Expansion Alternative

Construction activities for the San Luis Reservoir Expansion Alternative in combination with construction activities considered for cumulative impacts could result in degradation of roadway LOS in the area of analysis. Construction of projects considered for cumulative impacts in Merced County including the California High Speed Rail project, the *San Luis Reservoir SRA RMP/GP* and development projects related to projected growth in the county could create additional construction traffic in the area of analysis during the same time period.

The *San Luis Reservoir SRA RMP/GP* describes that traffic on SR 152 currently exceeds capacity during peak hours and additional development in the region related to the projects proposed at the SRA and development projects related to projected growth in the county would further add to this significant cumulative condition.

The *San Luis Reservoir SRA RMP/GP* notes that as specific projects at the SRA are developed, site-specific environmental analyses would be conducted and mitigation measures would be implemented to reduce impacts to visitor access or circulation on local roads.

Construction truck and worker trips associated with the San Luis Reservoir Expansion Alternative would not result in a short-term degradation of roadway

LOS values. **Given that construction-related traffic increases would not degrade the LOS values of roads in the area of analysis, the alternative's incremental contribution to significant cumulative impacts on traffic flow in the area of analysis would not be cumulatively considerable.**

Construction activities for the San Luis Reservoir Expansion Alternative in combination with construction activities considered for cumulative impacts could result in temporary traffic safety effects. The presence of additional heavy construction equipment and slower moving traffic on regional and local roads around San Luis Reservoir related to the California High Speed Rail project, the *San Luis Reservoir SRA RMP/GP* and development projects related to projected growth in the county would increase risks related to traffic safety. Some of the alternatives considered in the *San Luis Reservoir SRA RMP/GP* include signage improvements to address existing turning conflicts. Additionally, agencies with jurisdiction over nearby signage and roadways are expected to continue to incorporate roadway improvements over time, these cumulative construction actions contribute to a significant cumulative traffic safety effect.

Construction of the San Luis Reservoir Expansion Alternative in combination with cumulative construction actions and their associated construction traffic would generate a significant cumulative impact on traffic safety, and this Alternative's incremental contribution to this impact would be cumulatively considerable. Implementation of Mitigation Measure TR-1 would install caution signs at intersections immediately adjacent to construction zones as well as the first transition intersections from residential roadways to arterials and collectors along construction routes warning motorists of slow moving construction traffic, lane closures, implement dust control measures to maintain visibility near the dangerous intersections, and implement construction traffic management actions documented in a TCSP to reduce conflicts during periods of high traffic volume on impacted roadways. Added vehicle trips due to construction of the San Luis Reservoir Expansion Alternative would not contribute to traffic safety risks once construction is complete. **Thus, with implementation of Mitigation Measure TR-1, the San Luis Reservoir Expansion Alternative's incremental contribution to significant cumulative impacts on traffic safety would not be cumulatively considerable.**

Construction activities for the San Luis Reservoir Expansion Alternative in combination with construction activities considered for cumulative impacts could not result in reductions of public transit capacity, availability, or performance. **There would be no public transit impacts from operation of this alternative; therefore there would be no cumulative effects.**

Maintenance of the San Luis Reservoir Expansion Alternative in combination with projects considered for cumulative impact could result in cumulative effects to roadway LOS, traffic safety, and the availability of public transit.

Since there will no increase in long-term trips associated with the San Luis Reservoir Expansion Alternative, **no cumulative impacts would be involved during the operations phase of the San Luis Reservoir Expansion Alternative**.

S.3.10.4 Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction activities for the Pacheco Reservoir Expansion Alternative in combination with construction activities considered for cumulative impacts could result in degradation of roadway LOS in the area of analysis. Construction of projects considered for cumulative impacts in Merced County including the B.F. Sisk Dam SOD Modification Project, the California High Speed Rail project, the *San Luis Reservoir SRA RMP/GP* and development projects related to projected growth in the county could create additional construction traffic in the area of analysis during the same time period.

The *San Luis Reservoir SRA RMP/GP* describes that traffic on SR 152 is nearing capacity during peak hours east of Gilroy and on the eastbound ascent to Pacheco Pass, and additional development in the region related to the projects proposed at the SRA and development projects related to projected growth in the county would further add to this significant cumulative condition.

The *San Luis Reservoir SRA RMP/GP* notes that as specific projects at the SRA are developed, site-specific environmental analyses would be conducted and mitigation measures would be implemented to reduce impacts to visitor access or circulation on local roads.

Construction truck and worker trips associated with the Pacheco Reservoir Expansion Alternative would not result in a short-term degradation of roadway LOS values. **Given that construction-related traffic increases would not degrade the LOS values of roads in the area of analysis, the alternative's incremental contribution to significant cumulative impacts on traffic flow in the area of analysis would not be cumulatively considerable.**

Construction activities for the Pacheco Reservoir Expansion Alternative in combination with construction activities considered for cumulative impacts could result in temporary traffic safety effects. The presence of additional heavy construction equipment and slower moving traffic on regional and local roads around San Luis Reservoir related to the B.F. Sisk Dam SOD Modification Project, the California High Speed Rail project, the *San Luis Reservoir SRA RMP/GP* and development projects related to projected growth in the county would increase risks related to traffic safety. Some of the alternatives considered in the *San Luis Reservoir SRA RMP/GP* include signage improvements to address existing turning conflicts. Additionally, agencies with jurisdiction over nearby signage and roadways are expected to continue to incorporate roadway improvements over time, these cumulative construction actions contribute to a significant cumulative traffic safety effect.

Construction of the Pacheco Reservoir Expansion Alternative in combination with cumulative construction actions and their associated construction traffic would generate a significant cumulative impact on traffic safety, and this Alternative's incremental contribution to this impact would be cumulatively considerable. Implementation of Mitigation Measure TR-1 would install caution signs at intersections immediately adjacent to construction zones as well as the first transition intersections from residential roadways to arterials and collectors along construction routes warning motorists of slow moving construction traffic, lane closures, implement dust control measures to maintain visibility near the dangerous intersections, and implement construction traffic management actions documented in a TCSP to reduce conflicts during periods of high traffic volume on impacted roadways. Added vehicle trips due to construction of the Pacheco Reservoir Expansion Alternative would not contribute to traffic safety risks once construction is complete. **Thus, with implementation of Mitigation Measure TR-1, the Pacheco Reservoir Expansion Alternative's incremental contribution to significant cumulative impacts on traffic safety would not be cumulatively considerable.**

Construction activities for the Pacheco Reservoir Expansion Alternative in combination with construction activities considered for cumulative impacts could not result in reductions of public transit capacity, availability, or performance. **There would be no public transit impacts from construction or operation of this alternative; therefore there would be no cumulative effects.**

Maintenance of the Pacheco Reservoir Expansion Alternative in combination with projects considered for cumulative impact could result in cumulative effects to roadway LOS, traffic safety, and the availability of public transit. Since there will no increase in long-term trips associated with the Pacheco Reservoir Expansion Alternative, **no cumulative impacts would be involved during the operations phase of the Pacheco Reservoir Expansion Alternative**.

S.3.11 Hazards and Hazardous Materials

S.3.11.1 Alternative 2 - Lower San Felipe Intake Alternative

Construction and operation of the Lower San Felipe Intake Alternative could increase the risk of exposure from hazardous materials, contaminated soil and/or groundwater to the public and construction workers. Construction of the alternative could also conflict with sea plane maneuvers on San Luis Reservoir and operations at the San Luis Reservoir Sea Plane Base, increase the risk of wildfire within the vicinity of the project area, and temporarily interfere with an emergency response plan or emergency evacuation plan. Implementation of the Lower San Felipe Intake Alternative could result in the accidental release of and exposure of construction workers and the general public to hazardous materials

and potentially increase hazard levels in study area by conflicting with operations at the San Luis Reservoir Sea Plane Base, increasing the risk of wildfire or conflicting with emergency response. These effects were determined to all be either less than significant or would be lowered to a less than significant level with the implementation of mitigation measures.

The *San Luis Reservoir SRA RMP/GP* has been identified as a cumulative plan and the B.F. Sisk Dam SOD Modification Projec,t the San Luis Solar Project and the San Luis Transmission Project have been as cumulative projects that could contribute to hazards and hazardous materials effects during the construction of the Lower San Felipe Intake.

Construction of trails as a part of the *San Luis Reservoir SRA RMP/GP*, development of the San Luis Solar Project and the San Luis Transmission Project would be expected to require construction equipment which could require the use of motor oil, gasoline, diesel fuel, solvents and degreasers similar to those required for construction of the Lower San Felipe Intake Alternative. However, a SWPPP is required by the RWQCB for approval of a General Construction Permit under the NPDES Program. This permit, similar to the SWPPP required for the Lower San Felipe Intake Alternative, would require safety measures and BMPs to be implemented when transporting, storing or using hazardous materials.

Similar to the Lower San Felipe Intake Alternative, SR 152 would be the main site access for trucks, light equipment and construction worker access to the Park Plan trail construction areas, the B.F. Sisk Dam SOD Modification Project, the San Luis Solar Project and the San Luis Transmission Project. If the Park Plan trails, the B.F. Sisk Dam SOD Modification Project, the San Luis Solar Project or the San Luis Transmission Project are constructed at the same time as the Lower San Felipe Intake Alternative this construction traffic could conflict with emergency response and evacuation plans for the State Responsibility Area a potentially significant cumulative effect. Construction of the trails, the B.F. Sisk Dam SOD Modification Project, the San Luis Solar Project or the San Luis Transmission Project at a time different than the Lower San Felipe Intake Alternative would eliminate the potential for construction traffic conflict with emergency response and evacuation plans for the State Responsibility Area.

The *2030 Merced County General Plan – Background Report* identified the San Luis Reservoir area as a region at moderate or high risk for wildfire. Sparks could be generated while using mechanical equipment during construction of the Park Plan trails, the San Luis Solar Project or the San Luis Transmission Project, which could cause a wildfire, a potentially significant cumulative effect.

The construction and operation of the Lower San Felipe Intake Alternative in combination with these cumulative actions could result in significant cumulative impacts on hazards and hazardous materials, and this

Alternative's contribution to these impacts would be cumulatively considerable. The implementation of mitigation measures to reduce the severity of the alternative's potential for significant impacts from encountering contaminated soil, conflicting with airbase operations, increasing wildfire risk and conflicting with emergency response would be reduced to a less than significant. **Therefore, with implementation of Mitigation Measures HAZ-1, HAZ-2, HAZ-3, HAZ-4, and TR-1, the Lower San Felipe Intake Alternative's incremental contribution to significant cumulative effects on hazards and hazardous materials would not be cumulatively considerable.**

S.3.11.2 Alternative 3 - Treatment Alternative

Construction of the Treatment Alternative and operation of proposed facilities could increase the risk of hazardous situations or exposure to hazardous materials which could have adverse cumulative effects to the public and construction workers.

Construction of the Treatment Alternative would involve the transport, storage, and use of hazardous materials. The BMPs required by the SWPPP that will be prepared prior to construction of the Treatment Alternative would decrease erosion rates and delivery of sediments along with any other resident pollutants to surface waters through the use of mechanisms including stockpile covering, fill material compaction, construction vehicle washing and revegetation would limit the potential for any inadvertent release of hazardous materials during construction. Operation of new SCVWD facilities also requires the use, transport, storage and disposal of hazardous materials. The updated Business Plan for the Santa Teresa WTP that would be prepared in accordance with the California Environmental Protection Agency (CalEPA) Unified Program for the transport and handling of hazardous materials would outline the required procedures to respond to a spill or accidental release to contain a spill and the necessary steps to protect workers and the public from exposure would contain the impact of any inadvertent spills to the WTP site and limit the potential to contribute to any cumulative effect.

Other cumulative projects that could also have impacts related to hazards and hazardous materials in the study area would include ongoing residential and commercial development generated by forecasted population growth. Some potential projects that could occur at the same time as implementation of the Treatment Alternative include the Young Ranch Residential Project, Equinix Data Center, and Blanchard Road Warehouse/Distribution Center. These projects, along with other development in the area, could generate hazardous situations or expose the public to hazardous materials. **Together, these cumulative projects could result in significant cumulative effects associated with hazardous situations and hazardous material exposure during construction, but the Treatment Alternative's incremental contribution to this effect would not be cumulatively considerable**.

S.3.11.3 Alternative 4 - San Luis Reservoir Expansion Alternative

Construction and operation of the San Luis Reservoir Expansion Alternative could increase the risk of exposure from hazardous materials, contaminated soil and/or groundwater to the public and construction workers. Construction of the alternative could also conflict with sea plane maneuvers on San Luis Reservoir and operations at the San Luis Reservoir Sea Plane Base, increase the risk of wildfire within the vicinity of the project area, and temporarily interfere with an emergency response plan or emergency evacuation plan. Implementation of the San Luis Reservoir Expansion Alternative could result in the accidental release of and exposure of construction workers and the general public to hazardous materials and potentially increase hazard levels in study area by conflicting with operations at the San Luis Reservoir Sea Plane Base, increasing the risk of wildfire or conflicting with emergency response. These effects were determined to all be either less than significant or would be lowered to a less than significant level with the implementation of mitigation measures.

Similar to the analysis presented above for the Lower San Felipe Intake Alternative, the *San Luis Reservoir SRA RMP/GP* has been identified as a cumulative plan and the San Luis Solar Project and the San Luis Transmission Project have been as cumulative projects that could contribute to hazards and hazardous materials effects during the construction of the San Luis Reservoir Expansion Alternative.

Construction of trails as a part of the *San Luis Reservoir SRA RMP/GP*, development of the San Luis Solar Project and the San Luis Transmission Project would be expected to require construction equipment which could require the use of motor oil, gasoline, diesel fuel, solvents and degreasers similar to those required for construction of the San Luis Reservoir expansion. However, a SWPPP is required by the Regional Water Quality Control Board (RWQCB) for approval of a General Construction Permit under the National Pollutant Discharge Elimination System (NPDES) Program. This permit, similar to the SWPPP required for the San Luis Reservoir expansion, would require safety measures and BMPs to be implemented when transporting, storing or using hazardous materials.

Similar to the San Luis Reservoir Expansion Alternative, SR 152 would be the main site access for trucks, light equipment and construction worker access to the Park Plan trail construction areas, San Luis Solar Project and the San Luis Transmission Project. If the Park Plan trails, the San Luis Solar Project or the San Luis Transmission Project are constructed at the same time as the San Luis Reservoir expansion this construction traffic could conflict with emergency response and evacuation plans for the State Responsibility Area a potentially significant cumulative effect. Construction of the trails, the San Luis Solar Project or the San Luis Transmission Project at a time different than the San Luis Reservoir expansion would eliminate the potential for construction traffic conflict with emergency response and evacuation plans for the State Responsibility Area.

The *2030 Merced County General Plan – Background Report* identified the San Luis Reservoir area as a region at moderate or high risk for wildfire. Sparks could be generated while using mechanical equipment during construction of the Park Plan trails, the San Luis Solar Project or the San Luis Transmission Project, which could cause a wildfire, a potentially significant cumulative effect.

The construction and operation of the San Luis Reservoir Expansion Alternative in combination with these cumulative actions could result in significant cumulative impacts on hazards and hazardous materials and this Alternative's contribution to these impacts would be cumulatively considerable. The implementation of mitigation measures to reduce the severity of the alternative's potential for significant impacts from encountering contaminated soil, conflicting with airbase operations, increasing wildfire risk and conflicting with emergency response would be reduced to a less than significant. **Therefore, with implementation of Mitigation Measures HAZ-1, HAZ-2, HAZ-3, HAZ-4, HAZ-5, and TR-1, the San Luis Reservoir Expansion Alternative's incremental contribution to significant cumulative effects in the Merced County - San Luis Reservoir Region on hazards and hazardous materials would not be cumulatively considerable.**

S.3.11.4 Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction and operation of the Pacheco Reservoir Expansion Alternative could increase the risk of exposure from hazardous materials to the public and construction workers. Construction of the alternative could also increase the risk of wildfire within the vicinity of the project area, and temporarily interfere with an emergency response plan or emergency evacuation plan.
Implementation of the Pacheco Reservoir Expansion Alternative could result in the accidental release of and exposure of construction workers and the general public to hazardous materials and potentially increase the risk of wildfire or conflict with emergency response. These effects were determined to be either less than significant or would be lowered to a less than significant level with the implementation of mitigation measures.

The other cumulative projects are not in the immediate vicinity of the expanded Pacheco Reservoir such that hazards or hazardous materials may interact. **Therefore, the Pacheco Reservoir Expansion Alternative would not result in a cumulative significant impact related to hazards and hazardous materials.**

Similar to the San Luis Reservoir Expansion Alternative, SR 152 would be the main site access for trucks, light equipment and construction worker access to the Park Plan trail construction areas, the B.F. Sisk Dam SOD Modification Project, the San Luis Solar Project and the San Luis Transmission Project. If the Park Plan trails, the San Luis Solar Project or the San Luis Transmission Project are constructed at the same time as the San Luis Reservoir expansion

this construction traffic could conflict with emergency response and evacuation plans for the State Responsibility Area a potentially significant cumulative effect. Construction of the trails, the B.F. Sisk Dam SOD Modification Project, the San Luis Solar Project or the San Luis Transmission Project at a time different than the San Luis Reservoir expansion would eliminate the potential for construction traffic conflict with emergency response and evacuation plans for the State Responsibility Area.

The *2030 Merced County General Plan – Background Report* identified the San Luis Reservoir area as a region at moderate or high risk for wildfire. Sparks could be generated while using mechanical equipment during construction of the Park Plan trails, the B.F. Sisk Dam SOD Modification Project, the San Luis Solar Project or the San Luis Transmission Project, which could cause a wildfire, a potentially significant cumulative effect.

The construction and operation of the Pacheco Reservoir Expansion Alternative in combination with these cumulative actions could result in significant cumulative impacts on hazards and hazardous materials and this Alternative's contribution to these impacts would be cumulatively considerable. The implementation of mitigation measures to reduce the severity of the alternative's potential for significant impacts from encountering contaminated soil, conflicting with airbase operations, increasing wildfire risk and conflicting with emergency response would be reduced to a less than significant. **Therefore, with implementation of Mitigation Measures HAZ-1, HAZ-2, HAZ-3, HAZ-4, HAZ-5, and TR-1, the Pacheco Reservoir Expansion Alternative's incremental contribution to significant cumulative effects in the Merced County - San Luis Reservoir Region on hazards and hazardous materials would not be cumulatively considerable.**

S.3.12 Aquatic Resources

S.3.12.1 Alternative 2 - Lower San Felipe Intake Alternative

Construction activities could destroy or adversely affect aquatic habitats for special-status fish species. Construction of the Lower San Felipe Intake Alternative could result in temporary impacts on aquatic habitats for fish species from clearing, grading, staging of equipment, and other ground-disturbing activities. With the implementation of Mitigation Measure BIO-1 to avoid or reduce impacts on watercourses, wetlands, riparian areas, and other sensitive habitats during construction potential impacts to affect aquatic habitats for special-status fish species were determined to be less than significant.

The B.F. Sisk Dam SOD Modification Project would include construction activities at San Luis Reservoir similar to the Lower San Felipe Intake Alternative, and would include similar mitigation proposed in Mitigation Measure BIO-1 (Reclamation and DWR 2019). Other cumulative projects that could also have impacts on aquatic habitat conditions include State Water

Project Supply Allocation Settlement Agreement, Los Vaqueros Reservoir Expansion Project, and the San Joaquin River Restoration Program. These effects on aquatic habitat conditions would be localized to the action areas for each of those cumulative projects and would not be anticipated to affect habitat conditions in San Luis Reservoir. **Therefore, the Lower San Felipe Intake Alternative's incremental contribution to significant cumulative effects on aquatic habitats for special-status fish species would not be cumulatively considerable.**

Operation of a Lower San Felipe Intake could result in impacts to aquatic habitats for special-status fish species. Operation of the Lower San Felipe Intake Alternative would allow the San Felipe Division to draw water from San Luis Reservoir at the same elevation as the Gianelli Intake. Operations of the reservoir would be generally the same as under the No Project. CalSim II modeling results indicate that changes in Delta operations of the CVP and SWP would be very small (see Appendix B for a summary of this analysis).

Other cumulative projects that could also have impacts on aquatic habitat conditions include State Water Project Supply Allocation Settlement Agreement, Los Vaqueros Reservoir Expansion Project, and the San Joaquin River Restoration Program. These projects, if implemented, would influence operations in the Delta at the same time as the Lower San Felipe Intake Alternative. **Together, these projects and the Lower San Felipe Intake Alternative could result in significant cumulative effects on aquatic habitats for special-status fish species in the Delta.**

Modeling results indicate that, on average, operation of the Lower San Felipe Intake would result in very slight changes (<1%) to Delta hydrology, hydrodynamics, and water quality resulting from changes in Delta operations of the CVP and SWP. During most years, Delta conditions would be unchanged. **Therefore, the Lower San Felipe Intake Alternative's incremental contribution to significant cumulative effects on special-status fish species and their habitat would not be cumulatively considerable.**

S.3.12.2 Alternative 3 - Treatment Alternative

Impacts to aquatic habitats and the fish community were considered for the Treatment Alternative; however, all impacts from construction were determined to be "No Impact" are not included in the cumulative effects analysis for this alternative. The cumulative effect of operating the Treatment Alternative would be the same as the Lower San Felipe Intake Alternative.

S.3.12.3 Alternative 4 - San Luis Reservoir Expansion Alternative

Operation of a San Luis Reservoir Expansion Alternative could result in impacts to aquatic habitats and special-status fish species in the Delta. San Luis Reservoir Expansion Alternative operation could result in changes to CVP

and SWP operations in the Delta, which, in turn, could result in changes to hydrological indicators for habitat, including Sacramento River flow, the position of LSZ (X2), Delta outflows, Old and Middle river flows, and Delta exports. A description of each of these hydrologic indicators is provided below.

Sacramento River Flows

As discussed above, flow within the Sacramento River has been identified as an important factor affecting the survival of emigrating juvenile Chinook salmon, important to the downstream transport of planktonic fish eggs and larvae, such as delta smelt and longfin smelt, and important for seasonal floodplain inundation that has been identified as important habitat for successful seasonal foraging habitat for juvenile Chinook salmon and steelhead. Sacramento River flows are also important in the transport of organic material and nutrients from the upper regions of the watershed downstream into the Delta. While flows in the lower Sacramento River and Delta are highly altered compared to natural regimes, they are managed consistent with regulatory requirements (USFWS 2008, NMFS 2009) to provide essential habitat elements for a variety of species and ecological processes, including those described above.

Low Salinity Zone (X2)

The linkage between river inflow and the low salinity zone (LSZ) is referred to as X2, the distance along the main channel (usually in km) from the Golden Gate Bridge to the point where the salinity on the bottom is 2 ppt (Nobriga et al. 2008). Delta outflow largely determines the location of X2 and the LSZ, an area that historically had high prey densities and other favorable habitat conditions for rearing delta smelt (Kimmerer 2004). The LSZ is believed to provide the best combination of habitat conditions when X2 is located downstream from the confluence of the Sacramento and San Joaquin rivers (Kimmerer 2004). When Delta outflow is low, X2 is located in the relatively narrow channels of these rivers, whereas at higher outflows it moves downstream into more open waters (Kimmerer 2004).

Delta Outflow

Seasonal flows represented by Delta outflow influence the transport of eggs and young organisms (e.g., zooplankton, fish eggs, larvae) through the Delta and into San Francisco Bay. Flows during the months of April, May, and June play an especially important role in determining the reproductive success and survival of many estuarine species, including salmon, striped bass, American shad, delta smelt, longfin smelt, splittail, and others (Stevens et al. 1985, Meng and Moyle 1995).

Old and Middle River Flows

Reverse flows in Old and Middle rivers, resulting from low San Joaquin River inflows and increased exports to the CVP and SWP, have been identified as a

potential cause of increased delta smelt mortality at the CVP and SWP fish facilities within recent years (Simi and Ruhl 2005, Ruhl et al. 2006). Results of analyses of the relationship between the magnitude of reverse flows in Old and Middle rivers and salvage of adult delta smelt in the late winter shows a substantial increase in salvage as reverse flows exceed approximately -5,000 cfs. Concerns regarding reverse flows in Old and Middle rivers have also focused on planktonic egg and larval stages of striped bass, splittail, and on Chinook salmon and steelhead smolts, in addition to delta smelt, and while these species do not spawn to a large extent in the south Delta, eggs and larvae may be transported into the area by reverse flows in Old and Middle rivers. As discussed previously, these early life stages are generally entrained, because they are too small to be effectively screened from export waters.

Delta Exports

As described above, fish are vulnerable to entrainment in flows leading to the CVP and SWP water export facilities in the south Delta. Although fish facilities associated with the export facilities are designed to salvage fish from the water and return them to the estuary, the salvage process is not very efficient; many salmon and other fish are lost to predation in the waterways leading to the fish facilities; and delta smelt are inefficiently concentrated by the fish facilities and it is unlikely that many survive the salvage process (USFWS 2008, NMFS 2009). While the effectiveness of the salvage operations at the south Delta facilities is relatively low, it has improved in recent years, and measures are being implemented to further improve effectiveness in the future (USFWS 2008, NMFS 2009). General improvements implemented to the south Delta export facilities are expected to reduce entrainment losses and improve salvage of special status fish species through the implementation of the 2009 NMFS and 2008 USFWS BO requirements particularly the reverse Old and Middle Rivers (OMR) flow criteria, court-ordered restrictions on water operations, improvements at the fish facilities, and other actions taken by the water project operators (USFWS 2008, NMFS 2009).

Cumulative projects that could also have impacts on hydrologic and associated aquatic habitat conditions in the Delta include State Water Project Supply Allocation Settlement Agreement, Los Vaqueros Reservoir Expansion Project, and the San Joaquin River Restoration Program. These projects, if implemented, would influence hydrologic and associated habitat conditions in the Delta at the same time as the San Luis Reservoir Expansion Alternative.

Hydrology, hydrodynamics, and/or water quality in the Delta are highly altered compared to natural regimes and they are managed consistent with regulatory requirements (USFWS 2008, NMFS 2009) to minimize adverse effects while also considering water supply demands. Any new diversions or other water operation changes that have the potential to affect aquatic habitats in the Delta would also be required to operate consistent with regulatory requirements.

Modeling results indicate that, on average, operation of the San Luis Reservoir Expansion Alternative would result in small changes to Delta hydrology, hydrodynamics, and water quality and associated habitat conditions (see Appendix B for detailed modeling results). During most months of most years, Delta conditions would be unchanged. While any potential effect could be considered significant, the Smelt Working Group and the Delta Operations for Salmonids and Sturgeon (DOSS) group work with USFWS, NMFS, DWR, California Department of Fish and Wildlife (CDFW), and Reclamation to avoid reaching the actual take limit at the CVP and SWP facilities and reductions in exports or full stoppage of exports to avoid hitting the take limits established by USFWS and NMFS in the BOs and CDFW in the longfin smelt incidental take permit (ITP) would occur. **Therefore, the San Luis Reservoir Expansion Alternative's incremental contribution to significant cumulative effects on special-status fish species and their habitat would not be cumulatively considerable.**

S.3.12.4 Alternative 5 - Pacheco Reservoir Expansion Alternative

Operation of the Pacheco Reservoir Expansion Alternative could result in impacts to aquatic habitats and special-status fish species in the Delta. The Pacheco Reservoir Expansion Alternative operation could result in changes to CVP and SWP operations in the Delta and flows on Pacheco Creek.

In the Delta, cumulative projects that could also have impacts on hydrologic and associated aquatic habitat conditions include SWP Supply Allocation Settlement Agreement, Los Vaqueros Reservoir Expansion Project, and the San Joaquin River Restoration Program. These projects, if implemented, would influence hydrologic and associated habitat conditions in the Delta at the same time as the Pacheco Reservoir Expansion Alternative.

Hydrology, hydrodynamics, and/or water quality in the Delta are highly altered compared to natural regimes and they are managed consistent with regulatory requirements (USFWS 2008, NMFS 2009) to minimize adverse effects while also considering water supply demands. Any new diversions or other water operation changes that have the potential to affect aquatic habitats in the Delta would also be required to operate consistent with regulatory requirements.

Modeling results indicate that, on average, operation of the Pacheco Reservoir Expansion Alternative would result in small changes to Delta hydrology, hydrodynamics, and water quality and associated habitat conditions. During most months of most years, Delta conditions would be unchanged. While any potential effect could be considered significant, the Smelt Working Group and the DOSS group work with USFWS, NMFS, DWR, CDFW, and Reclamation to avoid reaching the actual take limit at the CVP and SWP facilities and reductions in exports or full stoppage of exports to avoid hitting the take limits established by USFWS and NMFS in the BOs and CDFW in the longfin smelt ITP would occur. **Therefore, the Pacheco Reservoir Expansion**

Alternative's incremental contribution to significant cumulative effects on special-status fish species and their habitat would not be cumulatively considerable.

Operation of the Pacheco Reservoir Expansion Alternative could result in impacts to aquatic habitats and special-status fish species in the Pajaro River Watershed. The Pacheco Reservoir Reoperation Project would provide steelhead habitat restoration in Pacheco Creek, downstream of the reservoir. This would be a beneficial impact. The Pacheco Reservoir Expansion Alternative operation could result in the introduction of Delta water into Pacheco Creek has the potential to introduce harmful invasive fish species, including striped bass, that may compete or prey upon listed South-Central California Coast Steelhead. Also, the release of CVP water could cause the introduction of non-native invertebrates (clams, mussels) or aquatic plant species that may alter the food-web of Pacheco Creek or Pajaro River. Construction and operation of the expanded Pacheco Reservoir could cause short and long-term direct or indirect impacts to South-Central California Coast Steelhead and their habitat further contributing to their threatened status given adverse significant cumulative conditions on Pacheco Creek caused by low water flow and habitat loss. In addition, the introduction of out-of-basin CVP water from the Delta may hinder the imprinting of juvenile steelhead on water from Pacheco Creek or Pajaro River, thereby affecting the homing behavior of adults returning to spawn. **This impact would be cumulatively considerable.**

While the introduction of Delta water into Pacheco Creek may negatively impact South-Central California Coast steelhead downstream by potentially affecting the imprinting of juveniles or through the introduction of non-native invasive species, the improved habitat quality resulting from the increased releases on Pacheco Creek proposed under Alternative 5 are anticipated to outweigh any potential negative impacts from imprinting. Following construction, with the implementation of Mitigation Measurses BIO-1 and BIO-2, Alternative 5 would improve conditions on Pacheco Creek with increased creek flows beneficial to aquatic resources downstream of the expanded reservoir. **Therefore, with the implementation of the incremental contribution to significant cumulative effects on aquatic resources, although cumulatively considerable pre-mitigation, would not be cumulatively considerable post-mitigation.**

S.3.13 Terrestrial Resources

S.3.13.1 Alternative 2 - Lower San Felipe Intake Alternative

Construction activities could destroy or adversely affect sensitive habitats including wetland and riparian vegetation communities. Construction activities for the Lower San Felipe Intake Alternative could result in impacts on wetland riparian vegetation communities at the San Luis Reservoir. Alternatives described in the *San Luis Reservoir SRA RMP/GP*, the B.F. Sisk Dam SOD

Modification Project, the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could also have impacts on wetland and riparian vegetation communities at the San Luis Reservoir, and could occur at the same time as the Lower San Felipe Intake Alternative. **Together, these projects and the Lower San Felipe Intake Alternative could result in significant cumulative effects associated with loss or adverse modification of wetland and riparian habitats.**

Mitigation Measure TERR-1 through Mitigation Measure TERR-16 outline requirements for the protection of special status plant species and special-status natural communities, and outline requirements for sensitive habitat and wetland surveys, avoidance requirements, and compensatory mitigation requirements to address impacts to sensitive wetland and riparian habitats. Mitigation Measure TERR-15 outlines requirements for the avoidance of wetlands whenever practicable, the use of fencing used to delineate waters of the U.S. and waters of the State within and adjacent to construction areas that cannot be directly filled, and to identify these areas as sensitive habitat prior to the start of construction to prevent unintended trampling of wetland vegetation by construction personnel and equipment. Mitigation Measure TERR-16 further requires that areas disturbed by construction would be replanted with native plants to minimize erosion. This mitigation would reduce impacts to previously unidentified sensitive habitats to a less-than-significant level. **With implementation of Mitigation Measures TERR-1 through TERR-16, the Lower San Felipe Intake Alternative's incremental contribution to significant cumulative effects on wetland and riparian habitats would not be cumulatively considerable.**

Construction activities could kill, harm, or disturb terrestrial wildlife, including special-status species, or their habitats. Construction activities for the Lower San Felipe Intake Alternative could result in impacts on special-status wildlife or their habitat at the San Luis Reservoir. Alternatives described in the *San Luis Reservoir SRA RMP/GP,* the B.F. Sisk Dam SOD Modification Project, the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could also have impacts on special-status wildlife or habitat at the San Luis Reservoir, and could occur at the same time as the Lower San Felipe Intake Alternative. **Together, these projects and the Lower San Felipe Intake Alternative could result in significant cumulative effects on special-status wildlife with potential to occur at the San Luis Reservoir.**

Mitigation Measures TERR-1 through TERR-15 outline requirements for special habitat and species surveys, avoidance requirements, and species specific compensatory mitigation requirements to address unavoidable impacts to habitats. This mitigation would reduce impacts to previously unidentified special status wildlife to a less-than-significant level. **With implementation of Mitigation Measures TERR-1 through TERR-14, the Lower San Felipe Intake Alternative's incremental contribution to significant cumulative effects on special-status wildlife would not be cumulatively considerable.**

Construction activities could disturb nesting migratory birds, including raptors. Construction activities for the Lower San Felipe Intake Alternative could result in impacts on migratory birds if construction occurs during nesting season and/or results in destruction of nesting habitat for migratory birds. Alternatives described in the *San Luis Reservoir SRA RMP/GP*, the B.F. Sisk Dam SOD Modification Project, the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could also have impacts on migratory birds or habitat at the San Luis Reservoir, and could occur at the same time as the Lower San Felipe Intake Alternative. **Together, these projects and the Lower San Felipe Intake Alternative could result in significant cumulative effects on migratory birds and raptors at the San Luis Reservoir.**

However, the Lower San Felipe Intake Alternative would implement Mitigation Measures TERR-6 through TERR-10 to avoid or reduce effects to migratory birds. **Therefore, with implementation of Mitigation Measures TERR-6 through TERR-10, the Lower San Felipe Intake Alternative's incremental contribution to significant cumulative effects on migratory birds would not be cumulatively considerable.**

Construction activities could destroy or adversely affect special-status plant species. Construction activities for the Lower San Felipe Intake Alternative could result in impacts on special-status plants at the San Luis Reservoir. Alternatives described in the *San Luis Reservoir SRA RMP/GP*, the B.F. Sisk Dam SOD Modification Project, the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could also have impacts on special-status plants at the San Luis Reservoir, and could occur at the same time as the Lower San Felipe Intake Alternative. **Together, these projects and the Lower San Felipe Intake Alternative could result in significant cumulative effects on special-status plants at the San Luis Reservoir.**

Mitigation Measure TERR-1 outlines requirements for sensitive habitat and species surveys, species specific avoidance requirements, and species specific compensatory mitigation requirements to address unavoidable impacts to habitats. This mitigation would reduce impacts to previously unidentified special status plant species to a less-than-significant level. **Therefore with the implementation of Mitigation Measure TERR-1, as appropriate, the Lower San Felipe Intake Alternative's incremental contribution to significant cumulative effects on special-status plants would not be cumulatively considerable.**

Construction activities could result in conflicts with local policies or ordinances protecting biological resources. The Merced County General Plan includes objectives and policies to preserve and protect biologic resources in the County. These include provisions to preserve existing and increase the overall acreage of protected lands in the County, and the designation of buffers around and

protection of wetlands. **Together these projects and the Lower San Felipe Intake Alternative could generate significant impacts on terrestrial wildlife and vegetation.** Mitigation Measures TERR-1 through 16 are required as a part of implementation of a Lower San Felipe Intake Alternative to reduce these potential impacts to terrestrial wildlife and vegetation including wetlands during construction near the San Luis Reservoir shoreline to a less than significant level. **Therefore, with implementation of Mitigation Measures TERR-1 through 16 the Lower San Felipe Intake Alternative's incremental contribution to significant cumulative effects on local policies or ordinances protecting biological resources would not be cumulatively considerable.**

S.3.13.2 Alternative 3 - Treatment Alternative

Construction activities could disturb nesting migratory birds, including raptors. Construction of the Treatment Alternative would not impact other terrestrial biological resources, but could have impacts on migratory birds, including raptors, if active nests are disturbed during construction. The implementation of Mitigation Measures BIO-1 and TERR-6 would minimize the potential for adverse effects. No other cumulative activities or projects have been identified that would take place at the same time as construction of the Treatment Alternative that would impact migratory birds in the vicinity of the Santa Teresa WTP. **Therefore, there would be no significant cumulative effects.**

S.3.13.3 Alternative 4 - San Luis Reservoir Expansion Alternative

Construction activities could destroy or adversely affect sensitive habitats including wetland and riparian vegetation communities. Construction activities for the San Luis Reservoir Expansion Alternative could result in impacts on wetland riparian vegetation communities at the San Luis Reservoir. Alternatives described in the *San Luis Reservoir SRA RMP/GP*, the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could also have impacts on wetland and riparian vegetation communities at the San Luis Reservoir, and could occur at the same time as the San Luis Reservoir expansion. **Together, these projects and the San Luis Reservoir Expansion Alternative could result in significant cumulative effects associated with loss or adverse modification of wetland and riparian habitats.**

However, the San Luis Reservoir expansion would implement Mitigation Measure TERR-16 which requires the avoidance of wetlands whenever practicable, the use of fencing used to delineate waters of the U.S. and waters of the State within and adjacent to construction areas that cannot be directly filled, and to identify these areas as sensitive habitat prior to the start of construction to prevent unintended trampling of wetland vegetation by construction personnel and equipment. Mitigation Measure TERR-16 further requires that areas disturbed by construction would be replanted with native plants to minimize erosion. This mitigation would reduce impacts to previously

unidentified sensitive habitats to a less-than-significant level. **With implementation of Mitigation Measure TERR-16, the San Luis Reservoir expansion's incremental contribution to significant cumulative effects on wetland and riparian habitats would not be cumulatively considerable.**

Construction activities could kill, harm, or disturb terrestrial wildlife, including special-status species, or their habitats. Construction activities for the San Luis Reservoir Expansion Alternative could result in impacts on special-status wildlife or their habitat at the San Luis Reservoir. Alternatives described in the *San Luis Reservoir SRA RMP/GP*, the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could also have impacts on special-status wildlife or habitat at the San Luis Reservoir, and could occur at the same time as the San Luis Reservoir Expansion Alternative. **Together, these projects and the San Luis Reservoir Expansion Alternative could result in significant cumulative effects on special-status wildlife with potential to occur at the San Luis Reservoir.**

However, the San Luis Reservoir expansion would implement Mitigation Measures TERR-1 through TERR-5 and TERR-11 through TERR-14 to complete special habitat and species surveys, implement avoidance requirements, and require species specific compensatory mitigation requirements to address unavoidable impacts to habitats. This mitigation would reduce impacts to previously unidentified special status wildlife to a less-than-significant level. **With implementation of Mitigation Measures TERR-1 through TERR-5 and TERR-11 through TERR-14, the San Luis Reservoir expansion's incremental contribution to significant cumulative effects on special-status wildlife would not be cumulatively considerable.**

Construction activities could disturb nesting migratory birds, including raptors. Construction activities for the San Luis Reservoir Expansion Alternative could result in impacts on migratory birds if construction occurs during nesting season and/or results in destruction of nesting habitat for migratory birds. Alternatives described in the *San Luis Reservoir SRA RMP/GP*, the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could also have impacts on migratory birds or habitat at the San Luis Reservoir, and could occur at the same time as the San Luis Reservoir expansion. **Together, these projects and the San Luis Reservoir Expansion Alternative could result in significant cumulative effects on migratory birds at the San Luis Reservoir.**

However, the San Luis Reservoir Expansion Alternative would implement Mitigation Measures TERR-6 through TERR-10 to avoid or reduce effects to migratory birds. **Therefore, with implementation of Mitigation Measures TERR-6 through TERR-10, the San Luis Reservoir Expansion Alternative's incremental contribution to significant cumulative effects on migratory birds would not be cumulatively considerable.**

Construction activities could destroy or adversely affect special-status plant species. Construction activities for the San Luis Reservoir Expansion Alternative could result in impacts on special-status plants at the San Luis Reservoir. Alternatives described in the *San Luis Reservoir SRA RMP/GP*, the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could also have impacts on special-status plants at the San Luis Reservoir, and could occur at the same time as the San Luis Reservoir Expansion Alternative. **Together, these projects and the San Luis Reservoir Expansion Alternative could result in significant cumulative effects on special-status plants at the San Luis Reservoir.**

However, the San Luis Reservoir Expansion Alternative would implement Mitigation Measure TERR-1, which outlines requirements for special habitat and species surveys, avoidance requirements, and compensatory mitigation requirements to address unavoidable impacts to habitats. This mitigation would reduce impacts to previously unidentified special status plant species to a less-than-significant level. **Therefore, with implementation of Mitigation Measure TERR-1, the San Luis Reservoir Expansion Alternative's incremental contribution to significant cumulative effects on special-status plants would not be cumulatively considerable.**

Construction activities could result in conflicts with local policies or ordinances protecting biological resources. The Merced County General Plan includes objectives and policies to preserve and protect biologic resources in the County. These include provisions to preserve existing and increase the overall acreage of protected lands in the County, and the designation of buffers around and protection of wetlands. Alternatives described in the *San Luis Reservoir SRA RMP/GP*, the California High Speed Rail Project, the San Luis Transmission Project, and the San Luis Solar Project could also have impacts on provisions of the Merced General Plan, and could occur at the same time as the San Luis Reservoir Expansion Alternative. **Together these projects and the San Luis Reservoir Expansion Alternative could generate significant impacts on terrestrial wildlife and vegetation.** Mitigation Measures TERR-1 through 18 are required to reduce these potential impacts to terrestrial wildlife and vegetation including wetlands during construction near the San Luis Reservoir shoreline to a less than significant level. **Therefore, with implementation of Mitigation Measures TERR-1 through 18 the San Luis Reservoir Expansion Alternative's incremental contribution to significant cumulative effects on local policies or ordinances protecting biological resources would not be cumulatively considerable.**

S.3.13.4 Alternative 5 - Pacheco Reservoir Expansion Alternative

Construction activities could destroy or adversely affect sensitive habitats including wetland and riparian vegetation communities. Construction activities for the Pacheco Reservoir Expansion Alternative could result in impacts on wetland and riparian vegetation communities at the Pacheco Reservoir.

Alternatives described in the California High Speed Rail Project could also have impacts on wetland and riparian vegetation communities at the expanded Pacheco Reservoir, and could occur at the same time as the Pacheco Reservoir Expansion construction. **Together, these projects and the Pacheco Reservoir Expansion Alternative could result in significant cumulative effects associated with loss or adverse modification of wetland and riparian habitats.**

However, the Pacheco Reservoir Expansion Alternative would implement Mitigation Measure TERR-16 which requires the avoidance of wetlands whenever practicable, the use of fencing used to delineate waters of the U.S. and waters of the State within and adjacent to construction areas that cannot be directly filled, and to identify these areas as sensitive habitat prior to the start of construction to prevent unintended trampling of wetland vegetation by construction personnel and equipment. Mitigation Measure TERR-16 further requires that areas disturbed by construction be replanted with native plants to minimize erosion and compensatory mitigation for any areas lost as a result of construction. This mitigation would reduce impacts to previously unidentified sensitive habitats to a less-than-significant level. **With implementation of Mitigation Measure TERR-16, the expanded Pacheco Reservoir construction's incremental contribution to significant cumulative effects on wetland and riparian habitats would not be cumulatively considerable.**

Construction activities could kill, harm, or disturb terrestrial wildlife, including special-status species, or their habitats. Construction activities for the Pacheco Reservoir Expansion Alternative could result in impacts on special-status wildlife or their habitat at the Pacheco Reservoir. Alternatives described in the California High Speed Rail Project could also have impacts on special-status wildlife or habitat at the Pacheco Reservoir, and could occur at the same time as the Pacheco Reservoir Expansion Alternative. **Together, these projects and the Pacheco Reservoir Expansion Alternative could result in significant cumulative effects on special-status wildlife with potential to occur at the Pacheco Reservoir.**

However, the expanded Pacheco Reservoir would implement Mitigation Measures TERR-1 through TERR-5 and TERR-11 through TERR-14 to complete special habitat and species surveys, implement avoidance requirements, and require species specific compensatory mitigation requirements to address unavoidable impacts to habitats. This mitigation would reduce impacts to previously unidentified special status wildlife to a less-than-significant level. **With implementation of Mitigation Measures TERR-1 through TERR-5 and TERR-11 through TERR-14, the Pacheco Reservoir Expansion Alternative's incremental contribution to significant cumulative effects on special-status wildlife would not be cumulatively considerable.**

Construction activities could disturb nesting migratory birds, including raptors. Construction activities for the Pacheco Reservoir Expansion Alternative could result in impacts on migratory birds if construction occurs during nesting season and/or results in destruction of nesting habitat for migratory birds. Alternatives described in the California High Speed Rail Project could also have impacts on migratory birds or habitat at the Pacheco Reservoir, and could occur at the same time as the expanded Pacheco Reservoir construction. **Together, these projects and the Pacheco Reservoir Expansion Alternative could result in significant cumulative effects on migratory birds at Pacheco Reservoir.**

However, the Pacheco Reservoir Expansion Alternative would implement Mitigation Measures TERR-6 through TERR-10 to avoid or reduce effects to migratory birds. **Therefore, with implementation of Mitigation Measures TERR-6 through TERR-10, the Pacheco Reservoir Expansion Alternative's incremental contribution to significant cumulative effects on migratory birds would not be cumulatively considerable.**

Construction activities could destroy or adversely affect special-status plant species. Construction activities for the Pacheco Reservoir Expansion Alternative could result in impacts on special-status plants at the Pacheco Reservoir. Alternatives described in the California High Speed Rail Project could also have impacts on special-status plants at the Pacheco Reservoir, and could occur at the same time as the Pacheco Reservoir Expansion Alternative. **Together, these projects and the Pacheco Reservoir Expansion Alternative could result in significant cumulative effects on special-status plants at the Pacheco Reservoir.**

However, the Pacheco Reservoir Expansion Alternative would implement Mitigation Measure TERR-1, which outlines requirements for special habitat and species surveys, avoidance requirements, and compensatory mitigation requirements to address unavoidable impacts to habitats. This mitigation would reduce impacts to previously unidentified special status plant species to a less-than-significant level. **Therefore, with implementation of Mitigation Measure TERR-1, the Pacheco Reservoir Expansion Alternative's incremental contribution to significant cumulative effects on special-status plants would not be cumulatively considerable.**

Construction activities could result in conflicts with local policies or ordinances protecting biological resources. The Santa Clara County General Plan includes objectives and policies to preserve and protect biologic resources in the County. These include provisions to preserve existing and increase the overall acreage of protected lands in the County, and the designation of buffers around and protection of wetlands**.** Alternatives described in the California High Speed Rail Project could also have impacts on provisions of the Santa Clara County General Plan, and could occur at the same time as the Pacheco Reservoir Expansion Alternative. **Together these projects and the Pacheco Reservoir Expansion Alternative could generate significant impacts on terrestrial**

wildlife and vegetation. Mitigation Measures TERR-1 through 18 are required to reduce these potential impacts to terrestrial wildlife and vegetation including wetlands during construction near the Pacheco Reservoir to a less than significant level. **Therefore, with implementation of Mitigation Measures TERR-1 through 18 the Pacheco Reservoir Expansion Alternative's incremental contribution to significant cumulative effects on local policies or ordinances protecting biological resources would not be cumulatively considerable.**

S.3.14 Regional Economics

S.3.14.1 Alternative 2 - Lower San Felipe Intake Alternative

The Lower San Felipe Intake Alternative, in combination with the Bay-Delta Conservation Plan and CVP M&I Water Shortage Policy, could have cumulative effects on SCVWD water supply. The Bay-Delta Conservation Plan and the Los Vaqueros Reservoir Expansion Project would increase water exports to south-of-Delta contractors. This would increase water supply reliability for SCVWD and reduce economic effects associated with potential water shortages. The CVP M&I Water Shortage Policy would increase CVP water supplies to SCVWD during drought to avoid adverse public health and safety impacts. This would also avoid economic losses avoided with water shortages. The Water Shortage Policy could reduce some deliveries to agricultural users in SCVWD during drought years. The Lower San Felipe Intake Alternative would increase SCVWD water supply reliability during low-point years and allow SCVWD to avoid economic effects of water shortages. Cumulatively, the projects would have a beneficial economic effect for SCVWD.

The Lower San Felipe Intake Alternative, in combination with the *B.F. Sisk Dam SOD Modification Project and the California High Speed Rail Project, could have regional economic effects.* The B.F. Sisk Dam SOD Modification Project would occur at San Luis Reservoir and a portion of the California High Speed Rail Project track alignment traverses Pacheco Pass adjacent to SR 152 and San Luis Reservoir. Construction expenditures for the project would result in economic output, labor income, and employment in Santa Clara and Merced counties as construction workers spend money in the counties and some construction materials may be purchased. This would be a positive economic effect. Similarly, construction expenditures for the Lower San Felipe Intake Alternative would also result in increased economic output, labor income, and jobs in Merced and Santa Clara counties. These would be positive cumulative economic effect.

Construction traffic for the B.F. Sisk Dam SOD Modification Project and the California High Speed Rail Project could deter some visitors to the reservoir, which would decrease visitor spending in Merced County. This would be an adverse cumulative economic effect. Construction activities under the San Luis

Transmission Project would also cause temporary closures of the San Luis Reservoir State Recreational Area. The Lower San Felipe Intake Alternative would also decrease visitor spending by closing the Basalt and Dinosaur Point use areas for construction activities. This reduction in visitor spending would contribute to adverse regional economic effects under the cumulative condition.

Projected population and employment growth in Santa Clara County, combined with the Lower San Felipe Intake Alternative, could result in both short-term and long-term regional economic effects. The population in Santa Clara County is projected to increase from 1.82 million in 2010 to 2.43 million in 2035. Jobs are projected to increase from 906,270 in 2010 to 1.4 million in 2035. Increases in population and jobs would increase economic activity in the county as more housing would be developed and commercial development would likely increase. Industries with the largest projected job growth, in number of jobs, include health, educational, and recreational services; financial and professional services, and manufacturing, wholesale, and transportation. Population and job growth would be a beneficial economic effect in the county.

There would be a short-term cumulative effect associated with economic growth and the construction of the Lower San Felipe Intake Alternative. A portion of the regional economic effects associated with construction expenditures for the Lower San Felipe Intake Alternative would occur in Santa Clara County, which would increase sales, labor income and employment. These effects, combined with the economic development associated with population and job growth, would be a cumulative benefit to the Santa Clara County economy. The economic effects of the Lower San Felipe Intake Alternative would be temporary and occur only during the construction period. Construction of Lower San Felipe Intake Alternative would have a positive, but temporary, cumulative economic effect. O&M expenditures would be long-term, but have relatively minor beneficial regional economic effects.

There would be a long-term cumulative effect associated with job and population growth and the water supply provided by the Lower San Felipe Intake Alternative. The Lower San Felipe Intake Alternative would provide a more reliable water supply to support population and job growth in Santa Clara County. This would be a positive, long-term cumulative effect.

Projected population and employment growth in Merced County, combined with the Lower San Felipe Intake Alternative, could result in regional economic effects. The population in Merced County is projected to increase from 273,935 in 2010 to 348,690 in 2020, a 2.4 percent increase in population. Jobs are project to increase by approximately 42,000 from 2010 to 2030. Increases in population and jobs would increase economic activity in the county as more housing would be developed and commercial development would likely increase. These would be beneficial economic effects in the county. A portion of the regional economic effects associated with construction expenditures for the Lower San Felipe Intake Alternative would occur in Merced County. There

would also be jobs generated in Merced County. These effects would also benefit the Merced County economy. The economic effects of the Lower San Felipe Intake Alternative would be temporary, during the construction period. Construction of Lower San Felipe Intake Alternative would have a positive, but temporary, cumulative economic effect. O&M expenditures would be long-term, but have relatively minor beneficial regional cumulative economic effects.

The San Felipe Intake Alternative, combined with the *B.F. Sisk Dam SOD Modification Project, the San Luis Reservoir SRA RMP/GP, San Luis Transmission Project, and San Luis Solar Project, could affect recreational expenditures at the San Luis Reservoir SRA and, in turn, affect the Merced County regional economy.* One purpose of the *San Luis Reservoir SRA RMP/GP* is to improve recreational facilities and opportunities to accommodate increased visitor use. The plan outlines alternatives that improve access and develop. One specific development proposed includes new trails connecting to both the Basalt and Dinosaur Point use areas. Improved facilities would attract more visitors to the San Luis Reservoir SRA. Increased number of visitors at the San Luis Reservoir SRA would result in additional spending in Merced County, which would have positive regional economic effects. Construction of the Lower San Felipe Intake Alternative would close the Basalt and Dinosaur Point recreation areas for up to 47 months, which would be in conflict with the objectives of the *San Luis Reservoir SRA RMP/GP*. It would decrease visitors to Merced County and adversely affect the regional economy. This would be an adverse cumulative economic effect of the Lower San Felipe Intake Alternative.

The Lower San Felipe Intake Alternative, the B.F. Sisk Dam SOD Modification Project, the San Luis Transmission Project, and the San Luis Solar Project, would all result in closures of recreational facilities during construction. This would reduce the amount of visitors to San Luis Reservoir and reduce spending in Merced County. This would be an adverse cumulative effect to the regional economy of Merced County. The Lower San Felipe Intake Alternative would have the largest impacts to recreational opportunities in the future and would contribute substantially to cumulative economic impacts related to reduced recreational spending in Merced County.

S.3.14.2 Alternative 3 - Treatment Alternative

The Treatment Alternative, in combination with the Bay-Delta Conservation Plan and CVP M&I Water Shortage Policy, could have cumulative effects on SCVWD water supply. The Treatment Alternative would have similar cumulative economic effects to SCVWD water supply as described for the Lower San Felipe Intake Alternative. The Treatment Alternative would increase SCVWD water supply reliability during low-point years and allow SCVWD to avoid economic effects of water shortages. Cumulatively, the projects would have a beneficial economic effect for SCVWD.

The Treatment Alternative, in combination with the California High Speed Rail Project, could have regional economic effects. Construction of the portion of the High Speed Rail Project that goes through Santa Clara County would temporarily increase jobs, labor income, and employment in the county. The project also has a proposed train stop in San Jose, which would bring additional visitors to the county and boost economic activity. This would be a beneficial cumulative economic effect. Construction of the Treatment Alternative would similarly increase economic output, jobs, and labor income in Santa Clara County during the construction period. The Treatment Alternative, combined with the California High Speed Rail Project, would have beneficial cumulative effects on the regional economy.

Projected population and employment growth in Santa Clara County, combined with the Treatment Alternative, could result in regional economic effects. Cumulative effects of population and job growth in Santa Clara County are described under the Lower San Felipe Intake Alternative. The Treatment Alternative would have similar cumulative economic effects related to projected population and job growth as the Lower San Felipe Intake Alternative. Construction expenditures associated with the Treatment Alternative would increase economic output, jobs, and labor income in Santa Clara County during the construction period. These would be beneficial cumulative effects to the county's economy. O&M expenditures would have long-term, beneficial cumulative effects, but they would be relatively minor. The Treatment Alternative would provide a water supply to support population and job growth in Santa Clara County. This would be a positive, long-term cumulative effect.

S.3.14.3 Alternative 4 - San Luis Reservoir Expansion Alternative

The San Luis Reservoir Expansion Alternative, in combination with the Bay-Delta Conservation Plan and CVP M&I Water Shortage Policy, could have cumulative effects on CVP M&I, including SCVWD, water supply. The San Luis Reservoir Expansion Alternative would have similar cumulative economic effects to water supplies to CVP contractors in the Bay Area Region, including SCVWD water supply, as described for the Lower San Felipe Intake Alternative. The San Luis Reservoir Expansion Alternative would increase CVP, including SCVWD water supply reliability during low-point years, and allow CVP M&I contractors to avoid some economic effects of water shortages. Cumulatively, the projects would have a beneficial economic effect for CVP M&I contractors in the Bay Area Region, including SCVWD.

The San Luis Reservoir Expansion Alternative, in combination with the Bay-Delta Conservation Plan, could have cumulative effects on SWP water supply. The San Luis Reservoir Expansion Alternative and the Bay-Delta Conservation Plan would increase water supplies to SWP contractors in the Bay Area and Southern California, which would provide economic benefits by reducing frequency and severity of water shortages. Cumulatively, the projects would have a beneficial economic effect for SWP M&I contractors.

The San Luis Reservoir Expansion Alternative, in combination with the Bay-Delta Conservation Plan and CVP M&I Water Shortage Policy, could have cumulative effects on agricultural water supplies in the San Joaquin Valley. These cumulative projects could increase water supplies for agricultural water contractors in the San Joaquin Valley. With increased and more reliable water supplies, growers could increase crop acreage planted or switch to higher value crops. Crop value of production would increase output, employment, and income in the regional economy. These projects would result in cumulative benefits to the regional economy in areas where agricultural water supplies are increased. The San Luis Reservoir Expansion Alternative would contribute to increased water supplies and also provide a cumulative economic benefit to the San Joaquin Valley region.

Projected population and employment growth in Merced County, combined with the San Luis Reservoir Expansion Alternative, could result in regional economic effects. The population in Merced County is projected to increase from 273,935 in 2010 to 348,690 in 2020, a 2.4 percent increase in population. Jobs are project to increase by approximately 42,000 from 2010 to 2030. The population in Santa Clara County is projected to increase from 1.82 million in 2010 to 2.43 million in 2035. Jobs are projected to increase from 906,270 in 2010 to 1.4 million in 2035. Increases in population and jobs would increase economic activity in the counties as more housing would be developed and commercial development would likely increase. These would be beneficial economic effects in the county. A portion of the regional economic effects associated with construction expenditures for the San Luis Reservoir Expansion Alternative would occur in Merced and Santa Clara Counties. There would also be jobs generated in Merced and Santa Clara Counties. These effects would also benefit the Merced and Santa Clara County economies and would occur during the 8 to 12 year construction period. Construction of San Luis Reservoir Expansion Alternative would have a positive cumulative economic effect. O&M expenditures would be long-term, but have relatively minor beneficial regional cumulative economic effects.

The San Luis Reservoir Expansion Alternative, combined with the San Luis Reservoir SRA RMP/GP, San Luis Transmission Project, and San Luis Solar Project, could affect recreational expenditures at the San Luis Reservoir SRA and, in turn, affect the Merced County regional economy. Cumulative effects would be similar to those described for the Lower San Felipe Alternative; however, the effects would be more substantial under the San Luis Reservoir Expansion Alternative because of the 8 to 12 year construction period. The reduced visitor spending would occur for an 8 to 12 year period, which would be a substantial cumulative effect to the regional economy in Merced County.

S.3.14.4 Alternative 5 – Pacheco Reservoir Expansion Alternative

The Pacheco Reservoir Expansion Alternative, in combination with the Bay-Delta Conservation Plan and CVP M&I Water Shortage Policy, could have cumulative effects on CVP M&I, including SCVWD, water supply. The Pacheco Reservoir Expansion Alternative would have similar cumulative economic effects to water supplies to CVP contractors in the Bay Area Region, including SCVWD water supply, as described for the Lower San Felipe Intake Alternative. The Pacheco Reservoir Expansion Alternative would increase CVP, including SCVWD water supply reliability during low-point years, and allow CVP M&I contractors to avoid some economic effects of water shortages. Cumulatively, the projects would have a beneficial economic effect for CVP M&I contractors in the Bay Area Region, including SCVWD.

The Pacheco Reservoir Expansion Alternative, in combination with the Bay-Delta Conservation Plan, could have cumulative effects on SWP water supply. The Bay-Delta Conservation Plan would increase water supplies to SWP contractors in the Bay Area and Southern California. However, the Pacheco Reservoir Expansion Alternative would have no impact on water supply deliveries to SWP contractors and would therefore have no cumulative impact on SWP M&I contractors.

The Pacheco Reservoir Expansion Alternative, in combination with the Bay-Delta Conservation Plan and CVP M&I Water Shortage Policy, could have cumulative effects on agricultural water supplies in the San Joaquin Valley. These cumulative projects could increase water supplies for agricultural water contractors in the San Joaquin Valley. With increased and more reliable water supplies, growers could increase crop acreage planted or switch to higher value crops. Crop value of production would increase output, employment, and income in the regional economy. These projects would result in cumulative benefits to the regional economy in areas where agricultural water supplies are increased. The Pacheco Reservoir Expansion Alternative would contribute to increased water supplies and also provide a cumulative economic benefit to the San Joaquin Valley region.

The Pacheco Reservoir Expansion Alternative, in combination with the *B.F. Sisk Dam SOD Modification Project and the California High Speed Rail Project, could have regional economic effects.* The B.F. Sisk Dam SOD Modification Project would be constructed at San Luis Reservoir and a portion of the California High Speed Rail Project track alignment traverses Pacheco Pass adjacent to SR 152 and San Luis Reservoir. Construction expenditures for the project would result in economic output, labor income, and employment in Santa Clara and Merced counties as construction workers spend money in the counties and some construction materials may be purchased. This would be a positive economic effect. Similarly, construction expenditures for the Pacheco Reservoir Expansion Alternative would also result in increased economic output, labor income, and jobs in Merced and Santa Clara counties. These would be positive cumulative economic effect.

Projected population and employment growth in Merced County, combined with the Pacheco Reservoir Expansion Alternative, could result in regional economic effects. The population in Merced County is projected to increase from 273,935 in 2010 to 348,690 in 2020, a 2.4 percent increase in population. Jobs are project to increase by approximately 42,000 from 2010 to 2030. The population in Santa Clara County is projected to increase from 1.82 million in 2010 to 2.43 million in 2035. Jobs are projected to increase from 906,270 in 2010 to 1.4 million in 2035. Increases in population and jobs would increase economic activity in the counties as more housing would be developed and commercial development would likely increase. These would be beneficial economic effects in the county. A portion of the regional economic effects associated with construction expenditures for the Pacheco Reservoir Expansion Alternative would occur in Merced and Santa Clara Counties. There would also be jobs generated in Merced and Santa Clara Counties. These effects would also benefit the Merced and Santa Clara County economies and would occur during the 5 year construction period. Construction of the Pacheco Reservoir Expansion Alternative would have a positive cumulative economic effect. O&M expenditures would be long-term, but have relatively minor beneficial regional cumulative economic effects.

S.3.15 Land Use and Agricultural Resources

S.3.15.1 Alternatives 2 and 3 - Lower San Felipe Intake Alternative and Treatment Alternative

Neither the Lower San Felipe Intake Alternative or the Treatment Alternative would have short-term or long-term impacts on land use or agricultural resources in the area of analysis.

Of the cumulative projects considered for all resources, construction and operations of the proposed alternatives for the *Bay-Delta Conservation Plan*, the B.F. Sisk Dam SOD Modification Project, California High Speed Rail Project, CVP M&I Water Shortage Policy, San Joaquin River Restoration Program, the San Luis Solar Project, and the San Luis Transmission Project could result in short-term and long-term changes in land use and agricultural resources. For example, potential land acquisitions could change land use designations or convert important farmland to nonagricultural land. The land use and agricultural resource effects of these projects would be analyzed in appropriate environmental impact documents and significant impacts would be mitigated where necessary.

Future growth and development in counties and cities in the area of analysis would undergo environmental review with mitigation for significant impacts, as required. Neither the Lower San Felipe Intake Alternative or the Treatment Alternative would result in cumulative effects relative to projects identified in the region or future potential growth and development in counties in the area of analysis. **Since there would be no impacts to land use and agricultural**

resources as a result of the Lower San Felipe Intake Alternative or the Treatment Alternative, there would be no contribution to cumulative effects.

S.3.15.2 Alternative 4 - San Luis Reservoir Expansion Alternative

Construction of the San Luis Reservoir Expansion Alternative would generate no short-term or long-term impacts on land use or agricultural resources in the area of analysis. Operation of the alternative would however generate small changes in CVP and SWP water deliveries to south-of-Delta contractors. These changes would include increases in deliveries to the CVP contractors and improved reliability in SWP Table A water supplies in dry and critically dry water years at the expense of reduced Article 21 supplies in wet water years. In addition, operation of the San Luis Reservoir Expansion Alternative would also inundate 394 additional acres of land at the San Luis Reservoir shoreline in years that the expanded reservoir would fill to capacity.

Of the cumulative projects considered for all resources, construction and operations of the proposed alternatives for the *Bay-Delta Conservation Plan*, California High Speed Rail Project, CVP M&I Water Shortage Policy, San Joaquin River Restoration Program, the San Luis Solar Project, and the San Luis Transmission Project could result in short-term and long-term changes in land use and agricultural resources. For example, potential land acquisitions could change land use designations or convert important farmland to nonagricultural land. The land use and agricultural resource effects of these projects would be analyzed in appropriate environmental impact documents and significant impacts would be mitigated where necessary.

Future growth and development in counties and cities in the area of analysis would undergo environmental review with mitigation for significant impacts, as required which would lessen but may not fully address these impacts. Operation of the San Luis Reservoir Expansion Alternative would result in no permanent land use conversion as a result of increased reservoir inundation area or as a result in changes in water supply deliveries. **Therefore, the San Luis Reservoir Expansion Alternative's incremental contribution to any significant cumulative impact on land use in the area of analysis would not be cumulatively considerable.**

S.3.15.3 Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction of the Pacheco Reservoir Expansion Alternative would generate no short-term and little long-term impacts on land use or agricultural resources in the area of analysis. The alternative would affect (inundate) approximately 1,245 acres of Ranchlands near the existing reservoir that are currently used for grazing. There would be no impacts to important farmland. Operation of the alternative would however generate small changes in CVP and/or SWP water deliveries to water users in the SCVWD service area. These changes could

include increases in deliveries and improved reliability to water users in wet water years.

Of the cumulative projects considered for all resources, construction and operations of the proposed alternatives for the *Bay-Delta Conservation Plan*, the B.F. Sisk Dam SOD Modification Project ,California High Speed Rail Project, CVP M&I Water Shortage Policy, San Joaquin River Restoration Program, the San Luis Solar Project, and the San Luis Transmission Project could result in short-term and long-term changes in land use and agricultural resources. For example, potential land acquisitions could change land use designations or convert important farmland to nonagricultural land. The land use and agricultural resource effects of these projects would be analyzed in appropriate environmental impact documents and significant impacts would be mitigated where necessary.

Future growth and development in counties and cities in the area of analysis would undergo environmental review with mitigation for significant impacts, as required which would lessen but may not fully address these impacts. **Therefore, the Pacheco Reservoir Expansion Alternative's incremental contribution to any significant cumulative impact on land use in the area of analysis would not be cumulatively considerable.**

Operation of the Pacheco Reservoir Expansion Alternative would inundate grazing lands currently covered by Williamson Act contracts. The inundation of this land would conflict with these Williamson Act contracts and would be **cumulatively considerable pre-mitigation,** although the impact would be reduced through Mitigation Measure LU-1 and **therefore would not be cumulatively considerable post-mitigation.**

S.3.16 Recreation

S.3.16.1 Alternative 2 - Lower San Felipe Intake Alternative

The *San Luis Reservoir SRA RMP/GP* has been identified as a cumulative plan and the San Luis Transmission Project has been identified as a cumulative project that could contribute to recreation effects during construction of the Lower San Felipe Intake. The proposed recreation facility expansions in the *San Luis Reservoir SRA RMP/GP* at the five use areas described in the Park Plan are presented below in Table S-8. The construction and operational effects of the San Luis Transmission Project is also described below. Together with the proposed project construction under the Lower San Felipe Intake Alternative, proposed improvements at San Luis Reservoir SRA and development of the San Luis Transmission Project could result in significant cumulative effects associated with recreation resources. No other cumulative projects or plans were identified that could contribute to recreation effects during construction of the Lower San Felipe Intake.

The *San Luis Reservoir SRA RMP/GP* includes a Park Plan, which outlines various alternatives for future park expansion. Funding for such improvements is not secured, thus a project construction timeline is not available. It is typical for park expansion projects to be phased; however, associated construction actions could take place prior to or concurrently with SLLPIP construction actions.

The B.F. Sisk Dam SOD Modification Project would complete modify the dam with a crest raise and embankment expansion. The project would generate construction related impacts to recreation at San Luis Reservoir with closure of the Basalt Use Area and the Medeiros Use Area throughout the 8-12 year construction schedule

The San Luis Transmission Project would construct new transmission lines near San Luis Reservoir to connect the San Luis Substation to a new transmission line that would be developed between the Tracy Substation and the Dos Amigos Substation. This new transmission line between Tracy and Dos Amigos would cross O'Neill Forebay and pass adjacent to the Medeiros Use Area. The San Luis Substation connection and the new transmission line segment near the Medeiros Use Area would generate short term, construction related impacts on recreation with the potential development of transmission line supports in the San Luis Reservoir SRA, which could require temporary closures during construction and could potentially, depending on placement, displace existing and planned camping sites.

The Park Plan proposes various trail improvements throughout the SRA, which could result in the temporary closure of additional trails during construction of the Lower San Felipe Intake Alternative. The Park Plan proposes new trails connecting to both the Basalt and Dinosaur Point use areas, which could result in reduced recreational trail use during construction of the Lower San Felipe Intake Alternative. A multi-modal trail system is proposed to connect both use areas to the Pacheco State Park (SP). The Dinosaur Point Use Area trail would also connect to the San Luis Wildlife Area (Reclamation and CDPR 2013). An additional trail is proposed to connect the Basalt and Los Banos Creek use areas.

If trail development is completed prior to construction of the Lower San Felipe Intake Alternative, recreational use of the new trails would be restricted during the construction period, due to the closure of both the Basalt and Dinosaur Point use areas. Users of the new trails during construction of the Lower San Felipe Intake Alternative would be unable to connect with San Luis Reservoir, which could cause a short-term (i.e., 33 to 47 months) reduction of recreational trail use. Closure of the new trails at the Basalt and Dinosaur Point use areas would cause a short-term reduction of recreational trail use at these sites. Together with the proposed project construction under the Lower San Felipe Intake Alternative, proposed improvements at San Luis Reservoir SRA could result in significant cumulative effects related to the short-term closure of trails.

Although trails at the Basalt Use Area would be temporarily affected, other hiking opportunities within the San Luis Reservoir SRA would still be available for use during project construction. These would include formally designated and primitive trails at both Los Banos Creek and San Luis Creek use areas, and within the designated wildlife use areas. In addition, Pacheco State Park, just west of the San Luis Reservoir SRA, offers several public hiking opportunities. **Therefore, the Lower San Felipe Intake Alternative's incremental contribution to any significant cumulative impact on recreation in the area of analysis would not be cumulatively considerable.**

The Park Plan proposes various park improvements at all five of the use areas within the SRA, which could result in the temporary closure of multiple recreation facilities during construction of the Lower San Felipe Intake Alternative. The San Luis Transmission Project proposes the development of transmission line support structures that could remove existing campsites at the Medeiros Use Area prior to construction of the Lower San Felipe Intake Alternative. If recreation facility expansions within the SRA identified in Table S-8 are completed during construction of the Lower San Felipe Intake Alternative, additional recreation facilities in the SRA could be temporarily closed to the public during the construction period. In addition, if recreation facilities in the Medeiros Use Area are made inaccessible by the B.F. Sisk Dam SOD Modification Project or removed by the San Luis Transmission Project prior to construction of the Lower San Felipe Intake Alternative, fewer facilities would be available to offset visitors unable to use the Basalt and Dinosaur Point use areas. This would be a significant cumulative impact. **The incremental contribution of the Lower San Felipe Intake Alternative to this significant cumulative effect on recreation opportunities in the area of analysis due to the temporary closure of recreation facilities would be cumulatively considerable if recreation facility expansions outlined in the Park Plan are completed at the same time.** Implementation of Mitigation Measure REC-1 would develop new campsites, a fish cleaning station, public storage lockers, and shower facilities and expand the boat launch to further reduce the impacts of the closure of the Basalt and Dinosaur Point use areas. **Thus, with implementation of Mitigation Measure REC-1, the Lower San Felipe Intake Alternative's incremental contribution to significant cumulative impacts on recreation would not be cumulatively considerable.**

Table S-8. Proposed Improvements at San Luis Reservoir SRA

Use Area	Camping			Boating/Water Sports	Day Use	Fishing	Picnicking	Trails	Other
	# of Sites	Group	RV						
Basalt	10	1	30					X	Reconfiguration of existing campsites to allow larger RV access and add full hookups. Upgraded campfire center or development of a new amphitheater.
Dinosaur Point	30			X	X			X	Potential new access road at Honker Bay off SR 152. Development of a new marina to relive demand at San Luis Creek Use Area.
Los Banos Creek	40	1							Development of a motel and restaurant, along with concessions. New trail connecting to the Basalt Use Area.
Medeiros	250			X					Development of an additional 100 primitive and 100 tent camp sites, along with associated parking.
San Luis Creek	30	2		X		X	X		Additional concessions, interpretive programs, and group event shelter are proposed. An ADA accessible fishing pier. A new amphitheater in the northern beach area.
Total	360	4	30						

Source: Reclamation and CDPR 2013.

The Park Plan proposes various park improvements at all five of the use areas within the SRA, which could displace visitors and substantially contribute to overcrowded conditions at other local and regional recreation sites during construction of the Lower San Felipe Intake Alternative. As identified in Table S-8, the Park Plan proposes various park expansions that would require construction at all five of the use areas within the SRA.

If the planned recreation facility expansions described in the Park Plan are completed during construction of the Lower San Felipe Intake Alternative, additional recreation facilities in the SRA, besides the Basalt and Dinosaur Point use areas closed by the alternative, could be temporarily closed. Simultaneous closures at additional use areas could further displace visitors to other already overcrowded areas within the San Luis Reservoir SRA.

Pacheco SP and Henry Coe SP, both located near the San Luis Reservoir SRA, could experience an increase in visitation. Both SPs could supplement some of the hiking and camping opportunities lost by the closure of the Basalt Use Area. Neither Pacheco nor Henry Coe State Park currently report user capacity issues, and displaced San Luis Reservoir users would not be expected to overcrowd the two SPs. At 87,000 acres and the largest state park in northern California, Henry Coe SP accommodates over 40,000 visitors each year. Henry Coe SP offers

opportunities for hiking, fishing, and camping. Approximately 2,000 people visit Pacheco SP each year. Pacheco SP offers opportunities for hiking and camping. In addition, San Luis National Wildlife Refuge in Merced County is approximately 22 miles from San Luis Reservoir and offers fishing, hunting, nature trails, and wildlife viewing. Water based recreation, camping, hiking, and other activities are offered at Coyote Lake Harvey Bear Ranch County Park and Anderson Lake County Park in Santa Clara County, approximately 35 miles from San Luis Reservoir.

Given the implementation of Mitigation Measure REC-1 at the San Luis Creek and Los Banos Creek use areas to offset lost capacity at the Basalt and Medeiros use areas, it is assumed that only a portion of the 55,000 day-use and 6,500 overnight visitors offset at San Luis Reservoir would shift to the other regional recreation area. As a result, the current capacities at these regional recreation areas would not be exceed. In addition, with a number of similar alternative recreational opportunities nearby, no one recreational area would be expected to experience substantial increase in use such that deterioration of its facilities would occur or be accelerated. **Therefore, Lower San Felipe Intake Alternative's incremental contribution to significant cumulative impacts on recreation in the area of analysis would not be cumulatively considerable.**

S.3.16.2 Alternative 3 - Treatment Alternative

The Treatment Alternative proposes treatment technology and facility upgrades, requiring construction at SCVWD's Santa Teresa WTP. No recreation facilities would be affected or are within proximity to the proposed project construction. Therefore, no cumulative activities or projects have been identified that, in combination with project construction, would affect recreation resources. The Treatment Alternative would have no cumulative effects on recreation.

S.3.16.3 Alternative 4 - San Luis Reservoir Expansion Alternative

The *San Luis Reservoir SRA RMP/GP* has been identified as a cumulative plan and the San Luis Transmission Project and San Luis Solar Project have been identified as a cumulative projects that could contribute to recreation effects during construction of the San Luis Reservoir Expansion Alternative. Together with the proposed project construction under the San Luis Reservoir Expansion Alternative, proposed improvements at San Luis Reservoir SRA and development of the San Luis Transmission Project and San Luis Solar Project could result in significant cumulative effects associated with recreation resources. No other cumulative projects or plans were identified that could contribute to recreation effects during construction of the San Luis Reservoir Expansion Alternative.

The San Luis Solar Project would develop a new 108-acre solar facility at the western corner of the Medeiros Use Area that would permanently convert land

that is currently used informally for recreation and is adjacent to approximately 18 established campsites.

The Park Plan proposes various trail improvements throughout the SRA, which could result in the temporary closure of additional trails during construction of the San Luis Reservoir Expansion Alternative. The Park Plan proposes new trails connecting to the use areas, which could result in reduced recreational trail use during construction of the San Luis Reservoir Expansion Alternative. A multi-modal trail system is proposed to connect both use areas to the Pacheco SP. The Dinosaur Point Use Area trail would also connect to the San Luis Wildlife Area (Reclamation and CDPR 2013). An additional trail is proposed to connect the Basalt and Los Banos Creek Trail use areas.

If trail development is completed prior to construction of the San Luis Reservoir Expansion Alternative, recreational use of the new trails would be restricted during the construction period, due to the closure of the Basalt, Medeiros, and Dinosaur Point use areas. Users of the new trails during construction of the San Luis Reservoir Expansion Alternative would be unable to connect with San Luis Reservoir, which could cause a reduction of recreational trail use. Together with the proposed project construction under the San Luis Reservoir Expansion Alternative, proposed improvements at San Luis Reservoir SRA could result in significant cumulative effects related to the short-term closure of trails.

Although trails at the Basalt Use Area would be temporarily affected, other hiking opportunities within the San Luis Reservoir SRA would still be available for use during project construction. These would include formally designated and primitive trails at both Los Banos Creek and San Luis Creek use areas, and within the designated wildlife use areas. In addition, Pacheco State Park, just west of the San Luis Reservoir SRA, offers several public hiking opportunities. **Therefore, the San Luis Reservoir Expansion Alternative's incremental contribution to any significant cumulative impact on recreation in the area of analysis would not be cumulatively considerable.**

The Park Plan proposes various park improvements at all five of the use areas within the SRA, which could result in the temporary closure of multiple recreation facilities during construction of the San Luis Reservoir Expansion Alternative. The San Luis Transmission Project proposes the development of transmission line support structures that could displace existing campsites at the Medeiros Use Area and the San Luis Solar Project proposes the permanent conversion of approximately 108 acres of land currently used for informal recreation in the Medeiros Use Area prior to construction of the San Luis Reservoir Expansion Alternative. If recreation facility expansions within the SRA identified in Table S-8 are completed during construction of the San Luis Reservoir Expansion Alternative, additional recreation facilities in the SRA could be temporarily closed to the public during the construction period. In addition, if recreation facilities in the Medeiros Use Area are removed by the San Luis Transmission Project and the San Luis Solar Project prior to

construction of the San Luis Reservoir expansion, fewer facilities would be available to offset visitors unable to use the Basalt and Dinosaur Point use areas. **This would be a significant cumulative impact.** Implementation of Mitigation Measure REC-1 would develop new campsites, a fish cleaning station, public storage lockers, and shower facilities and expand the boat launch to further reduce the impacts of the closure of the Basalt and Dinosaur Point use areas. **Therefore, San Luis Reservoir Expansion Alternative's incremental contribution to significant cumulative impacts on recreation in the area of analysis would not be cumulatively considerable.**

The Park Plan proposes various park improvements at all five of the use areas within the SRA, which could displace visitors and substantially contribute to overcrowded conditions at other local and regional recreation sites during construction of the San Luis Reservoir Expansion Alternative. As identified in Table S-8, the Park Plan proposes various park expansions that would require construction at all five of the use areas within the SRA.

If the planned recreation facility expansions described in the Park Plan are completed during construction of the San Luis Reservoir Expansion Alternative, additional recreation facilities in the SRA could be temporarily closed. Simultaneous closures at multiple use areas could displace visitors to other areas within the San Luis Reservoir SRA or at other local and regional recreation sites. This would be a significant cumulative impact because the displacement could contribute to overcrowding at these other recreation sites.

Pacheco SP and Henry Coe SP, both located near the San Luis Reservoir SRA, could experience an increase in visitation. Both SPs could supplement some of the hiking and camping opportunities lost by the closure of both the Basalt and Medeiros use areas. Neither Pacheco nor Henry Coe State Park currently report user capacity issues, and displaced San Luis Reservoir users would not be expected to overcrowd the two SPs. At 87,000 acres and the largest state park in northern California, Henry Coe SP accommodates over 40,000 visitors each year. Henry Coe SP offers opportunities for hiking, fishing, and camping. Approximately 2,000 people visit Pacheco SP each year. Pacheco SP offers opportunities for hiking and camping. In addition, San Luis National Wildlife Refuge in Merced County is approximately 22 miles from San Luis Reservoir and offers fishing, hunting, nature trails, and wildlife viewing. Water based recreation, camping, hiking, and other activities are offered at Coyote Lake Harvey Bear Ranch County Park and Anderson Lake County Park in Santa Clara County, approximately 35 miles from San Luis Reservoir.

Given the implementation of Mitigation Measure REC-1 at the San Luis Creek, Dinosaur Point, and Los Banos Creek use areas to offset lost capacity at the Basalt and Medeiros use areas, it is assumed that only a portion of the 60,000 day-use and 17,000 overnight visitors offset at San Luis Reservoir would shift to the other regional recreation area. As a result, the current capacities at these regional recreation areas would not be exceed. In addition, with a number of

similar alternative recreational opportunities nearby, no one recreational area would be expected to experience substantial increase in use such that deterioration of its facilities would occur or be accelerated. **Therefore, San Luis Reservoir Expansion Alternative's incremental contribution to significant cumulative impacts on recreation in the area of analysis would not be cumulatively considerable.**

The Park Plan proposes various park improvements at all five of the use areas within the SRA, which could contribute to recreation access during operation of the San Luis Reservoir Expansion Alternative. As identified in Table S-8, the Park Plan proposes various park expansions that would require construction at all five of the use areas within the SRA.

If the planned recreation facility expansions described in the Park Plan are completed following construction of the San Luis Reservoir Expansion Alternative, trail closures generated at the Basalt Campground Trail and the Lone Oak Trail by increased water surface elevations could occur while other use areas are closed limiting overall access to hiking trails in the San Luis SRA. These facilities are currently identified as overcrowded and the closure of one or more facility simultaneously would amplify this overcrowding at the sites that remain open. **The incremental contribution of the San Luis Reservoir Expansion Alternative to this significant cumulative effect on trail access in the area of analysis due to the temporary closure of trails when reservoir storage utilizes the new expanded capacity would be cumulatively considerable if recreation facility expansions outlined in the Park Plan are completed at the same time.** The trail rerouting actions required with implementation of mitigation measure REC-2 would avoid this potential impact. **Therefore, with the implementation of REC-2, the San Luis Reservoir Expansion Alternative's incremental contribution to this significant cumulative effect on trail access and overcrowding would not be cumulatively considerable.**

S.3.16.4 Alternative 5 - Pacheco Reservoir Expansion Alternative

The Pacheco Reservoir Expansion Alternative consists constructing a new dam at the Pacheco Reservoir, which would allow for more storage and a pump station to connect to the Pacheco Conduit. This Alternative would inundate a portion of land upstream from the dam and would increase the existing surface area. However, the project is not within proximity to any recreational facilities and would not result in any impacts to recreation. Therefore, no cumulative activities or projects have been identified that, in combination with project construction, would affect recreation resources. **The Pacheco Reservoir Expansion Alternative would have no cumulative effects on recreation.**

S.3.17 Environmental Justice

S.3.17.1 Alternative 2 - Lower San Felipe Intake Alternative

Expose a minority and or low-income population to adverse or disproportionately high effects or hazards from project construction in combination with other cumulative projects. Under the Lower San Felipe Intake Alternative, construction of a lower intake at the San Luis Reservoir has the potential to adversely and disproportionately affect minority populations within the San Luis Reservoir region including Census Tracts 20, 21, Census Tract 21/Block Group 1, 22.01, 22.02, 23.01 and 23.02 and a low-income population group in Census Tract 22.01.

The San Luis Reservoir SRA RMP/GP has been identified as a cumulative project with the potential to contribute to construction related effects to minority and/or low-income populations surrounding the reservoir. The plan includes a Park Plan, identifying construction related park improvements over a twenty five year period, starting at the time of adoption. This plan has yet to be adopted; however, if adopted prior to the completion of the lower intake construction period, it is assumed that some of the proposed park improvements could be concurrently constructed during the construction period of the lower intake.

The B.F. Sisk Dam SOD Modification Project has been identified as a cumulative project with the potential to contribute to construction related effects to minority and/or low-populations surrounding the reservoir. The project proposes modifications to the B.F. Sisk Dam embankment to improve dam safety conditions. The San Luis Solar Project has been identified as a cumulative project with the potential to contribute to construction related effects to minority and/or low-populations surrounding the reservoir. The project proposes a 30-year land use authorization to access, install, operate, maintain and remove a 26-megawatt alternating current solar photovoltaic energy generating project in and adjacent to the San Luis SRA. Project construction would be congruent with construction of the lower intake facility. The San Luis Transmission Project has been identified as a cumulative project with the potential to contribute to construction related effects to minority and/or low-income populations surrounding the reservoir. The project proposes the construction, maintenance, and operation of new transmission lines, which would be located adjacent to existing lines in Alameda, San Joaquin, Stanislaus, and Merced Counties. Additional components of the project include a new 230-kilovolts (kV) line terminal bays at the Western Area Power Administration's (Western) San Luis and Dos Amigos Substation, as well as a new 230/700-kV transformer bank and interconnection facilities at the San Luis Substation, and auxiliary facilities. The project would be constructed and operated between 2017 and 2021. If construction of the lower intake begins prior to 2021 it is assumed that some of the projects components could be concurrently constructed during the construction period of the lower intake.

Multiple, simultaneous construction projects at the San Luis Reservoir SRA, could increase the likelihood of minority and/or low-income populations being adversely and disproportionately affected by air quality related construction effects. If construction of the lower intake and implementation of other construction projects at the San Luis Reservoir SRA occurred at the same time, the Lower San Felipe Intake Alternative could contribute to a disproportionate adverse cumulative effect on minority and/or low-income populations. The Lower San Felipe Intake Alternative's incremental contribution to this effect would be cumulatively considerable.

S.3.17.2 Alternative 3 - Treatment Alternative

Expose a minority and or low-income population to adverse or disproportionately high effects or hazards from project construction in combination with other cumulative projects. Under the Treatment Alternative, construction of treatment upgrades would occur on SCVWD privately owned land at the Santa Teresa WTP. The Santa Teresa WTP Census Tract 5119.11 is not considered a minority affected area. However, at a regional level, Santa Clara County has been identified as a minority affected area.

The Santa Teresa WTP lies within the City of San Jose City Council District 2 boundaries, four development projects have been identified as cumulative projects with the potential to contribute to construction related effects to the identified minority populations. These projects include the Young Ranch Residential Project, Equinix Data Center, San Jose Behavior Health Hospital, and Blanchard Road Warehouse/Distribution Center. All projects propose major construction related activities.

If the proposed treatment retrofit is developed during the construction period of any of the identified cumulative projects or plan, retrofit development could increase construction-related impacts on minority populations in addition to those already anticipated from the other cumulative construction projects. However, any potential effects from construction would be temporary, and would be reduced by mitigation measures discussed in Sections 4.7 - Air Quality, 4.10 - Noise and Vibration, and 4.11 - Traffic and Transportation.

S.3.17.3 Alternative 4 - San Luis Reservoir Expansion Alternative

Expose a minority and or low-income population to adverse or disproportionately high effects or hazards from project construction in combination with other cumulative projects. Construction of the San Luis Reservoir Expansion Alternative has the potential to adversely and disproportionately affect minority populations within the San Luis Reservoir region including Census Tracts 20, 21, Census Tract 21/Block Group 1, 22.01, 22.02, 23.01 and 23.02 and a low-income population group in Census Tract 22.01.

Similar to the cumulative projects described above for the Lower San Felipe Intake Alterative, the *San Luis Reservoir SRA RMP/GP*, the San Luis Solar Project and the San Luis Transmission Project have been identified as cumulative projects with the potential to contribute to construction related effects to minority and/or low-income populations surrounding the reservoir.

Multiple, simultaneous construction projects at the San Luis Reservoir SRA, could increase the likelihood of minority and/or low-income populations being adversely and disproportionately affected by air quality related construction effects. If construction of the reservoir expansion and implementation of other construction projects at the San Luis Reservoir SRA occurred at the same time, the San Luis Reservoir Expansion Alternative could contribute to a disproportionate adverse cumulative effect on minority and/or low-income populations. The San Luis Reservoir Expansion Alternative's incremental contribution to this effect would be cumulatively considerable.

S.3.17.4 Alternative 5 – Pacheco Reservoir Expansion Alternative

Expose a minority and or low-income population to adverse or disproportionately high effects or hazards from project construction in combination with other cumulative projects. Under the Pacheco Reservoir Expansion Alternative, construction of the new reservoir would occur within Census Tract 5135, which is not considered a minority affected area. However, at a regional level, Santa Clara County has been identified as a minority affected area.

The California High Speed Rail has been identified as a cumulative project with the potential to contribute to construction related effects to minority and/ or low-income populations regionally.

If Pacheco Reservoir is developed during the construction period of any of the California High Speed Rail, Pacheco reservoir development could increase construction-related impacts on minority populations in addition to those already anticipated from the other cumulative construction projects. However, any potential effects from construction would be temporary, and would be reduced by mitigation measures discussed in Sections 4.7 - Air Quality, 4.10 - Noise and Vibration, and 4.11 - Traffic and Transportation.

S.3.18 Public Utilities, Services, and Power

S.3.18.1 Alternative 2 - Lower San Felipe Intake Alternative

Construction activities for the Lower San Felipe Intake Alternative, in combination with projects and projections considered for cumulative effects, could result in adverse impacts associated with the provision of governmental services or facilities including fire and police protection, and schools. Short-term construction activities could increase risks to workers and the public.

Construction of the Lower San Felipe Intake Alternative would have a less than significant impact on governmental services including fire and police protection, and schools.

Construction of projects considered for cumulative impact in Merced County including the B.F. Sisk Dam SOD Modification Project, the California High Speed Rail project, the San Luis Transmission Project and the San Luis Solar Project and development projects related to projected growth in the county could create construction-related risks during the same time period. Construction around San Luis Reservoir would be temporary and the implementation of emergency response or remediation and containment plans, as well as compliance with OSHA standards, would ensure that risks are properly managed and emergency situations are efficiently handled if they do occur. The majority of future construction work associated with projects considered for cumulative impacts would be completed by residents within the region. Thus, there would not be large population growth related to construction activities.

The impact analysis of general plan alternatives at the reservoir describes that future increases in population could lead to increases in demand for recreation at the reservoir. Thus, increased demand for emergency services would occur under each alternative considered for future development and expansion at the reservoir. The *San Luis Reservoir SRA RMP/GP* proposes specific mitigation measures to reduce impacts to the provision of public services. **As noted above, impacts associated with the Lower San Felipe Intake Alternative would be short-term and less than significant. Moreover, mitigation associated with other projects at San Luis Reservoir would ensure that impacts to public services would be less than significant. Cumulative impacts of the Lower San Felipe Intake Alternative, in combination with other projects at San Luis Reservoir, would not result in significant impacts on fire or police protection or schools.**

Construction activities under the Lower San Felipe Intake Alternative, in combination with projects and projections considered for cumulative effects could result in the need for new water, wastewater, or stormwater facilities. Projected population growth in Merced County could result in the need for new water supply facilities and related adverse physical impacts from their construction. Construction of water supply facilities under the Lower San Felipe Intake Alternative would be located at the reservoir and would not generate new demands on water supplies or wastewater treatment capacity.

Future growth and development in Merced County would likely require the construction and extension of water supply pipelines and wastewater and stormwater infrastructure close to where the growth and development takes place. This would be located in the vicinity of already developed urban areas in the county, not in close proximity to the reservoir.

The *San Luis Reservoir SRA RMP/GP* describes that, under all future development alternatives at the reservoir, maintenance and safety upgrades would be required. While increased visitation to the SRA under the alternatives in the *San Luis Reservoir SRA RMP/GP* would lead to an increased demand on water supply and wastewater facilities, the alternatives include varying amounts of utility upgrades in order to handle increased demands.

Utility upgrades at the reservoir proposed under the *San Luis Reservoir SRA RMP/GP* would be focused on providing water and wastewater services to visitors, and would expand on existing facilities in order to increase visitor capacity. Two of the development alternatives in the proposed *San Luis Reservoir SRA RMP/GP* include construction of new visitor and recreational facilities and could have impacts on public utilities during construction (Reclamation and CDPR 2013). These impacts, which include disruption to utility service during construction, would be minor after mitigation.

It is unlikely that the construction of new visitor facilities would occur at the same time as the construction associated with the alternatives discussed in this document, so no cumulative impacts associated with construction would be expected. Additionally, the Lower San Felipe Intake Alternative would not have a long term impact the visitor areas or infrastructure of the SRA.

The B.F. Sisk Dam SOD Modification Project proposes modifications to the B.F. Sisk Dam embankment to improve dam safety conditions. The San Luis Transmission Project would develop approximately 95 miles of new transmission lines connecting the Tracy Substation and the Dos Amigos Substation with segments crossing O'Neill Forebay and connecting to the San Luis Substation. The San Luis Solar Project would develop a new 108 acre solar facility adjacent to the SR 152 crossing of O'Neill Forebay. Both of these cumulative projects would introduce new impervious surfaces but would not generate new demands on water or wastewater systems. Construction of f these projects would, similar to the Lower San Felipe Intake Alternative, be subject to a SWPPP that would require the implementation of BMPs to control stormwater runoff during construction.

No additional stormwater or wastewater facilities are proposed under this project, and no cumulative impacts to these utilities is expected as a result of implementation. **The Lower San Felipe Intake Alternative in combination with the other cumulative projects and plans in the study area would not contribute to any significant cumulative impacts on demands on water, wastewater, or stormwater facilities.**

Construction activities would generate solid waste, the disposal of which could, in combination with projects and projections considered for cumulative effects, exceed the capacity of landfills designated to accommodate the project's solid waste disposal needs. The landfill proposed for disposal of construction debris from the Lower San Felipe Intake Alternative would not be adversely affected

by the alternative. Over time, construction debris from the B.F. Sisk Dam SOD Modification Project and the California High Speed Rail construction as well as from future growth and development throughout Merced County could cause the landfill to reach capacity. There are two regional landfills in the area, both of which contain adequate space for the small amount of material expected to be disposed of as a result of the Lower San Felipe Intake Alternative. The Billy Wright landfill, which would be the primary landfill utilized by this project, is expected to reach capacity in 2054 under normal operations (CalRecycle 2016a). Construction debris from the alternative would comprise approximately 0.01 percent of the remaining capacity at this landfill. Another landfill in the county, the SR 59 Landfill, is projected to cease operations in 2030 (CalRecycle 2016b), and will not be used by this project. Earthen fill and other inert material generated by the tunnel boring and other excavation activities will be disposed of on-site and not transported to the area landfills. The Lower San Felipe Intake Alternative's contribution to the regional landfills' remaining capacity would be minimal. **The Lower San Felipe Intake Alternative's contribution to the significant cumulative effect from future construction projects and population growth on regional landfill capacity would not be cumulatively considerable.**

Construction activities involved in the Lower San Felipe Intake Alternative, in combination with projects and projections considered for cumulative effects could result in adverse impacts associated with the use and/or depletion of local or regional energy supplies. Temporary power facilities would be used during construction of the Lower San Felipe Intake Alternative. Construction-related energy use would not result in adverse impacts to energy supplies at the reservoir or in the larger Merced area because of the use of generators. Use of power supplies at the reservoir during construction would not change existing operations at the reservoir. Other construction at the reservoir and in the county would also utilize local energy resources. However, the energy demand associated with construction of the cumulative projects, including the Lower San Felipe Intake Alternative, could be met by regional supplies, especially with in the case of the Lower San Felipe Intake Alternative construction efforts using generators as necessary. **Therefore, the Lower San Felipe Intake Alternative would not contribute to any significant cumulative impact on regional energy supplies.**

Operations of the Lower San Felipe Intake Alternative in combination with projects and projections considered for cumulative effects could result in increases in stormwater runoff and the need for new stormwater drainage facilities. Construction of the B.F. Sisk Dam SOD Modification Project, rail facilities as part of the California High Speed Rail project, the San Luis Transmission Project and the San Luis Solar project would have to comply with NPDES permit requirements and measures identified in a SWPPP. Additionally, stormwater related impacts from the Lower San Felipe Intake Alternative would be localized around the reservoir; thus, stormwater impacts from the California High Speed Rail project would not cumulatively add to

runoff effects at the reservoir. As described in the *San Luis Reservoir SRA RMP/GP*, implementation of the management and development alternatives at the reservoir would include utility upgrades. Thus, stormwater would continue to be managed onsite. Stormwater associated with operation of the San Luis Solar project would also be managed onsite with permanent BMPs planned as part of the project design (Reclamation 2015b). **Therefore, cumulative impacts to stormwater drainage facilities at San Luis Reservoir would be less than significant.**

Long-term operations of the hypolimnetic aeration system and increases in pumping at the Pacheco Pumping Plant, in combination with projects and projections considered for cumulative effects, could result in the need for additional capacity of energy supplies or the depletion of local or regional energy supplies. Energy supplies for the operation of the aeration system would be planned in coordination with Pacific Gas & Electric (PG&E). In the case that PG&E determines their existing resources cannot accommodate long-term operations of an air compressor to power the aeration facility, a liquid oxygen (LOX) tank and vaporizers would be used to operate the hypolimnetic aeration system. When determining the most efficient and reliable source of power for the aeration system, PG&E would consider projected energy demands in their service area. In addition, San Felipe Division diversions would not be interrupted by low point conditions and the Pacheco Pumping Plant and associated facilities would have the ability to operate more frequently. While these facilities require electricity to operate, they were constructed to be able to operate at their maximum capacity; thus, they have the electrical capacity to continue to operate under the Lower San Felipe Intake Alternative. Overall, changes in operation of the Pacheco Pumping Plant and associated facilities resulting from the ability to withdraw water from a lower elevation would not result in the need for additional energy supplies and would not result in the substantial depletion of local or regional energy supplies.

The California High Speed Rail Authority (HSRA) and the California Energy Resources Conservation and Development Commission (ERCDC) have entered into a Memorandum of Understanding (MOU) regarding the expanded use of renewable energy for the High Speed Rail project, buildings which emit and use zero net energy, and zero emission vehicles in California. The HSRA has committed to powering the project facility with 100 percent renewable energy sources, including the production of renewable energy on its facilities (CHSRA 2016). The long term power consumption of the compressed air system in combination with the High Speed Rail project is not considered to be cumulatively considerable because of HSRA's commitment for 100 percent renewable energy sources. **Therefore, the Lower San Felipe Intake Alternative would not contribute to any significant cumulative impact on regional energy supplies.**

S.3.18.2 Alternative 3 - Treatment Alternative

Construction activities for the Treatment Alternative, in combination with projections considered for cumulative effects, could result in substantial adverse impacts associated with the provision of governmental services and public utilities including water supply, wastewater, or stormwater facilities. Construction activities would take place at the existing Santa Teresa WTP and would not significantly increase risks to workers or the public. Additionally, construction would not increase water demand or the need for wastewater or stormwater facilities. Potable water and wastewater handling capacity demands generated by construction activities and the presence of construction workers would be met by existing local facilities and temporary/portable drinking water and waste disposal facilities. Future growth and development in the City of San Jose and in other areas of Santa Clara County could increase demands on governmental services and public utilities; however, the construction of this project would not create a significant impact to government services or public utilities, or contribute to increased growth in the project area. **Therefore, the alternative's incremental contribution to the significant cumulative effect would not be cumulatively considerable.**

Construction activities would generate solid waste, the disposal of which, in combination with projections considered for cumulative effects, could exceed the capacity of landfills designated to accommodate the project's solid waste disposal needs. Construction debris generated during construction of the Treatment Alternative would take up approximately 0.2 percent of the existing capacity at the Guadalupe Sanitary Landfill. Future growth and development in San Jose and other areas of Santa Clara County could produce debris and solid waste that exceeds the capacity of local landfills, and lead to significant cumulative impact; however, the Treatment Alternative's incremental contribution to local landfill capacity would be minimal. **The Treatment Alternative's incremental contribution to the significant cumulative effect associated with exceeding the capacity of the landfill would not be cumulatively considerable.**

Construction activities, in combination with projections considered for cumulative effects, could result in adverse impacts associated with the use and/or depletion of local or regional energy supplies. Construction equipment would require the use of temporary onsite generators and vehicle fuels. Construction would be temporary and energy resources used during construction would be supplied by the contractor. Energy used during construction would not interfere with surrounding residential, commercial, or industrial energy supplies and use. Energy used during construction of commercial, residential, and industrial development projected through future growth scenarios in the county could place increased demands on local and regional energy supplies, and lead to a significant cumulative impact. However, the energy demand associated with the cumulative projects, including the Treatment Alternative, could be met be regional supplies, especially with construction efforts using generators as necessary. **Therefore, the Treatment**

Alternative's incremental contribution to significant energy impacts would not be cumulatively considerable.

Operations of technology retrofits, in combination with projections considered for cumulative effects could result in the need for new water treatment or stormwater drainage infrastructure, the construction of which could cause significant environmental impacts. Future growth and development within the county could result in the need for new water treatment and stormwater drainage infrastructure. Long-term operations of the Santa Teresa WTP would not differ significantly from existing operations at the site and would not result in a substantial increase in stormwater runoff that would exceed the capacity of the existing stormwater drainage system. The Treatment Alternative would not result in the need for new treatment plants or stormwater infrastructure because the alternative would not substantially increase impervious surfaces or increase point source drinking water or wastewater demands; **Therefore, the alternative's incremental contribution to the significant cumulative effect on the need for new public utilities would not be cumulatively considerable.**

Solid waste generated during operation of technology retrofits at the Santa Teresa WTP in combination with projections considered for cumulative effects could exceed the capacity of a local landfill. Future growth and development in San Jose and other areas of the county could produce debris and solid waste that exceeds the capacity of local landfills, creating a significant cumulative impact when added to the Treatment Alternative's impact. Additionally, the new processes at the WTP as a part of the Treatment Alternative would recover more solids from the raw water delivered to the plants than currently possible. Dried sludge recovered through the treatment process would be disposed of in a local landfill. As described above, in Santa Clara County, there are at least five solid waste landfills that are available for waste disposal. The closest landfill to Santa Teresa is the Guadalupe Sanitary Landfill in San Jose. There would be adequate capacity to serve solid waste disposal needs for operation and maintenance of Santa Teresa WTP. The cumulative contributions of the Treatment Alternative to area landfills remaining capacity would be minimal. **Therefore, the Treatment Alternative's incremental contribution to the significant cumulative effect of regional population growth on local landfill capacity would not be cumulatively considerable.**

Long-term operations of technology retrofits in combination with projections considered for cumulative effects could result in the need for additional capacity of energy supplies or the depletion of local or regional energy supplies. Future growth and development in Santa Clara County could stress energy resources, creating a significant cumulative impact when added to the Treatment Alternative's impact. Under the Treatment Alternative, SCVWD operations would remain largely unchanged except during periods of low point conditions in San Luis Reservoir (typically August and September). During pilot testing of the ballasted clarification, the electrical system capacity at the WTP would be analyzed in greater detail to understand any necessary upgrades.

These technologies do not add significantly to the electrical demands of the water treatment processes and would not result in adverse effects related to the depletion of local or regional energy supplies. The increased energy demand associated with the Treatment Alternative, would be met be regional suppliers and would be minimal. **Therefore, the Treatment Alternative's incremental contribution to the significant cumulative energy impacts would not be cumulatively considerable.**

S.3.18.3 Alternative 4 - San Luis Reservoir Expansion Alternative

Construction activities for the San Luis Reservoir Expansion Alternative, in combination with projects and projections considered for cumulative effects, could result in adverse impacts associated with the provision of governmental services or facilities including fire and police protection, and schools. Construction of the San Luis Reservoir Expansion Alternative would have a less than significant impact on governmental services including fire and police protection, and schools. The impacts generated by cumulative projects and plans in the study area, described above under the Lower San Felipe Intake Alternative would also be less than significant. Impacts associated with the San Luis Reservoir Expansion Alternative would be short-term and less than significant. Moreover, mitigation associated with other projects at San Luis Reservoir would ensure that impacts to public services would be less than significant. **Cumulative impacts of the San Luis Reservoir Expansion Alternative, in combination with other projects at San Luis Reservoir, would not result in significant impacts on fire or police protection or schools.**

Construction activities associated with the San Luis Reservoir Expansion Alternative, in combination with projects and projections considered for cumulative effects could result in the need for new water, wastewater, or stormwater facilities. Construction of the San Luis Reservoir Expansion Alternative would have a less than significant impact on any changes in demand for new water, wastewater, or stormwater facilities.

The impacts generated by cumulative projects and plans in the study area, described above under the Lower San Felipe Intake Alternative would also contribute to the cumulative condition under the San Luis Reservoir Expansion Alternative. These cumulative effects with the implementation of mitigation actions would be less than significant. **The San Luis Reservoir Expansion Alternative in combination with the other cumulative projects and plans in the study area would not contribute to any significant cumulative impacts on demands on water, wastewater, or stormwater facilities.**

Construction activities would generate solid waste, the disposal of which could, in combination with projects and projections considered for cumulative effects, exceed the capacity of landfills designated to accommodate the project's solid waste disposal needs. Disposal of construction debris from the San Luis

Reservoir Expansion Alternative would generate a less than significant impact on remaining capacity at the landfill proposed for use. Over time, construction debris from the California High Speed Rail, the San Luis Solar Project and San Luis Transmission Project construction as well as from future growth and development throughout Merced County could however cause the landfill to reach capacity more quickly than originally planned when the facility was developed. There are two regional landfills in the area, both of which contain adequate space for the small amount of material expected to be disposed of as a result of this project. The Billy Wright landfill, which would be the primary landfill utilized by this project, is expected to reach capacity in 2054 under normal operations (CalRecycle 2016a). Construction debris from the alternative would comprise less than 1 percent of the remaining capacity at this landfill. Another landfill in the county, the SR 59 Landfill, is projected to cease operations in 2030 (CalRecycle 2016b), and will not be used by this project. The San Luis Reservoir expansion's incremental contribution to the regional landfills' remaining capacity would be minimal. **The San Luis Reservoir Expansion Alternative s contribution to the significant cumulative effect from future construction projects and population growth on regional landfill capacity would not be cumulatively considerable.**

Construction activities involved in the San Luis Reservoir Expansion Alternative, in combination with projects and projections considered for cumulative effects could result in adverse impacts associated with the use and/or depletion of local or regional energy supplies. Temporary power facilities would be used during construction of the San Luis Reservoir Expansion Alternative. Construction-related energy use would not result in adverse impacts to energy supplies at the reservoir or in the larger Merced area because of the use of generators or connections to existing power supplies at Gianelli Pumping Plant. Use of power supplies at the reservoir during construction would not change existing operations at the reservoir. Other construction at the reservoir and in the county would also utilize local energy resources. However, the energy demand associated with the cumulative projects, including the San Luis Reservoir Expansion Alternative, could be met by regional supplies, especially with in the case of the San Luis Reservoir Expansion Alternative expansion construction efforts using generators as necessary. **Therefore, the San Luis Reservoir Expansion Alternative would not contribute to any significant cumulative impact on regional energy supplies.**

Long-term operations of the San Luis Reservoir Expansion Alternative, in combination with projects and projections considered for cumulative effects, could result in the need for additional capacity of energy supplies or the depletion of local or regional energy supplies. Use of the existing Gianelli Pumping Plant to fill the new expanded space in San Luis Reservoir with additional water supply would require additional electricity when compared to existing operations. The projected frequency of this new storage capacity being filled is infrequent. In years when it is filled, the existing 10,600 megawatts of

production capacity in the Western Area Power Administration (WAPA) system can meet this increased demand.

The California HSRA and the ERCDC have entered into a MOU regarding the expanded use of renewable energy for the High Speed Rail project, buildings which emit and use zero net energy, and zero emission vehicles in California. The HSRA has committed to powering the project facility with 100 percent renewable energy sources, including the production of renewable energy on its facilities (CHSRA 2016). The long term power consumption of the compressed air system in combination with the High Speed Rail project is not considered to be cumulatively considerable because of HSRA's commitment for 100 percent renewable energy sources. **Therefore, the San Luis Reservoir Expansion Alternative would not contribute to any significant cumulative impact on regional energy supplies.**

S.3.18.4 Alternative 5 - Pacheco Reservoir Expansion Alternative

Construction activities for the Pacheco Reservoir Expansion Alternative, in combination with projects and projections considered for cumulative effects, could result in adverse impacts associated with the provision of governmental services or facilities including fire and police protection, and schools. Construction of the Pacheco Reservoir Expansion Alternative would have a less than significant impact on governmental services including fire and police protection, and schools. The impacts generated by cumulative projects and plans in the study area, described above under the Lower San Felipe Intake Alternative would also be less than significant. Impacts associated with the Pacheco Reservoir Expansion Alternative would be short-term and less than significant. Moreover, mitigation associated with other projects in the area would ensure that impacts to public services would be less than significant. **Cumulative impacts of the Pacheco Reservoir Expansion Alternative, in combination with other projects in the area, would not result in significant impacts on fire or police protection or schools.**

Construction activities associated with the Pacheco Reservoir Expansion Alternative, in combination with projects and projections considered for cumulative effects could result in the need for new water, wastewater, or stormwater facilities. Construction of the Pacheco Reservoir Expansion Alternative would have a less than significant impact on any changes in demand for new water, wastewater, or stormwater facilities.

The impacts generated by cumulative projects and plans in the study area, would also contribute to the cumulative condition under the Pacheco Reservoir Expansion Alternative. These cumulative effects with the implementation of mitigation actions would be less than significant. **The Pacheco Reservoir Expansion Alternative in combination with the other cumulative projects and plans in the study area would not contribute to any significant**

cumulative impacts on demands on water, wastewater, or stormwater facilities.

Construction activities would generate solid waste, the disposal of which could, in combination with projects and projections considered for cumulative effects, exceed the capacity of landfills designated to accommodate the project's solid waste disposal needs. Disposal of construction debris from the Pacheco Reservoir Expansion Alternative would generate a less than significant impact on remaining capacity at the landfill proposed for use. Over time, construction debris from the B.F. Sisk Dam SOD Modification Project and the California High Speed Rail construction as well as from future growth and development throughout Santa Clara County could however cause the landfill to reach capacity more quickly than originally planned when the facility was developed. There are two regional landfills in the area, both of which contain adequate space for the small amount of material expected to be disposed of as a result of this project. The Billy Wright landfill, which would be the primary landfill utilized by this project, is expected to reach capacity in 2054 under normal operations (CalRecycle 2016a). Construction debris from the alternative would comprise less than 1 percent of the remaining capacity at this landfill. Another landfill in the county, the SR 59 Landfill, is projected to cease operations in 2030 (CalRecycle 2016b), and will not be used by this project. The Pacheco Reservoir Expansion Alternative's incremental contribution to the regional landfills' remaining capacity would be minimal. **The Pacheco Reservoir Expansion Alternative's contribution to the significant cumulative effect from future construction projects and population growth on regional landfill capacity would not be cumulatively considerable.**

Construction activities involved in the Pacheco Reservoir Expansion Alternative, in combination with projects and projections considered for cumulative effects could result in adverse impacts associated with the use and/or depletion of local or regional energy supplies. Temporary power facilities would be used during construction of the Pacheco Reservoir Expansion Alternative. Construction-related energy use would not result in adverse impacts to energy supplies in the area because of the use of generators. Other construction in the county would also utilize local energy resources. However, the energy demand associated with the cumulative projects, including the Pacheco Reservoir Expansion Alternative, could be met by regional supplies, especially with in the case of the Pacheco Reservoir Expansion Alternative construction efforts using generators as necessary. **Therefore, the Pacheco Reservoir Expansion Alternative would not contribute to any significant cumulative impact on regional energy supplies.**

Long-term operations of the Pacheco Reservoir Expansion Alternative, in combination with projects and projections considered for cumulative effects, could result in the need for additional capacity of energy supplies or the depletion of local or regional energy supplies. Use at the new pump station to import and export water in and out of the expanded Pacheco Reservoir.

Operation of the new reservoir would also increase total electricity use at the new pump station to import and export water in and out of the reservoir would require additional electricity when compared to existing operations. The existing 70 kV PG&E transmission line would be upgraded to support the additional load required by the new pump station.

The CHSRA and the ERCDC have entered into a MOU regarding the expanded use of renewable energy for the High Speed Rail project, buildings which emit and use zero net energy, and zero emission vehicles in California. The HSRA has committed to powering the project facility with 100 percent renewable energy sources, including the production of renewable energy on its facilities (CHSRA 2016). The long term power consumption of the compressed air system in combination with the High Speed Rail project is not considered to be cumulatively considerable because of HSRA's commitment for 100 percent renewable energy sources. **Therefore, the Pacheco Reservoir Expansion Alternative would not contribute to any significant cumulative impact on regional energy supplies.**

S.3.19 Cultural Resources

S.3.19.1 Alternative 2 - Lower San Felipe Intake Alternative

The B.F. Sisk Dam SOD Modification Project, the California High Speed Rail Project, the San Luis Transmission Line Project, the San Luis Solar Project, and implementation of the *San Luis Reservoir SRA RMP/GP* have all been identified as cumulative actions that could contribute to cultural resource impacts during construction of the Lower San Felipe Intake Alternative. Each of these projects, similar to the Lower San Felipe Intake Alternative, could result in significant impacts to known and previously unreported cultural resources. Ground disturbing activities within the Lower San Felipe Intake Alternative Area of Potential Effect (APE), including the excavation of borrow pits, dredging, and the use or modification of staging areas and haul roads may alter or destroy cultural resources that are listed or may be eligible for listing in the National Register of Historic Places (NRHP) and/or the Center for Regional Heritage Research (CRHR). **Implementation of the Lower San Felipe Intake Alternative, when taken together with the cumulative actions noted above, could result in significant cumulative effects to cultural resources under CEQA.**

If the Lower San Felipe Intake Alternative is selected, CEQA Mitigation Measure CR-1, CR-2, and CR-3 would be implemented prior to signing a ROD. Because the APE for the proposed intake area is inundated and will remain so during construction of the tunnel or pipeline option, however, no mitigation measures are available to reduce the significance of potential impacts to known or previously unreported cultural resources in that location. **Therefore, even with the implementation of Mitigation Measure CR-1, CR-2, and CR-3 , the Lower San Felipe Intake Alternative's incremental contribution to**

significant cumulative effects on cultural resources within the Lower San Felipe Intake project area may be cumulatively considerable.

Adverse effects, as described in Section 106 of the National Historic Preservation Act (NHPA), could occur to historic properties if this alternative is implemented and would need to be mitigated. Avoidance, minimization of impacts, and/or mitigation measures, determined through completion of the Section 106 process, would be required prior to implementation of this alternative.

S.3.19.2 Alternative 3 - Treatment Alternative

No other cumulative activities or projects that would result in impacts to potentially significant cultural resources have been identified that would take place at the same time as construction of the Treatment Alternative. Technological retrofits proposed within the existing boundaries of the Santa Teresa WTP would result in no impacts to known cultural resources, therefore **the Treatment Alternative would not contribute to cumulative cultural resource impacts in the Project area.**

S.3.19.3 Alternative 4 - San Luis Reservoir Expansion Alternative

The California High Speed Rail Project, the San Luis Transmission Line Project, the San Luis Solar Project, and implementation of the *San Luis Reservoir SRA RMP/GP* have all been identified as cumulative actions that could contribute to cultural resource impacts during construction of the San Luis Reservoir Expansion Alternative. Each of these projects could, similar to the San Luis Reservoir Expansion Alternative, result in significant impacts to known and previously unreported cultural resources. Ground disturbing activities within the San Luis Reservoir Expansion Alternative APE, including raising the B.F. Sisk Dam, excavating borrow pits, modifying or using staging areas and haul roads, and inundation or erosion through the expansion of the reservoir may alter or destroy cultural resources that are listed or may be eligible for listing in the NRHP and/or the CRHR. **Implementation of the San Luis Reservoir Expansion Alternative, when taken together with the cumulative actions noted above, could result in significant cumulative effects to known and previously unrecorded cultural resources under CEQA.**

If the San Luis Reservoir Expansion Alternative is selected, CEQA Mitigation Measure CR-1, CR-2, and CR-3 would be implemented prior to signing a ROD. Because the APE for the expanded reservoir area will be subject to unavoidable mechanical and biochemical impacts, however, no mitigation measures are available to reduce the significance of potential impacts to known or previously unreported cultural resources to a level that is less than significant. **Therefore, even with the implementation of Mitigation Measure CR-1, CR-2, and CR-3, the San Luis Reservoir Expansion Alternative's incremental**

contribution to significant cumulative effects on cultural resources within the Lower San Felipe Intake project area may be cumulatively considerable.

Adverse effects, as described in Section 106 of the NHPA, could occur to historic properties if this alternative is implemented and would need to be mitigated. Avoidance, minimization of impacts, and/or mitigation measures, determined through completion of the Section 106 process, would be required prior to implementation of this alternative.

S.3.19.4 Alternative 5 - Pacheco Reservoir Expansion Alternative

The B.F. Sisk Dam SOD Modification Project, the California High Speed Rail Project, the San Luis Transmission Line Project, the San Luis Solar Project, and implementation of the *San Luis Reservoir SRA RMP/GP* have all been identified as cumulative actions that could contribute to cultural resource impacts during construction of the Pacheco Reservoir Expansion Alternative. Similar to the Pacheco Reservoir Expansion Alternative, each of these projects could generate significant impacts to known and previously unreported cultural resources. Ground disturbing activities within the Pacheco Reservoir Expansion Alternative APE, including demolishing the existing North Fork Dam, excavating borrow areas, modifying and using staging areas and haul roads, constructing pipelines/tunnels, and modifying an existing transmission line may alter or destroy cultural resources that are eligible for listing in the NRHP and/or the CRHR. **Implementation of the Pacheco Reservoir Expansion Alternative, when taken together with the cumulative actions noted above, could result in significant cumulative effects to known and previously unrecorded cultural resources under CEQA.**

If the Pacheco Reservoir Expansion Alternative is selected, CEQA Mitigation Measure CR-1, CR-2, and CR-3 would be implemented prior to signing a ROD. Because the APE for the expanded reservoir area will be subject to unavoidable mechanical and biochemical impacts, however, no mitigation measures are available to reduce the significance of potential impacts to known or previously unreported cultural resources to a level that is less than significant. **Therefore, even with the implementation of Mitigation Measure CR-1, CR-2, and CR-3, the Pacheco Reservoir Expansion Alternative's incremental contribution to significant cumulative effects on cultural resources within the Lower San Felipe Intake project area may be cumulatively considerable.**

Adverse effects, as described in Section 106 of the NHPA, could occur to historic properties if this alternative is implemented and would need to be mitigated. Avoidance, minimization of impacts, and/or mitigation measures, determined through completion of the Section 106 process, would be required prior to implementation of this alternative.

S.3.20 Population and Housing

S.3.20.1 Alternative 2 - Lower San Felipe Intake Alternative

Construction of the Lower San Felipe Intake Alternative (tunnel or pipeline options) could have the potential to temporarily induce population growth in the area of analysis and could require new housing to accommodate this growth. The cities expected to accommodate non-local workers for the duration of construction are Los Banos, Newman, Gilroy, and Gustine. As noted above, these cities have projected population growth through 2030 and have planned for this growth through their General Plans by encouraging new development, including new housing. As identified in Table S-9, population increases in Merced and Santa Clara counties through 2030 are expected to be substantial in all of the nearby communities, ranging from 12 percent in Gilroy to almost 83 percent in Los Banos. This projected population increase, and the associated need for increased housing, is considered to be cumulatively significant. The Lower San Felipe Intake Alternative would have the potential to increase the population of any one of these four communities by a maximum of 30 people. These impacts would be temporary and would end after construction as the non-local workers would return to their places of origin. The number of new people attributable to the alternative is less than one percent of the population of any of the individual nearby communities, and only a fraction of one percent of the population of all four communities combined. Moreover, no new housing is expected to be required to be constructed in order to accommodate the temporary workers as sufficient available housing stock is expected to be available. **Therefore, the Lower San Felipe Intake Alternative's incremental contribution to the significant cumulative effect associated with population growth and housing would not be cumulatively considerable.**

There would be no population and housing impacts from operation of this alternative; therefore there would be no cumulative effects.

Table S-9. Population Projections 2016-2030

Community	2016[1]	2030	2030 Population Projection Source
Los Banos	37,012	67,100	Merced County 2012
Gilroy	52,576	57,000	LAFCO Santa Clara County 2015
Newman	10,698	16,525	Stanislaus County 2016
Gustine	5,684	9,000	Merced County 2012
San Jose	1,009,363	1,192,100	LAFCO Santa Clara County 2015
Saratoga	30,830	31,900	
Campbell	40,788	44,800	
Milpitas	73,447	93,600	

Note: [1] U.S. Census Bureau 2016.
Key: LAFCO = Local Area Formation Committee

S.3.20.2 Alternative 3 - Treatment Alternative

Construction of the Treatment Alternative could have the potential to temporarily induce population growth in the area of analysis and could not require new housing to accommodate this growth. The City of San Jose is expected to accommodate non-local workers for the duration of construction. As noted above, San Jose has projected population growth through 2030 and have planned for this growth through their General Plan by encouraging new development, including new housing. As identified in Table S-9, the population increase in San Jose is expected to be almost 21 percent through 2030. This projected population increase, and the associated need for increased housing, is considered to be cumulatively significant. The Treatment Alternative would have the potential to increase the population of these communities by a maximum of 13 people. These impacts would be temporary and would end after construction as the non-local workers would return to their places of origin. The number of new people attributable to the alternative is a fraction of one percent of the population of San Jose. Moreover, no new housing is expected to be required to be constructed in order to accommodate the temporary workers as sufficient available housing stock is expected to be available. **Therefore, the Treatment Alternative's incremental contribution to the significant cumulative effect associated with population growth would not be cumulatively considerable.**

There would be no population and housing impacts from operation of this alternative; therefore there would be no cumulative effects.

S.3.20.3 Alternative 4 - San Luis Reservoir Expansion Alternative

Construction of the San Luis Reservoir Expansion Alternative could have the potential to induce population growth in the area of analysis and could require new housing to accommodate this growth. The cities expected to accommodate non-local workers for the duration of construction of the San Luis Reservoir Expansion Alternative are Los Banos, Newman, Gilroy, and Gustine. As noted above, these cities have projected population growth through 2020 and have planned for this growth through their General Plans by encouraging new development, including new housing. As identified in Table S-9, population increases in Merced and Santa Clara counties through 2020 are expected to be substantial in all of the nearby communities, ranging from 8 percent in Gilroy to almost 50 percent in Los Banos. This projected population increase, and the associated need for increased housing, is considered to be cumulatively significant. The San Luis Reservoir Expansion Alternative would have the potential to increase the population of any one of these four communities by a maximum of 54 people. These impacts would end after construction as the non-local workers would return to their places of origin however given the 8 to 12 year construction schedule of this alternative this effect is consider permanent. The number of new people attributable to the San Luis Reservoir Expansion Alternative is less than one percent of the population of any of the individual nearby communities, and only a fraction of one percent of the population of all

four communities combined. Moreover, no new housing is expected to be required to be constructed in order to accommodate the workers as sufficient available housing stock is expected to be available. **Therefore, the San Luis Reservoir Expansion Alternative's incremental contribution to the significant cumulative effect associated with population growth and housing would not be cumulatively considerable.**

There would be no population and housing impacts from operation of this alternative; therefore there would be no cumulative effects.

S.3.20.4 Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction of the Pacheco Reservoir Expansion Alternative could have the potential to induce population growth in the area of analysis and could require new housing to accommodate this growth. The cities expected to accommodate non-local workers for the duration of construction of the Pacheco Reservoir Expansion Alternative are Los Banos, Newman, Gilroy, and Gustine. As noted above, these cities have projected population growth through 2020 and have planned for this growth through their General Plans by encouraging new development, including new housing. As identified in Table S-9, population increases in Merced and Santa Clara counties through 2020 are expected to be substantial in all of the nearby communities, ranging from 8 percent in Gilroy to almost 50 percent in Los Banos. This projected population increase, and the associated need for increased housing, is considered to be cumulatively significant. The Pacheco Reservoir Expansion Alternative would have the potential to increase the population of any one of these four communities by a maximum of 119 people. These impacts would end after construction as the non-local workers would return to their places of origin however given the 5-year construction schedule of this alternative this effect is consider permanent. The number of new people attributable to the Pacheco Reservoir Expansion Alternative is less than one percent of the population of any of the individual nearby communities, and only a fraction of one percent of the population of all four communities combined. Moreover, no new housing is expected to be required to be constructed in order to accommodate the workers as sufficient available housing stock is expected to be available. **Therefore, the Pacheco Reservoir Expansion Alternative's incremental contribution to the significant cumulative effect associated with population growth and housing would not be cumulatively considerable.**

There would be no population and housing impacts from operation of this alternative; therefore there would be no cumulative effects.

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