BUREAU OF RECLAMATION

Long-Term Operations of the Central Valley Project and State Water Project

Draft Environmental Impact Statement

Central Valley Project, California

Interior Region 10 – California-Great Basin

July 2024

Mission Statements

The U.S. Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated Island Communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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Acronyms and Abbreviations

Term	Definition
CVP	Central Valley Project
Delta	Sacramento–San Joaquin Delta
DMC	Delta Mendota Canal
DWR	California Department of Water Resources
DWR	Department of Water Resources
EIS	environmental impact statement
ESA	Endangered Species Act
FR	Federal Register
M&I	municipal and industrial
MAF	million acre-feet
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
SWP	State Water Project
TAF	thousand acre-feet
USFWS	U.S. Fish and Wildlife Service

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Chapter 0 Executive Summary

0.1 Introduction

The Bureau of Reclamation (Reclamation) prepared this Environmental Impact Statement (EIS) for the 2021 Endangered Species Act Reinitiation of Section 7 Consultation on the Long-Term Operation of the Central Valley Project (CVP) and State Water Project (SWP). This EIS is meant to inform the public and decision-makers on potential federal actions by examining a range of reasonable alternatives and the potential effect on the environment. Reclamation manages the Central Valley Project (CVP). The California Department of Water Resources (DWR) manages the State Water Project (SWP). Collectively, the operation of the CVP and SWP provides flood control and navigation, delivers water to 30 million people, supports 4 million acres of agriculture, maintains 19 wildlife refuges on the Pacific Flyway, protects numerous iconic and endemic species such as Chinook salmon, coho salmon, steelhead, sturgeon, and smelt, generates 4.5 million megawatt hours of electricity, maintains water quality for beneficial uses in the California Bay-Delta, and supports recreation throughout Northern California.

Source: Reclamation

Figure 0-1: Shasta Dam

This summary provides a succinct overview of the development of alternatives in coordination with other agencies and the public, major conclusions for key environmental resource areas, the identification of avoidance and mitigation measures to address potential impacts, and issues that have been in dispute as raised by the public and other interested parties. This summary provides the material required by the Council on Environmental Quality's National Environmental Policy Act (NEPA) Implementing Regulations regarding the contents of an EIS summary.

0.1.1 Background

On January 20, 2021, President Biden issued "Executive Order 13990 on Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis", directing the Department of Interior to review all existing regulations, orders, guidance documents, policies, and any other similar agency actions (agency actions) promulgated, issued, or adopted between January 20, 2017, and January 20, 2021. This included the NMFS Biological Opinion on Long Term Operation of the Central Valley Project and the State Water Project (October 21, 2019) and USFWS Biological Opinion for the Reinitiation of Consultation on the Coordinated Operations of the Central Valley Project and State Water Project (October 21, 2019).

To address the required review, and to voluntarily reconcile CVP operating criteria, as appropriate, with operational requirements of the SWP under the California Endangered Species Act, Reclamation reinitiated consultation with USFWS and NMFS on September 30, 2021. Reclamation must also comply with NEPA for agency decision-making. On February 28, 2022, Reclamation posted a Notice of Intent (NOI) to Prepare an Environmental Impact Statement and Hold Public Scoping Meetings (87 Federal Register [FR] 11093).

0.2 Alternatives

This EIS considers a range of reasonable alternatives, consistent with 40 CFR §1502.14, including a No Action Alternative that would continue implementation of the 2020 Record of Decision on the Reinitiation of Consultation on the Coordinated Long-Term Operation of the CVP and SWP. The purpose of the action being considered is to continue the operation of the CVP and the SWP, for authorized purposes, in a manner that:

- Meets requirements under federal Reclamation law; other federal laws and regulations; and State of California water rights, permits, and licenses pursuant to Section 8 of the Reclamation Act;
- Satisfies Reclamation contractual obligations and agreements; and
- Implements authorized CVP fish and wildlife project purposes and meets federal trust responsibilities to Tribes, including those in the Central Valley Project Improvement Act (CVPIA).

The action alternatives must accomplish the purpose of this proposed action. As part of the EIS process, Reclamation formulated and considered a range of alternatives through a process involving agencies, interested parties, and the public. Reclamation released an Initial Alternatives Report (Reclamation 2022) documenting an analysis of options to inform alternative formulation. Reclamation developed potential options through the NEPA scoping process, coordination under the Water Infrastructure Improvement for the Nation (WIIN) Act, interagency coordination teams, outreach to interested parties, and Reclamation's decades of experience in operating the CVP. Development of initial alternatives relied upon exploratory modeling to simulate potential water operations under a range of criteria. Reclamation then used the Initial Alternatives Report to develop public draft alternatives to be analyzed in this Public Draft EIS for potential impacts on the environment.

The alternatives consider the operation of dams, power plants, diversions, gates, and related facilities of the CVP and the Delta facilities of the SWP. Operation of the CVP and SWP impacts the environment by altering hydrology through storing water in reservoirs, releasing water from storage, blending releases of water from different temperature strata within a reservoir, routing water into different channels, and diverting water for beneficial uses. This EIS analyzes:

- No Action Alternative: continued operation of the CVP and SWP as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. DWR would also operate the SWP consistent with the California Department of Fish and Wildlife's 2020 Incidental Take Permit for the SWP. NEPA requires evaluation of the No Action Alternative.
- Alternative 1 (Water Quality Control Plan (D-1641, 90-5, etc.)): operation to water right terms and conditions, including obligations for water quality control plan objectives for the Bay-Delta, water quality and minimum flows on CVP tributaries, and water right settlements. The needs of listed fish would rely upon habitat restoration and facility improvements completed since the 2008 and 2009 biological opinions rather than on additional flows.
- Alternative 2 (Multi-Agency Consensus): actions developed with the California Department of Fish and Wildlife, DWR, NMFS, and USFWS to harmonize operational requirements of CVP with California Endangered Species Act requirements for the SWP. It includes actions and approaches for the CVP and SWP identified by the state and federal fish agencies, in addition to the water supply and power generation objectives of Reclamation and DWR.
  A Sub-Alternative, "2B", is derived from Alternative 2, but includes components developed by CDFW and DWR during DWR's current Incidental Take Permit application process for the SWP. Alternative 2b is anticipated to result in changes on Delta exports from more restrictive QWEST criteria. Alternative 2B also includes an extension of the CCF operation period to December 1 through March 31 from mid-December through mid-March, effectively increasing the operation of the SWP by one month. These components were not available in time to be included in quantitative modeling.
- Alternative 3 (Modified Natural Hydrograph): operation to increased Delta outflow up to 65% of unimpaired inflow and to carryover storage requirements in addition to other measures. This alternative was developed in coordination with the NGO community.
- Alternative 4 (Risk Informed Operation): modified Shasta and Folsom Dam operations for a different balance between water made available for diversion and storage to protect

against subsequent dry years. It scales Delta operations based on effects to listed fish populations.

A Sub-Alternative, “4B” is derived from Alternative 4, but includes modifications developed by American River interested parties. Operations criteria on the American River vary from Alternative 4 through lower minimum flows and higher carryover storage. Unintended consequences outside the American River geography will be managed by real-time operations to ensure that implementation of Alternative 4B does not result in effects on other Central Valley rivers in the action area other than the American River.

Reclamation has identified Alternative 2B as the preferred alternative. Alternative 2B best meets the Purpose and Need, including the goals of E.O.13990 because NMFS and USFWS reached consensus on an alternative for Reclamation to submit for consultation. Alternative 2B incorporates the Delta criteria proposed in DWR’s ITP for the Delta facilities of the SWP to harmonize operations of the CVP and SWP.

0.3 Major Conclusions

The Alternatives described above establish different objectives for storage, release, and diversion of water that result in different downstream flow, water supply, and power generation impacts that change between wetter and drier periods, as well as seasonally and long-term. This EIS evaluates the potential positive and negative environmental impacts of each alternative on a broad suite of resources that could potentially be affected by the actions. The resources most anticipated to have impacts are summarized below.

0.3.1 Water Quality

The analysis of water quality impacts focuses on constituents of concern that could be affected by changes in CVP and SWP water operations. The Final California 2020-2022 Integrated Report (Clean Water Act [CWA] Section 303(d) List/305(b) Report) and other water quality reports identify constituents of concern. Flow is used as a surrogate for water quality in the EIS water quality analysis. Changes in CVP and SWP operation will change the flow in rivers within the study area. Flow reductions in rivers could result in increased concentrations of constituents of concern because there would be less water in the waterway to dilute runoff containing those constituents. Constituents of concern are present in study area due to urban and agricultural runoff along with legacy drainage from areas that historically had supported mining activities. If the constituent source is downstream from a reservoir, reductions in flow could result in increased constituent of concern concentrations due to reductions in dilution.

In the Trinity and San Joaquin rivers and their tributaries, the changes in river flows under Alternatives 1 through 4 would have minor effects on water quality compared to the No Action Alternative. In the Sacramento River (under Alternatives 1, 3, and 4), Stanislaus River (under Alternatives 2 and 4), and American River (under Alternative 3), changes in flow would have minor effects on water quality. These changes are not of sufficient magnitude to affect the concentration of constituents of concern and would not affect overall water quality.

In Clear Creek, the action alternatives would cause flow reductions in some water year types that could result in water quality degradation. In the Stanislaus River (under Alternatives 1, 2, and 4), American River (under Alternatives 1 and 2), and Sacramento River (under Alternative 3), flow reductions under certain water year types could result in water quality degradation from mercury contamination derived from historical gold mining.

Water quality in the Bay-Delta is influenced by Delta outflow, Delta inflow, and the position of X2 (see Figure 0-2: Delta Outflow AveragesFigure 0-2, Figure 0-3, and Figure 0-4).

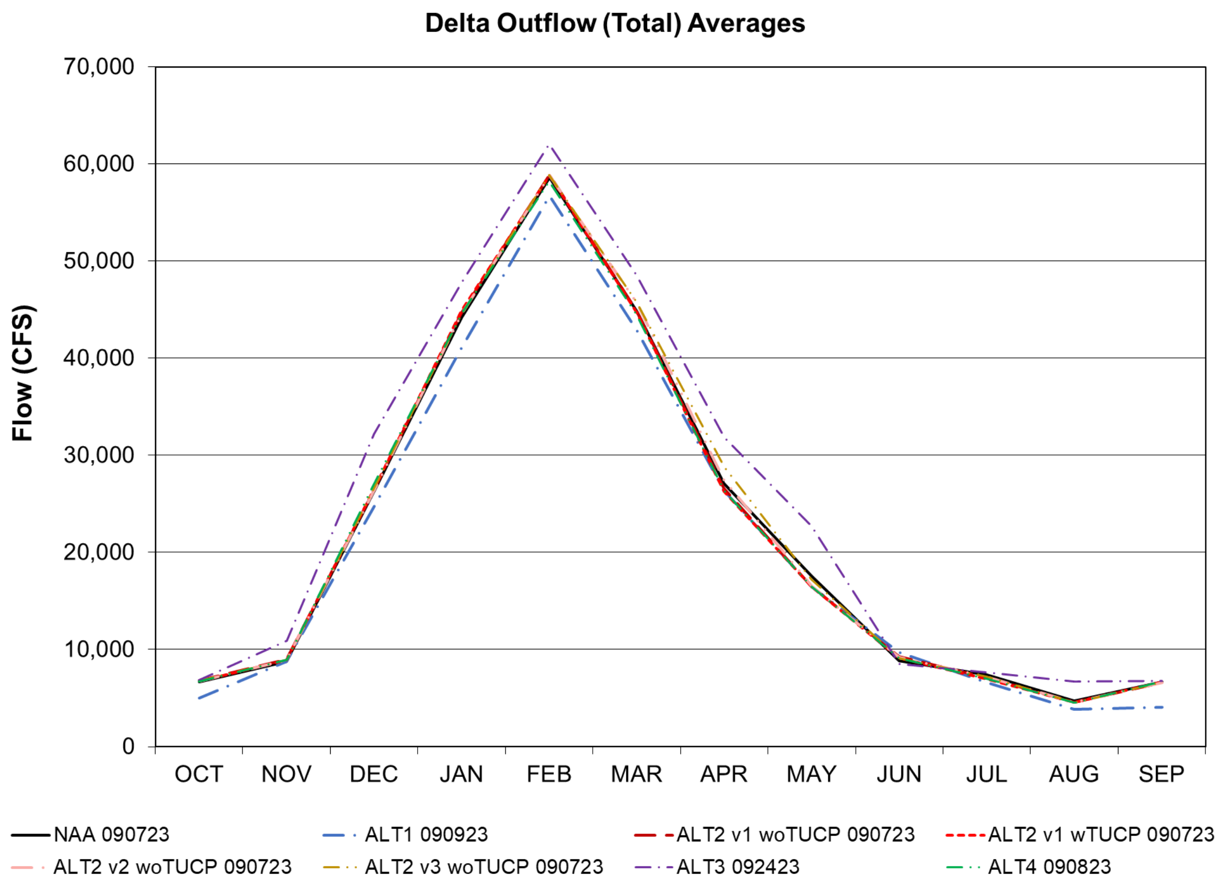

Figure 0-2: Delta Outflow Averages

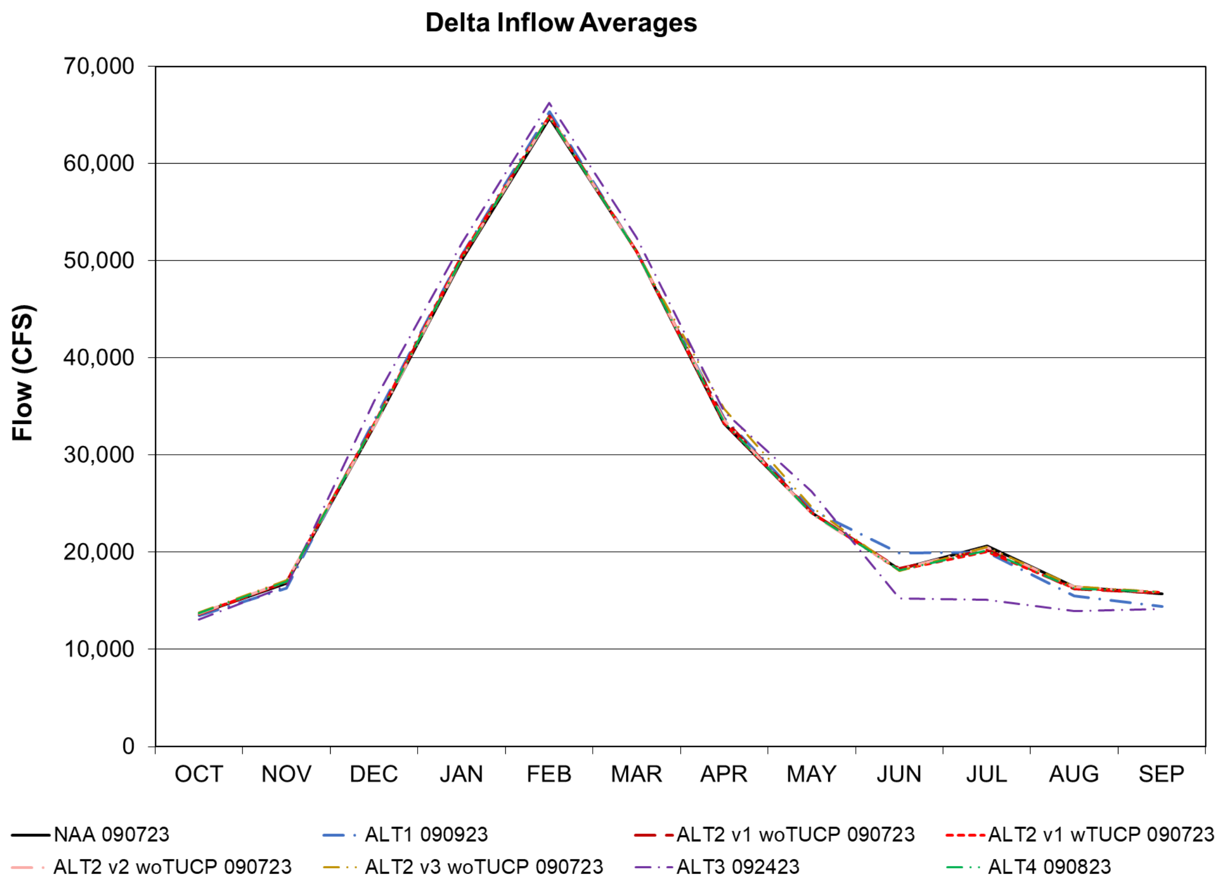

Figure 0-3. Delta Inflow Averages

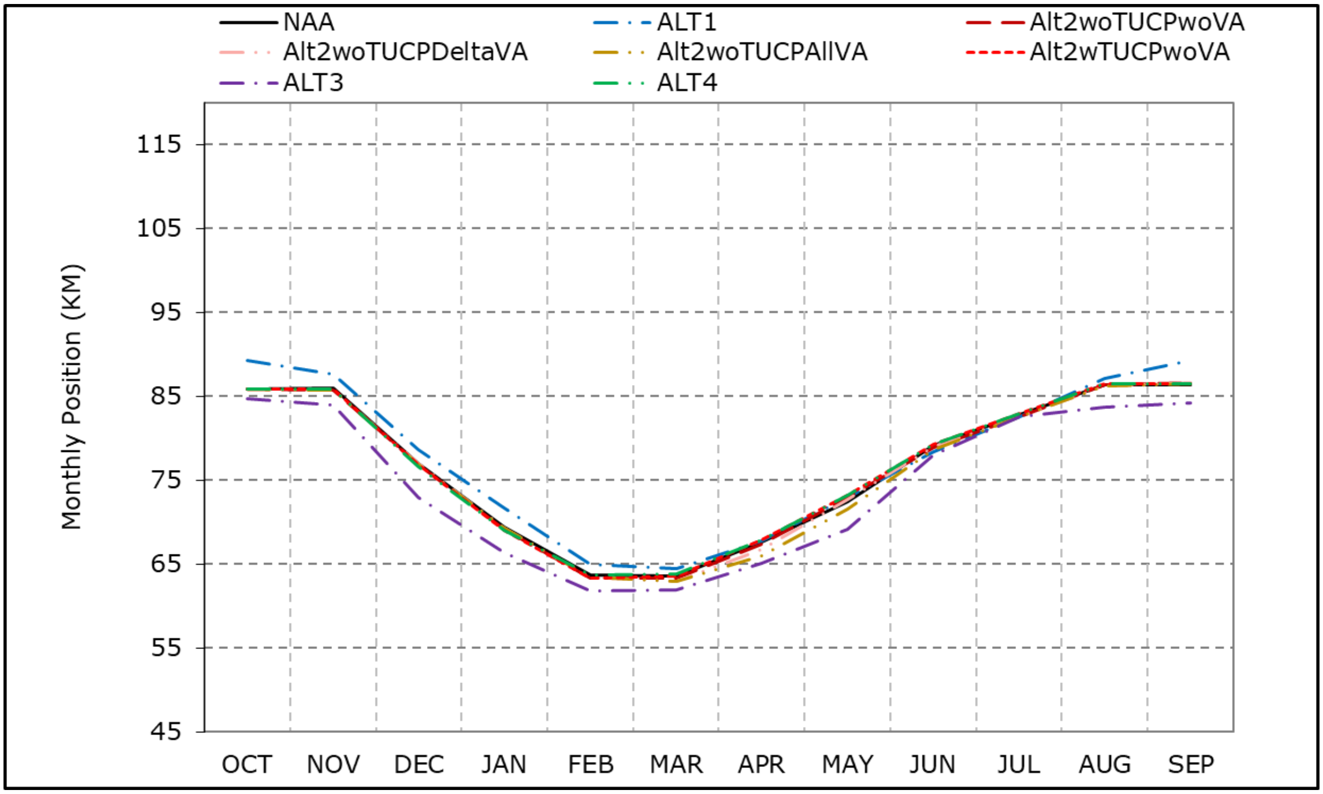

Figure 0-4. Long-Term Average X2 Position

In the Bay-Delta, the constituents for which there would be an appreciable difference in water quality under at least one of the action alternatives are the salinity-related parameters electrical conductivity (EC), chloride, bromide, methylmercury, and cyanobacteria harmful algal blooms (CHABs).

EC, Chloride, and Bromide: Under Alternative 1, EC levels and chloride and bromide concentrations at western Delta locations would be substantially higher than under the No Action Alternative. In contrast, under Alternative 3, EC levels and chloride, and bromide concentrations at western Delta locations would be substantially lower compared to the No Action Alternative. EC levels and chloride and bromide concentrations for Alternatives 2 and 4 would be similar to the No Action Alternative across the Delta. EC levels in Suisun Marsh would be higher than under the No Action Alternative in September through November under Alternative 1, lower under Alternative 3, and similar under Alternatives 2 and 4. Figure 0-45 presents the modeled average EC levels for the Sacramento River at Emmaton, to illustrate the degree to which the alternatives could affect salinity parameters in the western Delta in the various months. Monthly average chloride concentrations in CVP and SWP reservoirs storing water diverted from the Delta are expected to increase under all action alternatives; however, the CVP and SWP would continue to operate to meet the Bay-Delta Plan water quality objectives.

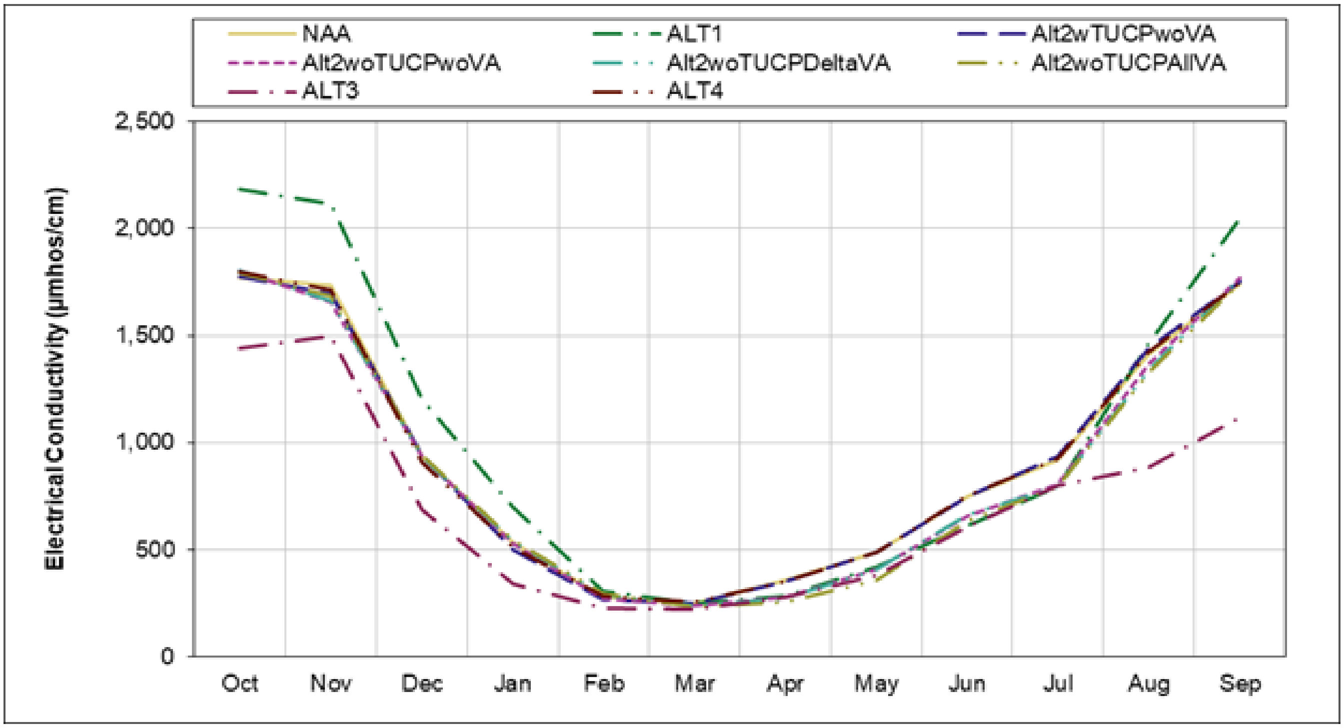

Figure 0-5. Long-Term Monthly Average EC for the Sacramento River at Emmaton for Water Years 1922–2021

Methylmercury: Water column methylmercury concentrations and methylmercury bioaccumulation in biota the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay are similar to the No Action Alternative under Alternatives 1, 2, and 4. Alternative 3 may result in higher water column methylmercury concentrations in the Delta, Suisun Bay, and San Francisco Bay. Figure 0-6 presents the average of the modeled average methylmercury concentrations in largemouth bass fish fillets twelve Delta assessment locations. The figure illustrates the differences in methylmercury concentrations between alternatives. Bars in the chart define the minimum and maximum average concentrations at the assessment locations.

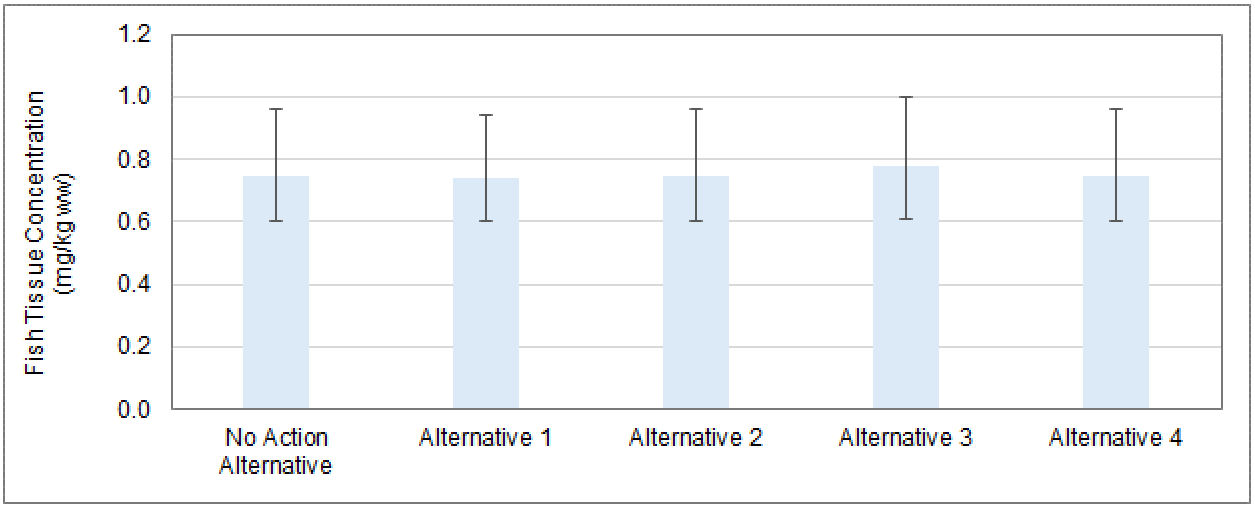

Figure 0-6. Average Modeled Total Methylmercury Concentrations in Largemouth Bass Fillets (in milligrams per kilogram wet weight) for all Delta Assessment Locations for the Full Simulation Period.

CHABs: Alternatives 1, 2, and 4 would not have substantial increased risk of increased CHABs in the Delta and Suisun Marsh. Alternative 3 could increase the risk of CHABs in the Delta and Suisun Marsh. There is no increased risk of CHABs in Suisun Bay and San Francisco Bay for any action alternative.

0.3.2 1.3.2 Surface Water Supply

Surface water supply analysis was conducted using the CalSim 3 model, as described in Appendix F, to simulate operational assumptions of each alternative. Inputs to CalSim 3 include water demands (including water rights), stream accretions and depletions, reservoir inflows, irrigation efficiencies, and parameters to calculate return flows, nonrecoverable losses and groundwater operations. CalSim 3 outputs for the alternatives are compared to CalSim 3 outputs for the No Action Alternative to evaluate changes in water supply deliveries to CVP and SWP water users.

0.3.2.1 CVPIA Wildlife Refuges

Average annual deliveries to CVPIA wildlife refuges north of the Delta would remain similar under all alternatives. In certain multiple year droughts, deliveries to CVPIA refuges north of the Delta would be reduced compared to the No Action Alternative, except under Alternative 3.

Average annual deliveries to CVPIA wildlife refuges south of the Delta would remain similar under all alternatives, excluding dry and critical water year conditions under Alternative 3. Under Alternative 3, during dry and critical water year conditions within the Tulare Lake Region, CVP Refuge Level 2 water deliveries would be reduced by approximately 8%.

0.3.2.2 CVP North of the Delta

Average annual deliveries to CVP Settlement Contractors north of the Delta would remain the same under Alternative 1 and decrease for Alternatives 2, 3, and 4, particularly in dry and critical water year conditions.

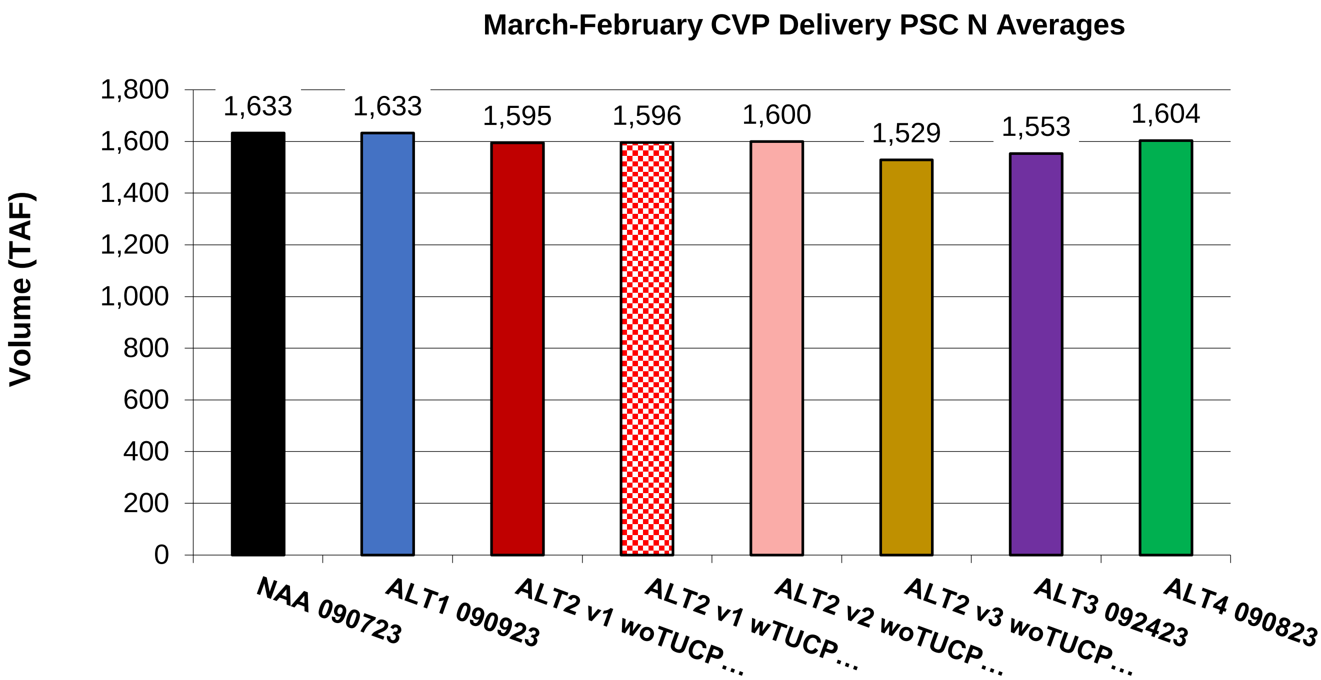

Figure 0-7. Sacramento River Settlement Contractor average annual deliveries under alternative long-term operation criteria.

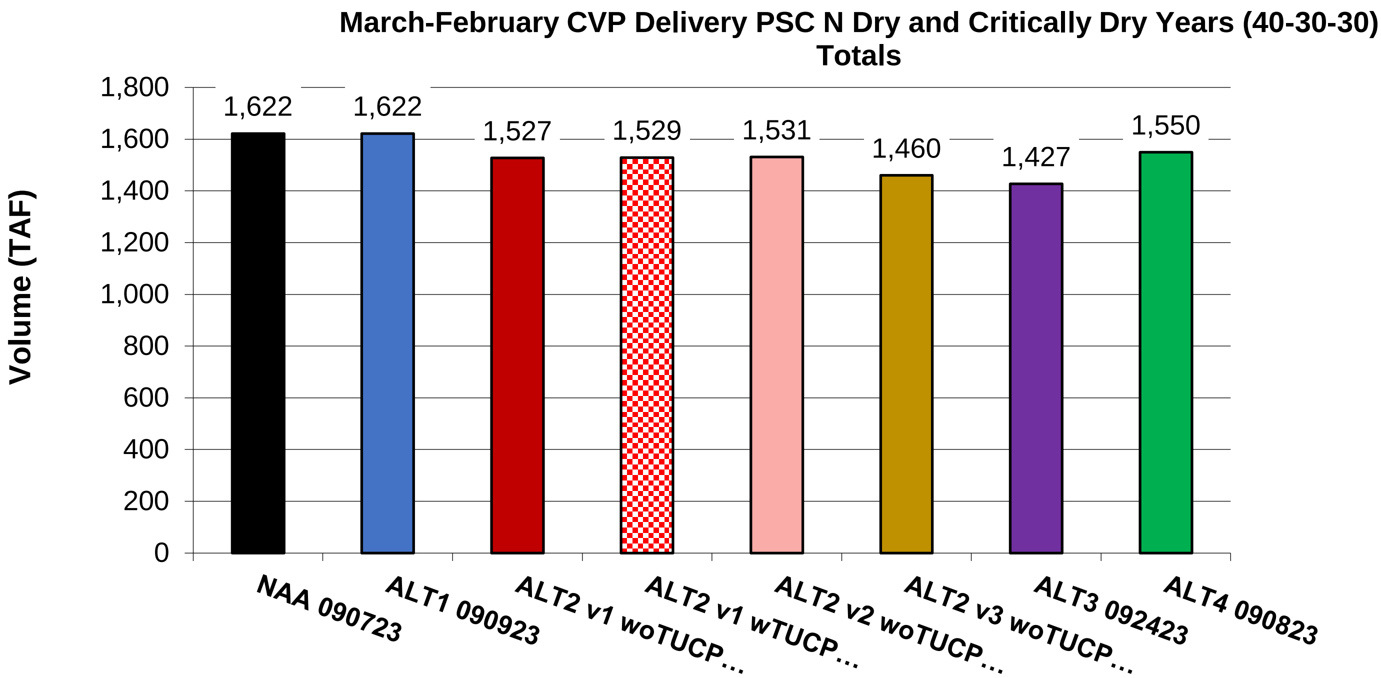

Figure 0-8. Sacramento River Settlement Contractor deliveries in dry and critical water year type conditions under alternative long-term operation criteria.

Average annual deliveries to CVP American River M&I Contractors north of the Delta would remain similar to the No Action Alternative under Alternatives 1, 3, and 4 and would increase under Alternative 2. Average annual deliveries to Contra Costa Water District would remain the same under all of the alternatives. Average annual deliveries to other CVP M&I contractors north of the Delta would remain similar under Alternatives 1, 2, and 4 and would decrease under Alternative 3.

Deliveries to CVP agricultural contractors North of Delta under Alternatives 2, 3, and 4 would decrease, particularly in dry and critical water year conditions.

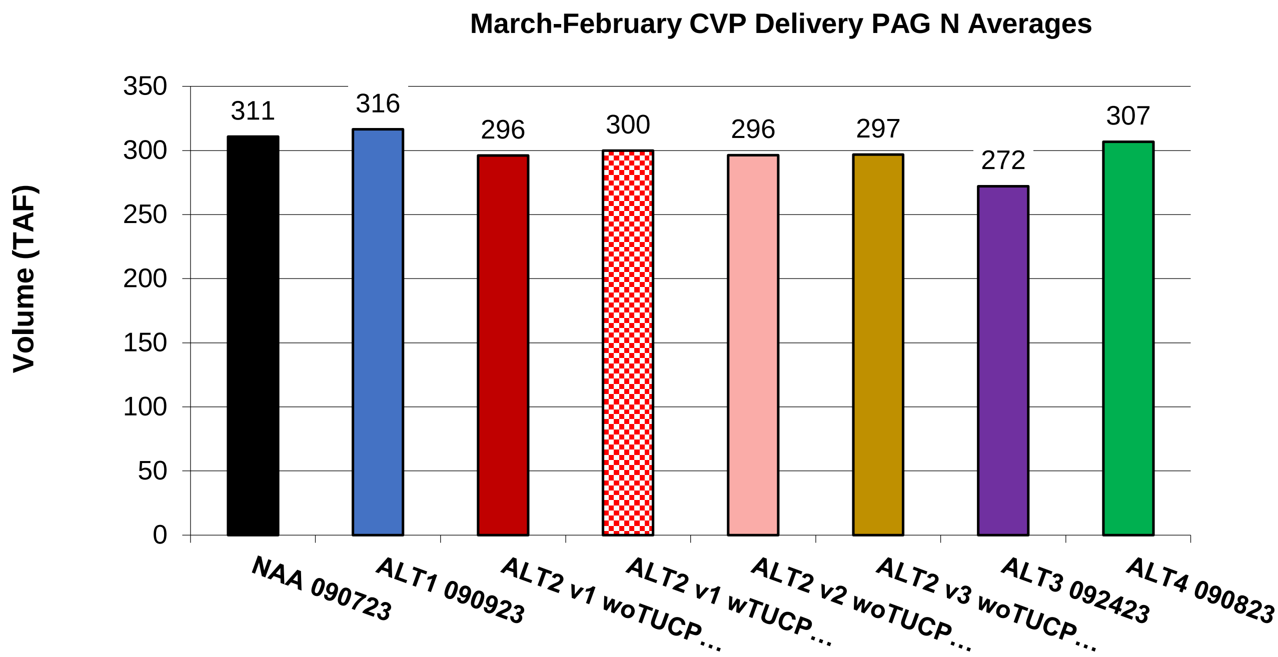

Figure 0-9. CVP north of Delta agricultural annual average deliveries under alternative long-term operation criteria

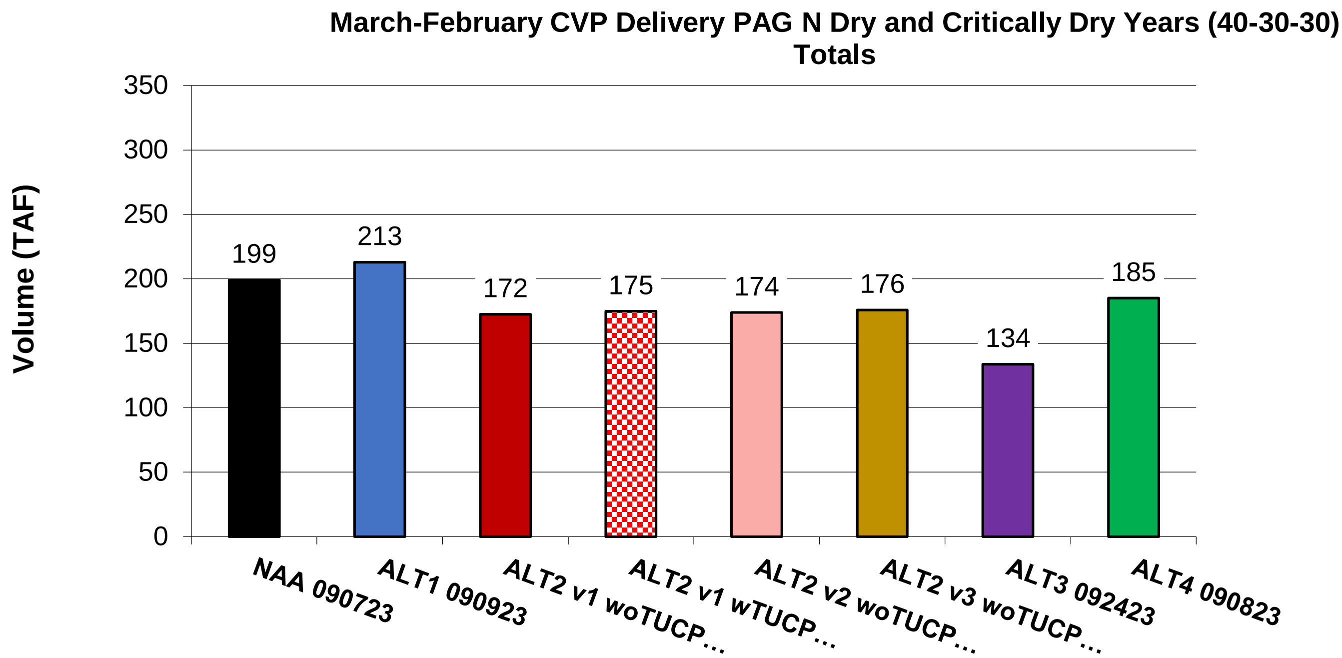

Figure 0-10. CVP north of Delta agricultural deliveries in dry and critical water year type conditions under alternative long-term operation alternatives

0.3.2.3 CVP South of the Delta

Average annual deliveries to CVP M&I water users south of the Delta would remain similar under Alternatives 1, 2 and 4, and would decrease under Alternative 3 when compared to the No Action Alternative. Average annual deliveries to CVP Exchange Contractors and to the Friant Division would remain similar under the alternatives.

Under Alternative 1, there would be an increase in water supply deliveries for CVP agricultural contractors south of the Delta. Under Alternatives 2, 3. and 4, deliveries to CVP agricultural water users would decrease. Changes are concentrated in dry and critical water year conditions

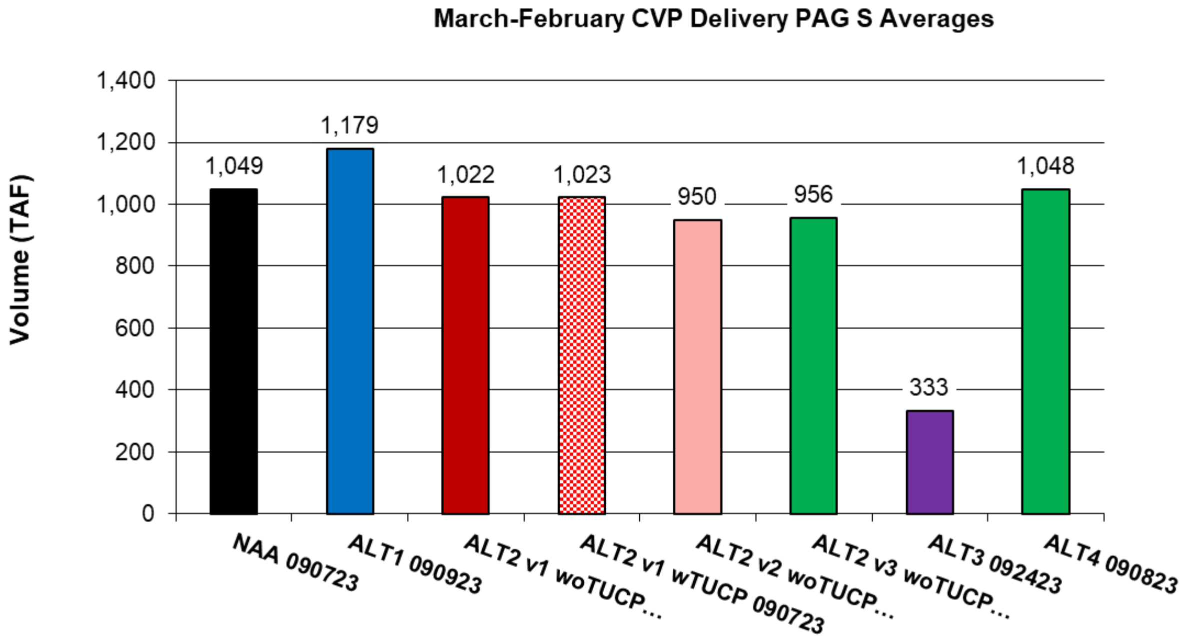

Figure 0-11. CVP south of Delta agricultural annual average deliveries under alternative long-term operation criteria

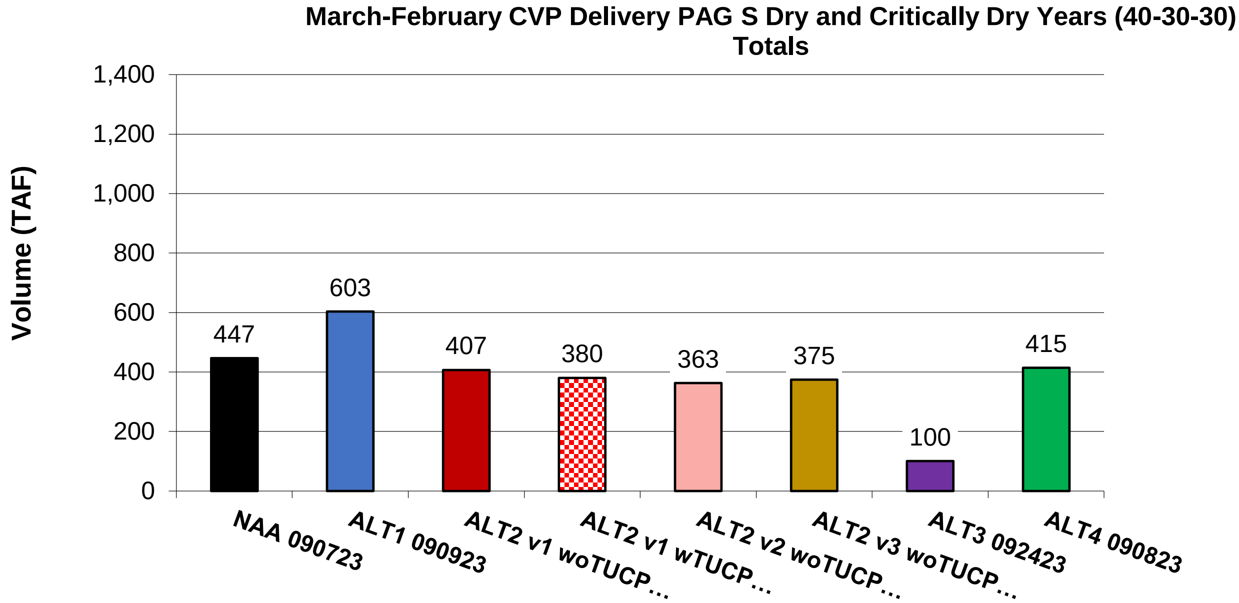

Figure 0-12. CVP south of Delta agricultural deliveries in dry and critical water year type conditions under alternative long-term operation alternatives

0.3.2.4 SWP North of Delta

Average annual deliveries to SWP M&I water users north of the Delta would remain the same under Alternatives 1, 2, and 4 and decrease under Alternative 3 when compared to the No Action Alternative.

0.3.2.5 SWP South of the Delta

Average annual deliveries to SWP M&I water users north of the Delta would remain the same under Alternatives 1, 2, and 4 and decrease under Alternative 3 when compared to the No Action Alternative. Average annual deliveries to SWP agricultural and M&I water users south of the Delta would increase under Alternatives 1, 2, and 4, and decrease under Alternative 3. During dry and critical water year conditions average annual deliveries to SWP agricultural and M&I water users south of the Delta would increase or remain the same under Alternatives 1, 2, and 4 and decrease under Alternative 3.

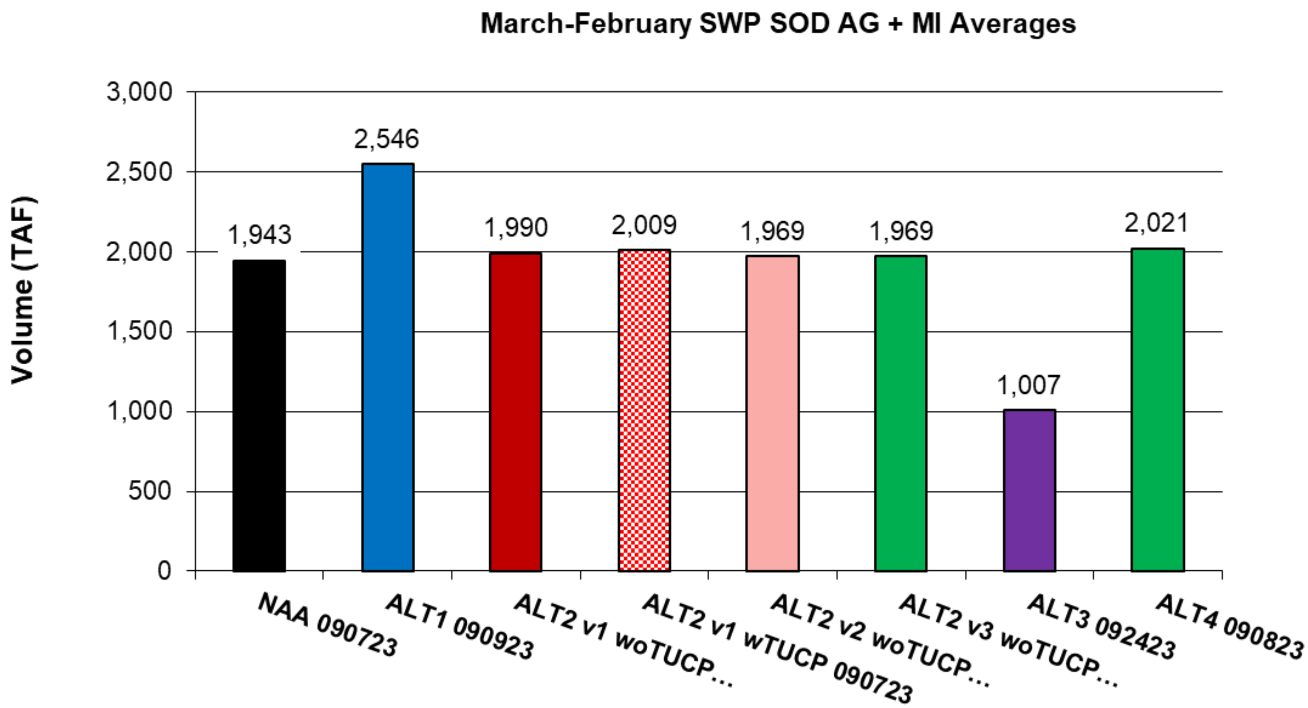

Figure 0-13. SWP south of Delta annual average deliveries under alternative long-term operation criteria.

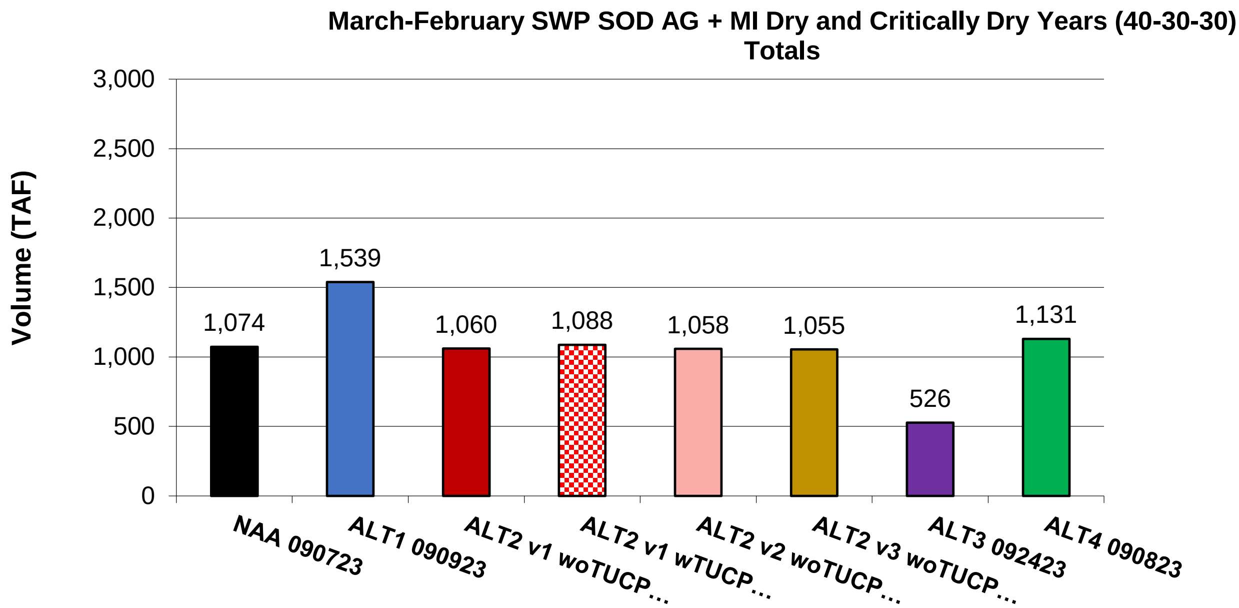

Figure 0-14. SWP south of Delta deliveries in dry and critical water year type conditions under alternative long-term operation alternatives.

0.3.3 Groundwater

Changes to CVP and SWP operations may result in water users changing their amount of groundwater pumping to offset changes surface water supply. CalSim 3 results for surface water were applied to the California Central Valley Groundwater-Surface Water Simulation Model – Fine Grid (C2VSimFG) groundwater flow model to simulate changes in groundwater conditions, including the changes to pumping, groundwater-surface water interaction, and groundwater elevation.

Under Alternatives 1, 2, and 4, groundwater pumping would be similar to the No Action Alternative. Under Alternative 1, changes in SWP and CVP deliveries would result in a negligible reduction in the annual average groundwater pumping in Central Valley compared to the No Action Alternative. Alternatives 2 and 4 would result in a negligible average increase in groundwater pumping. Alternative 3 would increase groundwater pumping in the Central Valley. Figure 0-15 shows the simulated change in groundwater elevation in the western Sacramento Valley for each alternative compared to the No Action Alternative. Figure 0-16 presents similar information for the northern San Joaquin Valley. Figure 0-17 presents the simulated values for the southwestern San Joaquin Valley. Simulated changes in groundwater elevations for locations throughout the Central Valley are provided in Appendix I, *Groundwater Technical Appendix*.

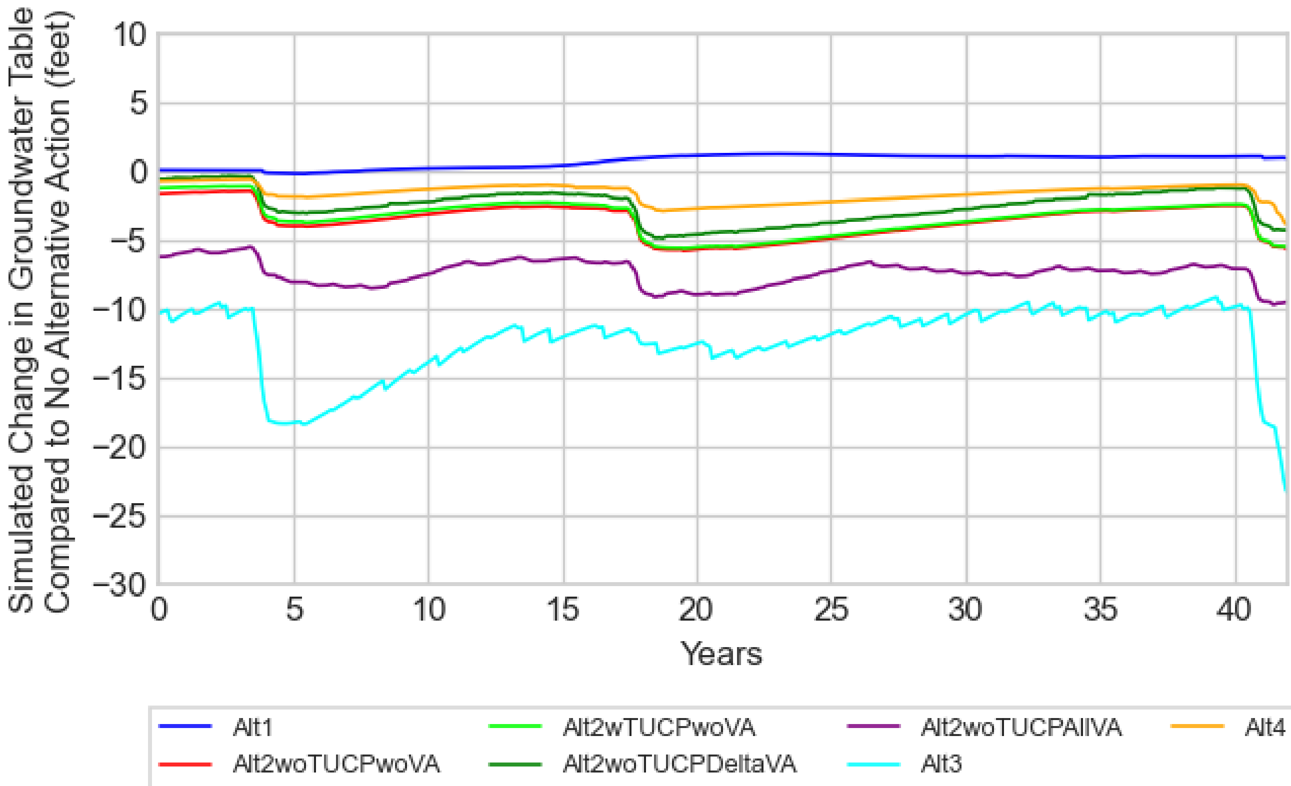

Figure 0-15. Simulated Change in Groundwater Table Elevation in the Western Sacramento Valley

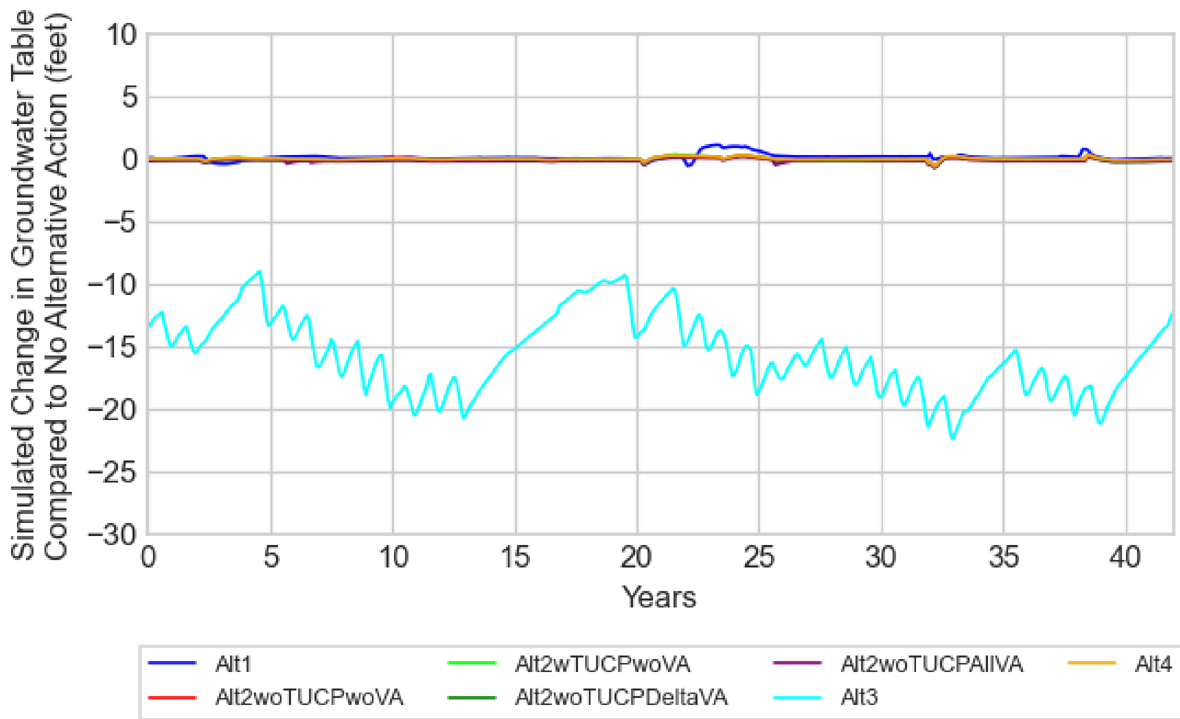

Figure 0-16. Simulated Change in Groundwater Table Elevation in the Northern San Joaquin Valley

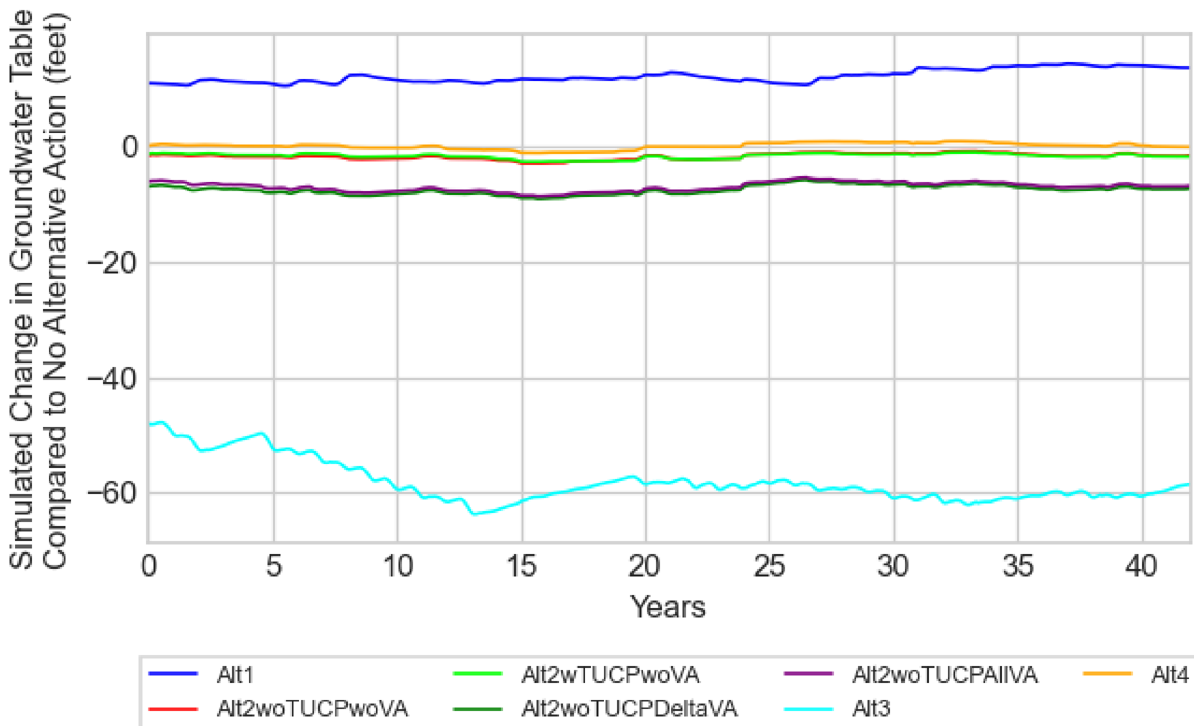

Figure 0-17. Simulated Change in Groundwater Table Elevation in the Southwestern San Joaquin Valley

Average groundwater elevations in Alternative 1 are expected to increase compared to the No Action Alternative due to the reduction in pumping. Depending on the year type and subregion, average groundwater water elevation changes could range between a decrease of 22 feet to an increase of 3.6 feet. Alternative 4 would result in similar groundwater elevation changes as Alternative 2, with a range of a decrease of 7 feet to an increase of up to 3 feet. Larger increases in pumping associated with Alternative 3 could result in groundwater elevation decreases of up to 159 feet compared to the No Action Alternative, depending on the water year type and location.

Alternatives 1, 2, and 4 would result in average annual increases in groundwater discharge from the subsurface to the surface water system similar to the No Action Alternative. The increase in pumping and decrease in groundwater elevations associated with Alternative 3 would result in an average 4.7% increase in the amount of water discharging from the surface water system to groundwater compared to the No Action Alternative.

Additional land subsidence would generally not be expected due to the annual average decrease in pumping (Alternative 1). The relatively small increase in pumping (Alternatives 2 and 4) would also not result in additional land subsidence. The relatively large increase in pumping under Alternative 3 could result in increased land subsidence when compared to the No Action Alternative.

0.3.4 Aquatic Biological Resources

CVP and SWP operations under all alternatives impact aquatic species from changes in flow and water temperature. The aquatic biological resources evaluation is based principally on modeled changes in flow and water temperature, which come from CalSim 3 and Hec-5Q respectively. Secondary biological models use those flow and temperature results to support the analysis of impacts to variables such as survival, abundance, and entrainment (e.g., Temperature-Dependent Mortality, Central Valley Improvement Act Decision Support Model Winter-Run Chinook Salmon Lifecycle Model, Negative Binomial Loss Model). Secondary biological models have mainly been developed for some listed species of salmonids and smelt. Where a secondary biological model has not been developed, changes in flow and water temperature were used to analyze impacts to species.

0.3.4.1 Winter-Run Chinook Salmon

Under the No Action Alternative, Reclamation operates the Temperature Control Device on Shasta Reservoir to manage water temperatures on the Sacramento River downstream of Keswick Reservoir for egg incubation. Storage of water in Shasta Reservoir reduces instream flows during the juvenile migration period. Restrictions on Delta exports minimizes the loss of juvenile salmon at the Delta fish collection facilities. Increased spring Delta outflow may improve survival for outmigrating salmonids.

Source: USFWS

Figure 0-18: Winter-run Chinook salmon

Alternative 1 includes minimum instream flows and does not operate to pulse flows. Compared to the No Action Alternative, Alternative 1 would increase temperature-dependent mortality during egg incubation. While operations would improve juvenile survival during migration down the Sacramento River, increased loss of juveniles at the Delta fish collection facilities would occur from increased Delta exports. Operations generally decrease through-Delta survival, especially in drier years in the December – February timeframe, with some variability dependent on water year type and month.

Alternative 2 prioritizes storage of water in Shasta Reservoir for water temperature management during multiple years of drought and results in reduced temperature-dependent mortality during egg incubation. Alternative 2 would reduce deliveries for CVP water service and repayment contracts and Sacramento River Settlement Contractors under specific drought conditions to increase storage in Shasta Reservoir. This increased storage would result in higher fall and winter releases in non-drought conditions. Higher fall and winter releases would improve juvenile Chinook salmon survival during migration down the Sacramento River. In drier years, Alternative 2 reduces fall and winter releases and reduces survival during migration. Loss of juvenile winter-run Chinook salmon at the Delta fish collection facilities is generally similar to the No Action Alternative based on similar OMR flows. Through-Delta survival is also generally similar to the No Action Alternative, based on Delta inflow, with increases in January, March and April of critically dry water year types.

Alternative 3 prioritizes release of water for Delta outflow and reduces diversions to store water in Shasta Reservoir which would generally decrease temperature-dependent mortality and improve juvenile Chinook salmon survival during migration down the Sacramento River. Delta inflow would generally decrease loss of juvenile winter-run Chinook salmon at the Delta fish collection facilities, and operations would generally improve through-Delta survival.

Real-time management under Alternative 4 aims to store more water in Shasta Reservoir to decrease temperature-dependent mortality during egg incubation. Increased fall flows due to real-time storage management would result in higher releases that would improve juvenile Chinook salmon survival during migration down the Sacramento River. Delta inflow would increase loss of juvenile winter-run Chinook salmon at the Delta fish collection facilities, and through-Delta survival is generally similar to the No Action Alternative.

Figure 0-19 demonstrates how each alternative would affect temperature dependent mortality (TDM) of winter-run Chinook salmon according to Martin et al (2017) model outputs. In most years, the 80^{th} percentile in proportional TDM would be highest under Alternative 1 and lowest under Alternative 3. Proportional TDM would be higher than the NAA in Alternative 1 in nearly all years and in Alternative 4 in ~80% of years. Proportional TDM would be lower than the NAA under all phases of Alternative 2 and Alternative 3 in nearly all years.

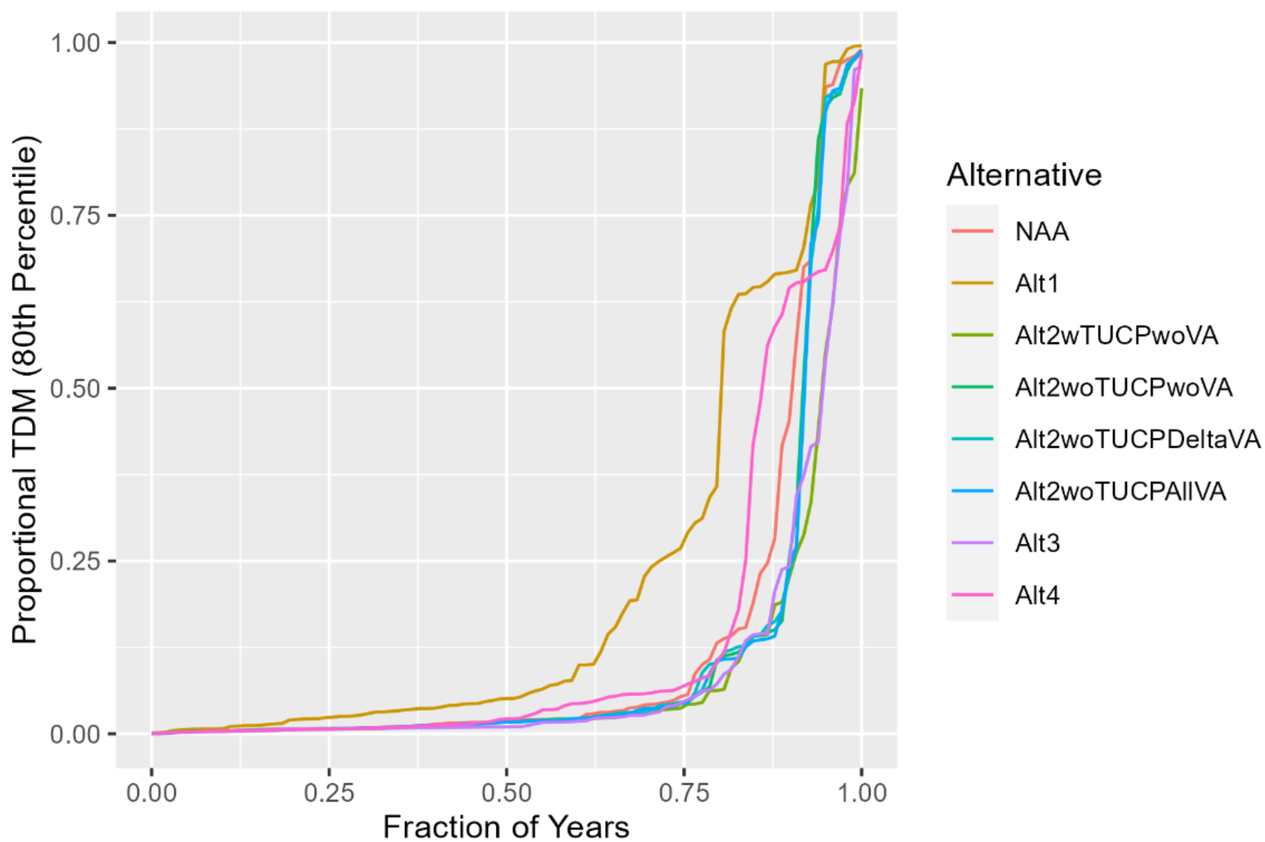

Figure 0-19. Exceedance plots of proportional Temperature Dependent Mortality (TDM) estimates across all water year types for the Martin TDM model, calculated using the 80th percentile of TDM for each water year type.

Spawner abundance predicted by the CVPIA winter-run Chinook salmon life cycle model is generally similar with a slight annual decrease under Alternatives 1, 3, and 4 relative to the No Action Alternative. Spawner abundance under Alternative 2 is expected to generally decrease, with some annual increases in dry and wet water years.

Figure 0-20 demonstrates how each alternative would affect survival of migrating juvenile Chinook salmon migrating through the Delta according to STARS model. The greatest expected survival values occurred in January, February, and March, which corresponded to months with greater Delta inflows. The four phases of Alternative 2 and Alternative 3 had higher survival than the No Action Alternative, whereas Alternative 1 generally had decreased survival relative to the No Action Alternative. Alternative 4 had minimal differences in survival relative to the No Action Alternative.

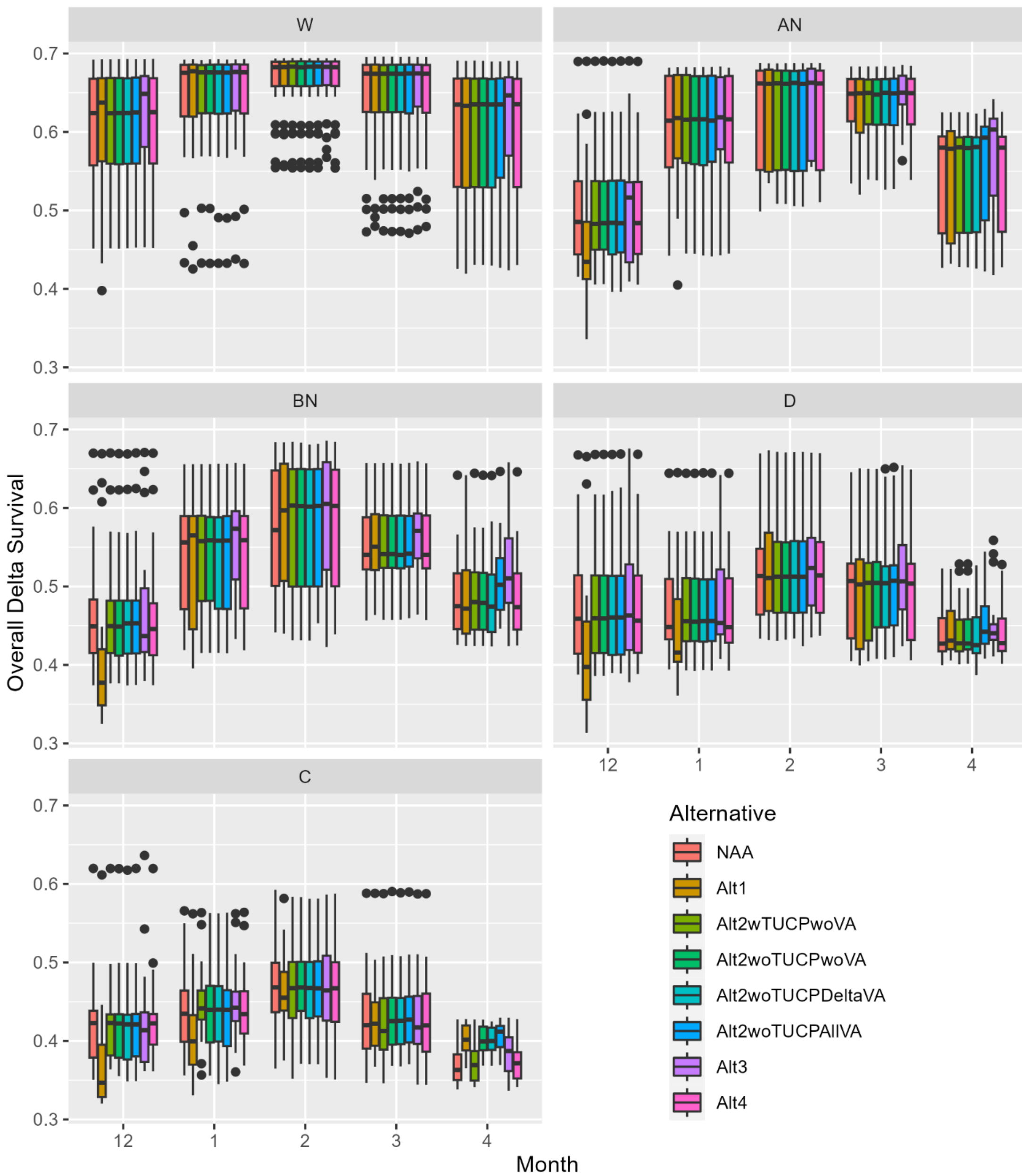

Figure 0-20. Boxplots of predicted mean through-Delta survival across all routes for relevant migratory months, box edges represent 25th and 75th percentiles, whiskers are the product of the interquartile range and 1.5, for each water year type.

Figure 0-21 demonstrates how each alternative would affect winter-run Chinook salmon population change over time from 1980-1999 according to the SIT CVPIA winter-run Chinook salmon lifecycle model. The highest variation in lambda is predicted to occur under the three Alternative 2 phases without a TUCP, although mean lambda was very similar among all alternatives.

1999.

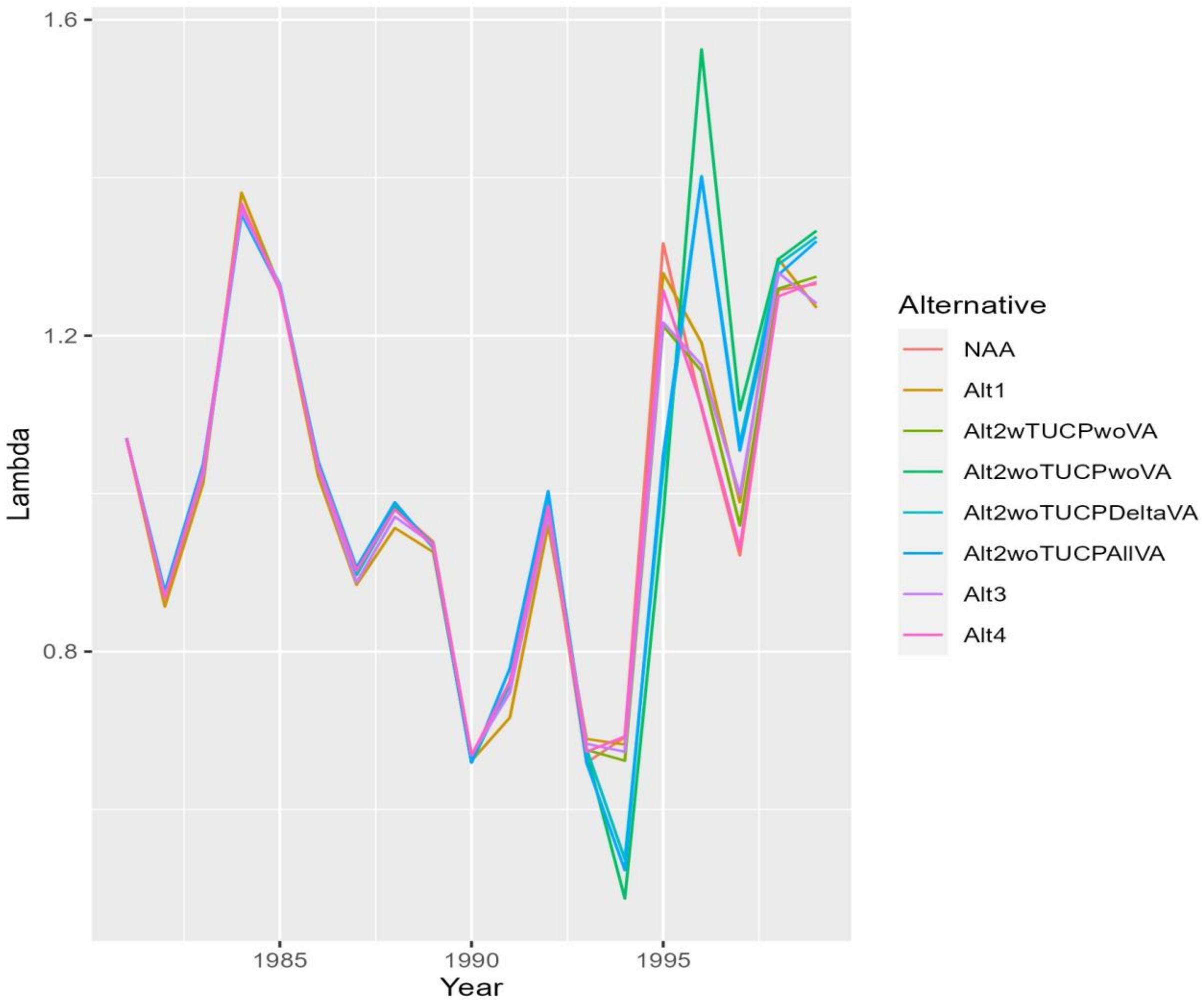

Figure 0-21. Predicted annual lambda values (N_{t+1}/N_t) for total winter-run spawner abundance in the Upper Sacramento River, including both natural- and hatchery-origin fish, from deterministic model runs.

0.3.4.2 Spring-Run Chinook Salmon

Under the No Action Alternative, Reclamation operates the Temperature Control Device (TCD) on Shasta Reservoir to manage water temperatures on the Sacramento River downstream of Keswick Reservoir to achieve fisheries objectives, including objectives for winter-run Chinook salmon, and suitable temperatures for spring-run Chinook salmon. Storage of water in Shasta Reservoir during the winter and spring reduces instream flows during the spring-run juvenile Chinook salmon migration period. Spring pulse flows help spring-run Chinook salmon juvenile out-migration including spring-run from non-project streams. Whiskeytown Reservoir summer and fall operations may adversely or beneficially impact spring-run Chinook salmon; potential adverse impacts include low flows and elevated water temperatures in Clear Creek, while potential beneficial impacts include cold water releases to reduce thermal stress during holding, spawning, and egg incubation. Pulse flows in Clear Creek during the spring could attract spring-run Chinook salmon holding in the Sacramento mainstem, encouraging movement towards spawning habitat. In the Delta, export restrictions minimize the loss of juvenile salmon at the Delta fish collection facilities. Increased spring Delta inflow may improve survival for outmigrating salmonids.

Alternative 1 includes minimum instream flows and does not operate to pulse flows. Compared to the No Action Alternative, Alternative 1 improves juvenile Chinook salmon survival during migration down the Sacramento River and negligibly impacts spawning, spawner abundance, and egg incubation. In Clear Creek, Alternative 1 provides minimum instream flows and water temperature management but does not include specific pulse flows and adversely impacts spawning habitat area. Higher OMR reverse flows increases loss of juveniles at the Delta fish collection facilities. Higher Delta inflows may increase through-Delta survival.

Alternative 2 prioritizes storage of water in Shasta Reservoir for temperature management during multiple years of drought and operates to higher fall and winter releases. Alternative 2 improves spawning and egg incubation as well as juvenile survival during migration down the Sacramento River. Adverse impacts on juvenile stranding in drier water year types may occur. In Clear Creek, operations would adversely impact spawning and rearing habitat. Water temperature management would also adversely impact spawning, egg incubation, juveniles, and yearlings. More negative OMR generally increases loss of juvenile spring-run Chinook salmon at the Delta fish collection facilities, especially in April, and operations for increased Delta inflow increase through-Delta survival.

Alternative 3 prioritizes release of water for Delta outflow and reduces diversions to store water in Shasta Reservoir. Water temperatures for spawning and egg/incubation would improve, as would juvenile Chinook salmon survival during migration down the Sacramento River. In Clear Creek, operations would decrease flows, adversely impacting spawning habitat area and upstream migration in the summer. Differences in water temperatures would have a negligible impact on spawning, egg incubation, fry emergence, and juvenile and yearling rearing. Less negative OMR flows would decrease loss of juvenile spring-run Chinook salmon at the Delta fish collection facilities, and operations to increase Delta inflow would increase through-Delta survival.

Real-time management under Alternative 4 aims to store more water in Shasta Reservoir to decrease temperature-dependent mortality during egg incubation. Increased fall flows result in higher releases that improve juvenile Chinook salmon survival during migration down the Sacramento River. In Clear Creek, operations would adversely impact spawning and rearing habitat and water temperatures for spawning and egg incubation. More negative OMR would increase loss of juvenile spring-run Chinook salmon at the Delta fish collection facilities, and similar Delta inflows would have a negligible change on through-Delta survival.

0.3.4.3 California Central Valley Steelhead

Under the No Action Alternative, Reclamation operates the TCD on Shasta Reservoir to manage water temperatures on the Sacramento River downstream of Keswick Reservoir primarily for winter-run Chinook salmon egg incubation. There may be beneficial impacts of water temperature management for steelhead adult migration and juveniles rearing through reduction of thermal stress. Spring pulses may improve outmigration by decreasing travel time down the

Sacramento River. In Clear Creek and the lower American River, pulse flows, minimum instream flows, and water temperature management would benefit steelhead. In the Stanislaus River, pulse flows, minimum instream, and winter instability flow would benefit steelhead. While these components of the No Action Alternative benefit steelhead, research over the last decade has identified that rivers with high, stable flows tend to favor residency (Courter et al. 2009; Kendall et al. 2015). Therefore, managed flows in these tributaries may have disparate impacts on rates of steelhead anadromy. Restrictions on Delta exports minimize loss of juvenile steelhead at the Delta fish collection facilities.

Source: USFWS

Figure 0-22: Steelhead at Coleman National Fish Hatchery

Alternative 1 includes minimum instream flows and does not operate to pulse flows. Compared to the No Action Alternative, Alternative 1 is expected to have a negligible impact on steelhead spawning and egg/alevin incubation below Keswick Dam. Increased flows in the Sacramento River would increase survival for outmigrating juveniles. Changes in flow would increase fry stranding during wetter water year types and would decrease fry stranding during drier water year types. In Clear Creek, flow reductions throughout the year would decrease spawning habitat and negatively impact juvenile rearing and emigration. In the lower American River, minimum instream flows would negatively impact spawning and rearing habitat, redd dewatering, and water temperatures for spawning and egg incubation. In the Stanislaus River, operations would generally decrease spawning and rearing habitat; however, there would be improved water temperatures for spawning, egg incubation, and juvenile emigration. Delta inflow increases loss of juvenile steelhead at the Delta fish collection facilities, and operations increases survival due to a smaller proportion of flow routed to the interior Delta.

Alternative 2 prioritizes storage of water in Shasta Reservoir for water temperature management during multiple years of drought, operates to higher fall and winter releases which impacts steelhead fry stranding (increased stranding in wetter water year types, decreased in drier water year types). Changes to water temperature would have a beneficial impact on juvenile rearing and emigration. In Clear Creek, changes in flows would improve spawning habitat area but would adversely impact juvenile rearing by reducing habitat and increasing water temperatures. In the lower American River, operations would negatively impact spawning habitat area and redd dewatering. In the Stanislaus River, operations would increase water temperatures during spawning, egg incubation, and juvenile emigration. Alternative 2 would impact entrainment at the Delta fish facilities; however, there is no clear trend by water year type on increased and decreased entrainment. Survival of outmigrating juveniles would increase or decrease dependent on Delta inflow conditions.

Alternative 3 prioritizes release of water for Delta outflow and reduces diversions to store water in Shasta Reservoir. Changes in flow in the Sacramento River would increase fry stranding during above normal/below normal water year types and decrease fry stranding during dry water year types. Changes to water temperature would benefit juvenile rearing and emigration. In Clear Creek, operations would have varying effects on habitat: improving spawning habitat, negligibly impacting fry rearing habitat, and adversely impacting juvenile rearing habitat. Water temperature impacts are negligible. In the lower American River, operations would worsen water temperatures impacts for steelhead spawning and egg incubation and juvenile rearing and emigration. In the Stanislaus River, operations would have varying impacts on habitat area, but would improve water temperatures impacts for steelhead spawning and egg incubation and juvenile rearing and emigration. Delta inflow decreases loss of juvenile steelhead at the Delta fish collection facilities, and survival of outmigrating juveniles would increase or decrease dependent on OMR conditions.

Alternative 4 aims to store more water in Shasta Reservoir to decrease temperature-dependent mortality during egg incubation for winter-run Chinook salmon. Increases in fall flows due to storage result in higher releases that decrease steelhead fry stranding. Changes to water temperature would have a beneficial impact on steelhead juvenile rearing and emigration. In Clear Creek, operations would have varying impacts on habitat and negligible impacts from water temperature management. In the lower American River, operations would have adverse impacts on spawning and rearing habitat. Water temperature management impacts would vary, with negative impacts to spawning and egg incubation and improvements to juvenile rearing and emigration. In the Stanislaus River varying impacts on habitat and negligible impacts from water temperature management. Loss of juvenile steelhead at the Delta fish collection facilities, and survival of outmigrating juveniles would increase or decrease dependent on OMR conditions and increased use of real-time management would support water supply with smaller impacts to listed fish.

0.3.4.4 Delta Smelt

The No Action Alternative includes OMR flow management criteria and provides restrictions on Delta exports by incorporating real-time monitoring of fish distribution, turbidity, water temperature, hydrodynamic models, and entrainment models to focus protections for fish attempting to minimize loss of Delta smelt at the Delta fish collection facilities.

Source: Reclamation

Figure 0-23: Delta smelt

Alternative 1 may result in minor increases to minor decreases in suitable habitat depending on water year type and the application of a water temperature threshold and would likely have adverse impacts on juvenile Delta smelt summer and fall habitat. Under Alternative 1, there would be lower population growth rates and lower sub-adult to adult survival during the winter. Results from the USFWS life cycle model found lower population growth rates, particularly during the below normal, dry, and critically dry water year types. Therefore, adverse impacts are anticipated specific to population abundance. Alternative 1 does not include OMR criteria resulting in lower Delta outflows and exports are not adjusted beyond D-1641 to minimize entrainment of fish and protection of critical habitat.

Alternative 2 may result in minor increases or minor decreases in suitable habitat depending on water year type and the application of a temperature threshold. Alternative 2 would likely have negligible to minor adverse and minor beneficial impacts on juvenile Delta smelt summer and fall habitat. Under Alternative 2, there would be minimal potential impacts on sub-adult to adult Delta smelt survival, with lower rates identified during wet and above normal water year types for the phases without VAs. Therefore, adverse and beneficial impacts are anticipated specific to population abundance. Alternative 2 includes OMR Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

Alternative 3 may result in minor increases and minor decreases in suitable habitat depending on water year type and the application of a temperature threshold and would likely have minor beneficial to minor adverse impacts on juvenile Delta smelt summer and fall habitat. Under Alternative 3, depending on the water year type, there would be a substantially higher population growth rate when compared to the No Action Alternative. Alternative 3 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

Alternative 4 may result in minor increases and minor decreases in suitable habitat depending on water year type and the application of a temperature threshold and would likely have negligible to minor adverse impacts on juvenile Delta smelt summer and fall habitat. Under Alternative 4, there would be minimal potential impacts on sub-adult to adult Delta smelt survival. Alternative 4 ranged lower in terms of population growth rates depending on the water year type when compared to the No Action Alternative. Therefore, adverse impacts are anticipated specific to population abundance Alternative 4 includes OMR Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

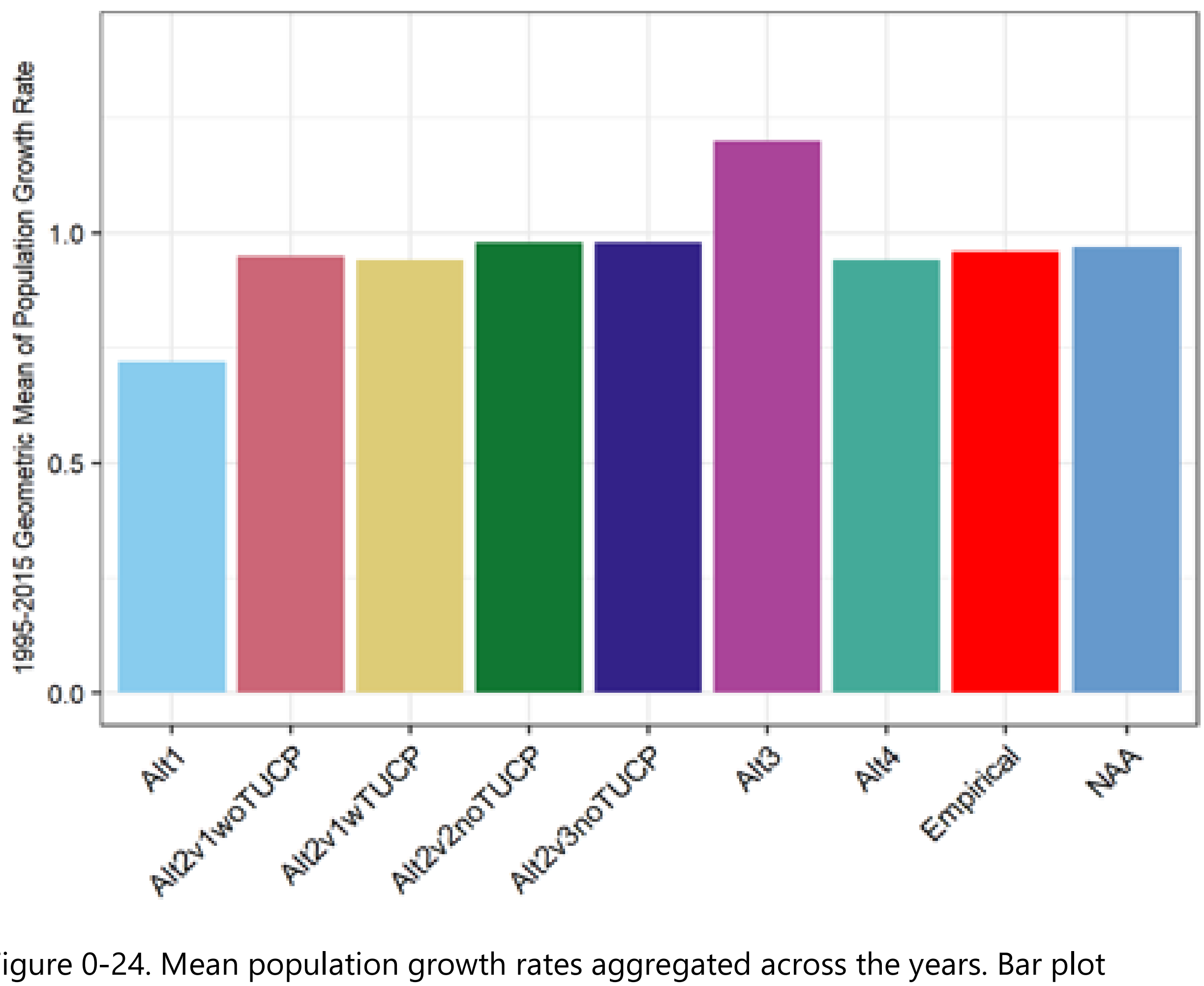

Figure 0-24. Mean population growth rates aggregated across the years. Bar plot demonstrating the geometric mean of population growth rate (lambda) from 1995 to 2015 for the various alternatives.

0.3.4.5 Longfin Smelt

The No Action Alternative includes OMR flow management criteria and provides restrictions on Delta exports by incorporating real-time monitoring of fish distribution, turbidity, water temperature, hydrodynamic models, and entrainment models to focus protections for fish attempting to minimize loss of longfin smelt at the Delta fish collection facilities. Increased spring Delta outflow and managed Delta outflow in the summer and fall would support improvements in food resources for longfin smelt.

Source: CDFW

Figure 0-25. Longfin smelt

Alternative 1 does not include OMR flow management criteria. Under Alternative 1, there may be an increase in entrainment compared to the No Action Alternative, particularly during the above normal water year type. Compared to the No Action Alternative, CPUE of longfin smelt prey species is expected to decrease under Alternative 1 particularly during the winter and spring. Under Alternative 1, abundance is predicted to be lower than the No Action Alternative. Therefore, adverse impacts are anticipated related to population abundance.

Alternative 2 includes OMR management criteria protections for listed species. Alternative 2 is expected to increase entrainment in all water years except in a dry year. Compared to the No Action Alternative, CPUE of longfin smelt prey species is expected to generally minorly change during the fall, winter and increase in the spring depending on Alternative 2 phase and water year type. Under Alternative 2, juvenile abundance will be lower during wet years or higher during critically dry years compared to the No Action Alternative. Therefore, adverse and beneficial impacts are anticipated related to population abundance.

Alternative 3 includes OMR management criteria allowing exports to meet public health and safety standards. Alternative 3 is expected to have a substantial beneficial impact on the entrainment due to differences in flow. Under Alternative 3, salvage would decrease substantially when compared to the No Action Alternative. Compared to the No Action Alternative, CPUE of longfin smelt prey species is expected to increase under Alternative 3 during the fall, winter and spring. Juvenile longfin smelt abundance is predicted to be higher under Alternative 3 than it is for the No Action Alternative.

Under Alternative 4, OMR management criteria includes protections for listed species. Compared to the No Action Alternative, Alternative 4 is expected to have an adverse impact on the entrainment. Compared to the No Action Alternative, CPUE of longfin smelt prey species is expected to minorly increase and decrease under Alternative 4 during the fall, winter, and spring, depending on water year type. Juvenile longfin smelt abundance is predicted to be no different to minorly lower under Alternative 4 than it is for the No Action Alternative.

0.3.4.6 Green Sturgeon

Under the No Action Alternative, seasonal operations and other common components may negatively affect the population including potential adverse impacts of low flows and elevated water temperatures impacting the movement or survival of adults and larvae.

Source: NMFS

Figure 0-26. Green sturgeon

Alternative 1 includes minimum instream flows and does not operate to pulse flows. Alternative 1 compared to the No Action Alternative is expected to have negligible impacts to potential adverse impacts on spawning and egg incubation habitat, larval and juvenile rearing, emigration and entrainment due to differences in flow. Under Alternative 1 potential adverse impacts on upstream migration and holding habitats due to differences in flow is expected. Beneficial and adverse impacts are anticipated depending on location, month, and water year type due to differences in water temperature compared to the No Action Alternative.

Alternative 2 prioritizes storage of water in Shasta Reservoir for water temperature management during multiple years of drought and would reduce deliveries for CVP water service and repayment contracts and Sacramento River Settlement Contractors under specific drought conditions to increase storage in Shasta Reservoir. This increased storage would result in higher fall and winter releases in non-drought conditions. Alternative 2 relative to the No Action Alternative is expected to have negligible impacts and possible beneficial impacts on spawning habitat, minor adverse impacts on rearing and emigration, and beneficial impacts and adverse impacts on upstream migration and holding habitats dependent upon location, month, and/or water year type due to differences in flow. Alternative 2 relative to the No Action Alternative is expected to have beneficial impacts and minor adverse impacts on spawning and egg incubation, beneficial and adverse impacts on rearing and emigration, and minor beneficial and adverse impacts on upstream migration and holding dependent upon location, month, and water year type due to differences in water temperature. Alternative 2 is expected to have negligible impacts on the entrainment of juveniles at facilities.

Alternative 3 prioritizes release of water for Delta outflow and reduces diversions to store water in Shasta Reservoir. Alternative 3 relative to the No Action Alternative is expected to have possible beneficial impacts and adverse impacts on spawning habitats, possible adverse impacts on rearing and emigration, and potential beneficial impacts and adverse impacts on migration and holding habitat due to differences in flow. Alternative 3 relative to the No Action Alternative is expected to have beneficial and adverse impacts on spawning, beneficial and adverse impacts on rearing and emigration, and adverse impacts and negligible beneficial impacts on migration and holding depending on location, month, and water year type due to differences in water temperature. Alternative 3 relative to the No Action Alternative is expected to have negligible impacts on the entrainment of juveniles.

Real-time management under Alternative 4 aims to store more water in Shasta Reservoir and increased fall flows due to real-time storage management would result in higher releases. Alternative 4 relative to the No Action Alternative is expected to have negligible impacts on spawning habitats, negligible impacts or possible beneficial impacts on rearing and emigration habitats, and negligible impacts to possible beneficial impacts on upstream migration and holding habitats due to differences in flow. Alternative 4 relative to the No Action Alternative is expected to have beneficial and adverse water temperature-related impacts on spawning, beneficial and adverse impacts on rearing and emigration, and adverse impacts on upstream migration and holding depending on location, month, and water year type due to differences in water temperature. Alternative 4 relative to the No Action Alternative is expected to have negligible impacts on the entrainment of juveniles.

0.3.4.7 Fall-Run Chinook Salmon

Adult fall-run Chinook salmon use the Sacramento River as a migration corridor and as spawning grounds between September and June. Release reductions from Shasta Reservoir early in the fall under the No Action Alternative may adversely impact the fall-run Chinook salmon population from low flows and elevated water temperatures leading to unsuccessful outmigration, and redd dewatering. Similarly, in Clear Creek, low flows and elevated water temperatures may negatively impact fall-run Chinook salmon and coldwater releases may be beneficial. In the lower American River, operations would ramp down to the revised minimum flows from Folsom Reservoir as soon as possible in the fall and maintain these flows through fall-run Chinook salmon spawning and egg emergence, where possible, to minimize redd dewatering and juvenile stranding. In the Stanislaus River, pulse flows may benefit migrating juveniles in the spring and adults in the fall. In the Delta, OMR management season may cause adverse or beneficial impacts for fall-run Chinook salmon in the Delta dependent on fish presence, distribution, and flows.

Alternative 1 includes minimum instream flows and does not operate to pulse flows. Compared to the No Action Alternative, flows in the Sacramento River under Alternative 1 would adversely and beneficially impact spawning and rearing habitat, reduce redd dewatering, and increase fry stranding in wetter years and decrease fry stranding in critically dry years. Water temperature under Alternative 1 would adversely impact spawning initiation and have varying effects on juvenile rearing and emigration. In Clear Creek, operations would adversely impact spawning and rearing habitat and water temperature management would adversely impact spawning and egg incubation. In the lower American River, operations would have varying impacts on habitat and water temperatures for spawning, egg incubation, and juvenile rearing and emigration. In the Stanislaus River, operations would improve spawning habitat but adversely impact water temperatures for spawning and egg incubation. Alternative 1 would impact entrainment at the Delta fish facilities; however, there is no clear trend by water year type. Under Alternative 1 survival of outmigrating juveniles would generally decrease.

Flows in the Sacramento River under Alternative 2 increase redd dewatering potential in drier years and reduce it in wetter years compared to the No Action Alternative. Generally, fry stranding would be reduced but water temperatures would have adverse impacts on spawning initiation. In Clear Creek, flows would improve spawning habitat, but water temperatures would have adverse impacts on spawning initiation. In the lower American River, flows would decrease spawning habitat and water temperatures would have varying impacts spawning, rearing, and emigration. In the Stanislaus River, water temperatures would have adverse impacts on spawning, rearing and emigration and flows would have varying impacts on spawning and rearing habitat. Alternative 2 would impact entrainment at the Delta fish facilities; however, there is no clear trend by water year type. Survival of outmigrating juveniles would be similar to the No Action Alternative.

Alternative 3 would change flows in the Sacramento River, resulting in adverse and beneficial impacts, with an increase in fry stranding and redd dewatering potential depending on water year type. Changes in water temperature would have similar impacts on spawning and egg incubation as the No Action Alternative, and adverse and beneficial impacts on juvenile rearing and emigration. In Clear Creek, spawning habitat improves while rearing habitat decreases, and operations have similar water temperatures to the No Action Alternative. In the lower American River, spawning habitat and redd dewatering would improve and water temperatures would adversely impact spawning and beneficially impact juveniles. In the Stanislaus River, spawning and rearing habitat would improve, and water temperatures would adversely impact spawning, egg incubation, and juvenile emigration. Alternative 3 would impact entrainment at the Delta fish facilities; however, there is no clear trend by water year type. Survival of outmigrating juveniles would improve.

Alternative 4 would change flows in the Sacramento River and increase redd dewatering potential in critically dry years compared to the No Action Alternative. Water temperatures would generally be similar to the No Action Alternative for spawning, egg incubation, and juvenile rearing and emigration. Alternative 4 seeks to preserve a portion of the cold-water pool for fall temperature management. In Clear Creek, spawning habitat would improve while rearing habitat would worsen. In the lower American River, redd dewatering potential would worsen in wet water year types and improve in critically dry years. Water temperatures both improve and worsen conditions for fall-run Chinook salmon depending on water year type and month. Flows in the Stanislaus River under Alternative 4, impact spawning and rearing habitat in a similar or improved manner than the No Action Alternative. Water temperatures for juvenile emigration may worsen. Alternative 4 would impact entrainment at the Delta fish facilities; however, there is no clear trend by water year type. Survival of outmigrating juveniles would be similar to the No Action Alternative.

0.3.4.8 Striped Bass

The No Action Alternative operates the Temperature Control Device on Shasta Reservoir to manage water temperatures on the Sacramento River downstream of Keswick Reservoir for winter-run Chinook salmon egg incubation, which may prove detrimental to striped bass. In the lower American River, there may be beneficial impacts of continued water temperature management for juveniles rearing through reduction of thermal stress May through October. Minimum instream flows in the Stanislaus River would benefit spawning and rearing striped bass. With year-round presence in the Delta, impacts of spring outflow on striped bass are uncertain. Increased outflow may expedite the rate at which their prey base migrates through the system and could diminish their ability to access that prey.

Compared to the No Action Alternative, Alternative 1 Sacramento River flows and water temperatures would generally benefit striped bass spawning, juvenile rearing and emigration. In the lower American River, there would be beneficial and adverse impacts from flow for adult habitat and juvenile rearing and similar or improved water temperature conditions. In the Stanislaus River, flow changes would benefit all life stages of striped bass and water temperatures would worsen conditions for spawning and egg incubation and may improve conditions for juveniles. Striped bass abundance in the Delta would be similar to the No Action Alternative except in critically dry years when the population may increase. Increased exports are likely to entrain higher numbers of stiped bass juveniles.

Alternative 2 would have positive impacts on water temperature conditions for striped bass spawning and egg incubation in the Sacramento River. Flows and water temperature under Alternative 2 would negatively impact juvenile rearing and emigration. In the lower American River, flow and water temperatures would generally be similar to the No Action Alternative for adults and juveniles. In the Stanislaus River, striped bass would be adversely impacted by flows during spawning and egg incubation and beneficially impacted during juvenile rearing and emigration. In the Delta, striped bass abundance would be similar to that under the No Action Alternative, except for an increase in critically dry water year types.

Alternative 3 flow and water temperatures would adversely impact striped bass in the Sacramento River during spawning and incubation. Impacts during larval – juvenile life stages would vary. In the American River, there would be generally beneficial and adverse flow impacts on adult habitat. There would be negligible water temperature-related impacts for adults, and positive and negative water temperature-related impacts to juveniles. In the Stanislaus River, beneficial flow impacts and negligible water temperature-related impacts would occur to spawning and egg incubation. Water temperature-related impacts would negatively impact juveniles. In the Delta, abundance would increase under Alternative 3.

Under Alternative 4, flow and water temperature changes in the Sacramento River would be similar to the No Action Alternative for spawning, incubating eggs, and juvenile rearing and emigration. In the lower American River, impacts would be similar to the No Action Alternative except for adverse water-temperature related impacts to juvenile rearing. In the Stanislaus River, operations would generally adversely impact flows in April and negligibly impact water temperature-related for spawning and egg incubation, while juvenile rearing would be adversely impacted by water temperatures, however, would benefit from flow changes. Abundance in the Delta would be similar to the No Action Alternative.

0.3.4.9 Coho Salmon

Under the No Action Alternative, Trinity River flow below Lewiston Dam would continue to be managed to improve habitat conditions for anadromous fish, including coho salmon. Seasonal flow releases in addition to water-year-specific peak flows would continue to include natural hydrograph elements that support habitat-forming processes, maintain suitable water temperatures, and support life-stage-specific habitat requirements.

Source: NMFS

Figure 0-27. Coho salmon

Compared to the No Action Alternative, Alternative 1 is expected to have spatially variable but negligible impacts of flow and water temperature on spawning and egg incubation and no adverse impacts on juvenile rearing habitat. Alternative 2 is expected to have spatially variable impacts of flow and water temperature on spawning and egg incubation and juvenile rearing habitat, likely ranging from adverse (up to approximately a 12% decrease in spawning WUA in a more heavily used reach in December of below normal water years) to no adverse impacts. Alternative 3 would have spatially variable impacts of flow and water temperature on spawning and egg incubation and juvenile rearing habitat, likely ranging from minor adverse to no adverse impacts. Alternative 4 would have no adverse impacts of flow and water temperature on spawning and egg incubation and juvenile rearing habitat.

0.3.4.10 Eulachon

Under the No Action Alternative, Trinity River flow and water temperature below Lewiston Dam would continue to be managed to improve habitat conditions for anadromous fish. Monthly average flows from December through June would be equal to or greater than 300 cfs in all water year types and would provide sufficient flows and suitable temperatures for eulachon spawning, larval emigration, and adult upstream migration in combination with Klamath River flows. Compared to the No Action Alternative, all action alternatives would have negligible or no adverse impacts from flow and water temperatures for all life stages.

Source: Reclamation

Figure 0-28. Eulachon

0.3.5 Terrestrial Biological Resources

Reclamation referenced existing data sources to evaluate the potential impacts on terrestrial biological resources. Reclamation used existing land cover data from sources such as the USGS, including for identifying potential wetlands and waters land cover types may be affected. To identify federally listed as endangered and threatened species that may occur in the study area, Reclamation used the list generated by the USFWS's Information for Planning and Consultation (IPaC) online service. This species list fulfills the requirements of the USFWS under section 7(c) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*). To determine which project components could affect the federally listed terrestrial species, Reclamation reviewed species range maps to assess which project components overlap the species' ranges and used existing species habitat models where available to assess which project components would affect the habitat of federally listed species. The California Natural Diversity Database (CNDDB) was used to identify non-federally listed special status species and the CNDDB query is applicable to the SWP operations.

0.3.5.1 Giant Garter Snake

Giant garter snakes in the action area are within an active rice growing region that experiences variability in rice production and farming activities, therefore they are already subject to the risks of fallowing under the No Action Alternative.

Sources: USFWS 2011

Figure 0-29. Giant garter snake

Alternative 1 does not propose to decrease water diversions to SRS Contractors in agricultural areas. Therefore, temporary loss of habitat for giant garter snake as a result of cropland idling/shifting actions would be the same as the No Action Alternative.

Under Alternative 2, total SRS Contractor diversions would remain the same or decrease relative to the No Action Alternative. In dry and critical years, some of the largest reductions in average diversions would be up to 11% relative to the No Action Alternative during some months of the active season for giant garter snake. Proposed decreases in water diversions to SRS Contractors in agricultural areas during dry and critical years under Alternative 2 could result in temporary loss of aquatic habitat for giant garter snake through the conversion of rice to dryland farming or fallowed lands.

Under Alternative 3, total SRS Contractor diversions would decrease in the spring through fall and would remain the same in the winter months relative to the No Action Alternative. In dry and critical years, SRS Contactor agricultural diversions are reduced by 34% from 100 TAF to 66 TAF in April and approximately 11% during the remaining months of the active season for giant garter snake under Alternative 3. Proposed decreases in water diversions to SRS Contractors in agricultural areas during dry and critical years under Alternative 3 could /result in the temporary loss of aquatic habitat for giant garter snake through the conversion of rice to dryland farming or fallowed lands.

Under Alternative 4, total SRS Contractor diversions would remain the same or decrease. In dry and critical years, the largest reductions in SRS Contactor agricultural diversions would be up to 11-13% during some months of the active season for giant garter snake relative to the No Action Alternative under Alternative 4. Proposed decreases in water diversions to SRS Contractors in agricultural areas during dry and critical years under Alternative 4 could result in the temporary loss of aquatic habitat for giant garter snake through the conversion of rice to dryland farming or fallowed lands.

0.3.5.2 Bank Swallow

Under the No Action Alternative, bank swallows experience variable flow conditions and water levels along the Sacramento River during the breeding season, where flows greater than 14,000 cfs regularly occur from April through June from Red Bluff, downstream to Verona. Therefore, bank swallows are already subject to the risks described below under the No Action Alternative.

Source: USFWS 2019

Figure 0-30. Bank swallow colony.

Flows on the Sacramento River would be higher under Alternative 1 for the majority of bank swallow breeding season (April through June) while flows would be lower than the No Action Alternative towards the end of the breeding season (July to August). Flows greater than 14,000 cfs during breeding season such as at Verona, where flows in below normal water years are predicted to be over 14,600 cfs in April (approximately 181 cfs more than the No Action Alternative), could result in localized bank collapses that result in partial or complete colony failure in April through June. Projected flows would be higher under Alternative 1 during part of the non-breeding season, where higher flows would occur from December to March. The increased flows in the Sacramento River during a majority of the non-breeding season could provide the necessary bank erosion functions needed for new bank swallow breeding habitat and therefore could result in a beneficial effect on bank swallow.

Average flows on the Sacramento River downstream of Keswick Reservoir, at Bend Bridge, and below Red Bluff Diversion Dam would generally decrease under Alternative 2 for at least two months of bank swallow breeding season except in April, where average flows are expected to be greater than the No Action Alternative. Average flows will stay below 15,000 cfs at these locations in normal water years. Increased flows at the beginning of the breeding season are present under Alternative 2, however average flows on the Sacramento River at Hamilton City, at

Wilkins Slough, and at Verona under Alternative 2 generally decrease during the bank swallow breeding season. Monthly flows during normal water years are highest at Verona during the bank swallow breeding season, with predicted monthly flows over 20,200 cfs under Alternative 2. Flows greater than 14,000 cfs during breeding season, such as at Verona under Alternative 2, where flows exceed are predicted to be at 20,233 cfs (an approximate increase of 1,270 cfs compared to the No Action Alternative), could result in localized bank collapses that result in partial or complete colony failure.

Flows on the Sacramento River under Alternative 3 would be variable month to month during normal water years. Flows under Alternative 3 would be up to 1,990 cfs higher than the No Action Alternative in May in above normal and wet years and up to 1,913 cfs higher in August in dry years during bank swallow breeding season. Flows under Alternative 3 would be up to 954 cfs lower from April to June in below normal, dry, and critically dry years, and up to 2,218 cfs lower in July of above normal years. Projected flows would also be variable under Alternative 3 during the non-breeding season, where higher flows would occur in October and from December to March. The increased flows in the Sacramento River during a majority of the non-breeding season could provide the necessary bank erosion functions needed for new bank swallow breeding habitat and therefore could result in a beneficial effect on bank swallow. Flows greater than 14,000 cfs such as at Verona, where flows can average 20,577 cfs in April (more than 1,600 cfs above the No Action Alternative), could result in localized bank collapses that result in partial or complete colony failure.

Flows on the Sacramento River would be higher under Alternative 4 at the beginning of bank swallow breeding season in April and lower for the duration of the breeding season compared to the No Action Alternative. Projected flows would be higher under Alternative 4 during the non-breeding season, where higher flows would occur from September to March. Average flows on the Sacramento River downstream of Keswick Reservoir, at Bend Bridge, and below Red Bluff Diversion Dam would increase under Alternative 4 at the beginning of the bank swallow breeding season in April and lower for the duration of the breeding season, with model results predicting flow staying below 14,000 cfs in normal years. Average flows on the Sacramento River at Hamilton City, at Wilkins Slough, and at Verona under Alternative 4 would generally decrease during the bank swallow breeding season except in April, where flow increases are minor. Monthly flows are highest at Verona during the bank swallow breeding season, with predicted monthly flows between 10,770 and 19,103 cfs under Alternative 4. Flows greater than 14,000 cfs such as at Verona, where flows can average 19,103 cfs in April, could result in localized bank collapses that result in partial or complete colony failure. However, flow increases are minor compared to the No Action Alternative (approximate increase of 50 cfs), therefore, habitat conditions are expected to be similar to habitat conditions experienced by bank swallow under the No Action Alternative.

Downstream of the Sacramento River at Verona, the river becomes channelized by levee banks which do not provide suitable bank habitat for nesting, therefore there is no potential for the alternatives to impact bank swallow downstream of the confluence of the Sacramento and Feather Rivers.

0.3.5.3 Northwestern Pond Turtle

The No Action Alternative is based on 2040 conditions. The changes to terrestrial biological resources that are assumed to occur by 2040 under the No Action Alternative conditions would be different than existing conditions because it includes climate change and sea-level rise and general plan development throughout California, including increased water demands in portions of the Sacramento Valley. The No Action Alternative is expected to result in potential changes in northwestern pond turtle habitat at reservoirs that store CVP water, tributaries, and the Delta.

Source: USFWS 2023

Figure 0-31. Western pond turtle.

Alternatives 1 through 4 would change river flows and reservoir levels that could adversely impact aquatic habitat for northwestern pond turtle. Depending on the tributary and water year, the alternatives would result in both increased flows and reduced flows, which may contribute to adverse impacts to northwestern pond turtle. Higher flows under Alternatives 1 through 4 result in increased velocity and water levels, which may cause inundation of upland nesting, basking, overwintering, aestivation, and movement habitat. Increased flow velocity and water levels may directly kill eggs if nests are inundated and/or kill hatchlings and make hatchlings more vulnerable to predation by causing shallower areas to become more accessible to aquatic predators. Increased flows relative to the No Action Alternative may also result in lower water temperatures, which can slow growth rates of developing juveniles. Decreased flows relative to the No Action Alternative could limit availability of aquatic breeding and basking habitat and may increase the distances juveniles would need to traverse between areas of aquatic and upland habitat, making them more vulnerable to predation. Lower flows relative to the No Action Alternative may also cause aquatic habitat to become unsuitable for hatchlings and force them to move into deeper areas that are more accessible to aquatic predators. While lower flows can lead to negative impacts to pond turtle, decreased flows can also increase water temperature which could improve the growth of juveniles and lead to expanded basking areas.

The SMSCG reoperations proposed under Alternative 1 would not include Delta smelt summer and fall habitat actions to improve Delta smelt food supply and habitat. This could incrementally increase marsh salinities in the summer and fall compared to the No Action Alternative. Higher basking activity of northwestern pond turtles has been observed in Suisun Marsh in areas with low salinity, indicating an increase in habitat suitability when salinity is decreased and vice versa. Thus, a seasonal increase in salinity in summer and fall may result in decreased habitat suitability and contribute to negative impacts on northwestern pond turtle. The SMSCG are being proposed to direct more fresh water into the Suisun Marsh to improve habitat conditions for Delta smelt in the region under Alternatives 2 through 4, which will likely have a beneficial impact on northwestern pond turtle.

The No Action Alternative is based on 2040 conditions. The changes to terrestrial biological resources that are assumed to occur by 2040 under the No Action Alternative conditions would be different than existing conditions because it includes climate change and sea-level rise and general plan development throughout California, including increased water demands in portions of the Sacramento Valley. The No Action Alternative could result in potential changes in foothill yellow-legged frog habitat at the Stanislaus River.

Source: Golden Gate National Parks Conservancy 2022.

Figure 0-32. Foothill yellow-legged frog

Proposed flow changes in the lower Stanislaus River downstream from New Melones Reservoir under the alternatives could both positively and negatively impact aquatic habitat for the South Sierra DPS of foothill yellow-legged frog.

Alternatives 1 through 4 would result in relatively minor increased flows in the Stanislaus River. Incrementally higher flows and water levels could impact adults' ability to feed or reside in the Stanislaus River and may lead to sedimentation of cobbled substrates. These impacts could negatively impact all the applicable life stages for the foothill yellow legged frog associated with lower water temperatures in the summer, high pulse flow water releases during developmental periods and a minor increase in sedimentation of cobbled substrates. Lower flows resulting from all Alternatives may increase the dispersal distance required between aquatic and upland habitat, increasing the risk of predation. Potential benefits include the expansion of basking areas, improved juvenile growth from warmer water temperatures, and reducing natural variability in water releases, beyond major flood events, which will create more stable conditions (i.e., more stable flow levels that are less likely to flush and/or kill eggs, tadpoles, metamorphs, and adults, and increase sedimentation) for foothill yellow-legged frogs.

Compared to the No Action Alternative, the limited discretion on flow releases from New Melones Reservoir into the Stanislaus River will result in possible dislodging, isolation, or mortality of egg masses, and possibly strand and/or kill tadpoles and metamorphs. Incrementally higher flows and water levels under all alternatives could impact adults' ability to feed or reside in the Stanislaus River and may lead to sedimentation of cobbled substrates. Lower water temperatures in the summer, high pulse flow water releases during developmental periods and a minor increase in sedimentation of cobbled substrates could negatively impact applicable life stages of the foothill yellow-legged frog.

0.3.6 1.3.6 Regional Economics

Regional economic effects from changes to M&I water supply were evaluated quantitatively using California Water Economics Spreadsheet Tool (CWEST) and IMPLAN models. CWEST is a spreadsheet representation of urban water supplies and costs for CVP and SWP project water agencies. IMPLAN estimates effects of various economic measures, including employment, labor income, and total value output.

The changes in water supply deliveries to M&I water contractors under the alternatives would affect regional economics (i.e., employment, labor income, and regional output). Alternative 1 would result in an increase in regional economic activity while Alternative 3 is expected to have an overall decrease in regional economic activity compared to the No Action Alternative. Under Alternative 2, all regions are expected to see an increase in regional economic activity with the exception of the San Francisco Bay area under some Alternative 2 phases. Under Alternative 4, the Sacramento River Region and San Francisco Bay Area Region are expected to have a decrease in regional economic activity, and the San Joaquin River Region, Central Coast and South Coast regions would have an increase in regional economic activity compared to the No Action Alternative.

The changes in water supply deliveries to agricultural contractors would affect regional economics. Alternative 1 would result in an increase in regional economic activity in the Sacramento River Region under dry conditions and San Joaquin River Region under average and dry conditions. Under Alternative 2, regional economic activity in the Sacramento River and San Joaquin River Regions would primarily decrease. Alternative 3 would result in a decrease in regional economic activity in the Sacramento River and San Joaquin River Regions under the dry and average conditions. Alternative 4 would result in an increase in regional economic activity in the Sacramento River Region under the average and dry condition and San Joaquin River Region under average conditions compared to the No Action Alternative.

The commercial and recreational (ocean sports) ocean salmon fishery along the Southern Oregon/Northern California Coast are affected by the population of salmon that rely upon the Northern California rivers, including the Sacramento and San Joaquin rivers. Annual average

Central Valley Chinook salmon abundance (includes spring, winter, fall and late-fall runs) in the Bay under all alternatives would be negligible in comparison to the No Action Alternative (Figure 0-33). Consequently, revenues received by fisherman from changes to ocean salmon harvest are expected to be the same. Ocean fisheries support industries such as fish processors, boat manufacturers, repair, and maintenance would see no changes in revenue.

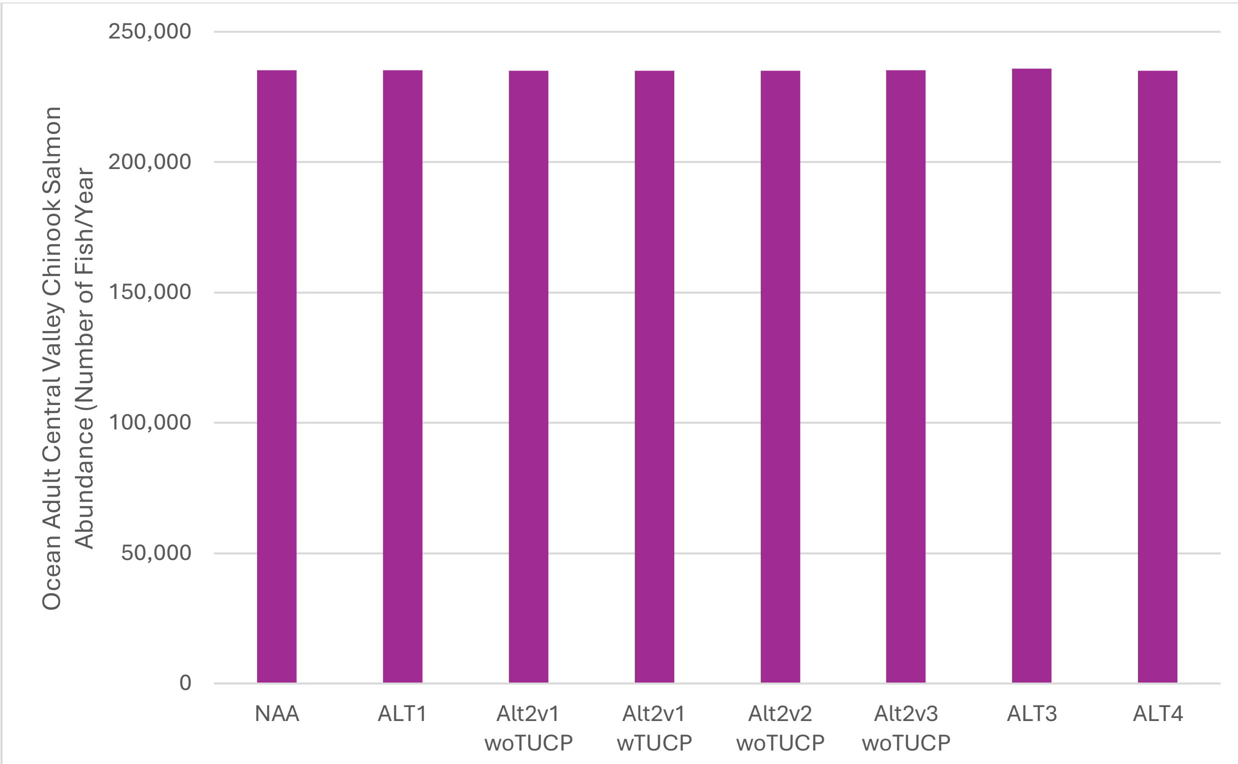

Figure 0-33. Central Valley Chinook Salmon Abundance.

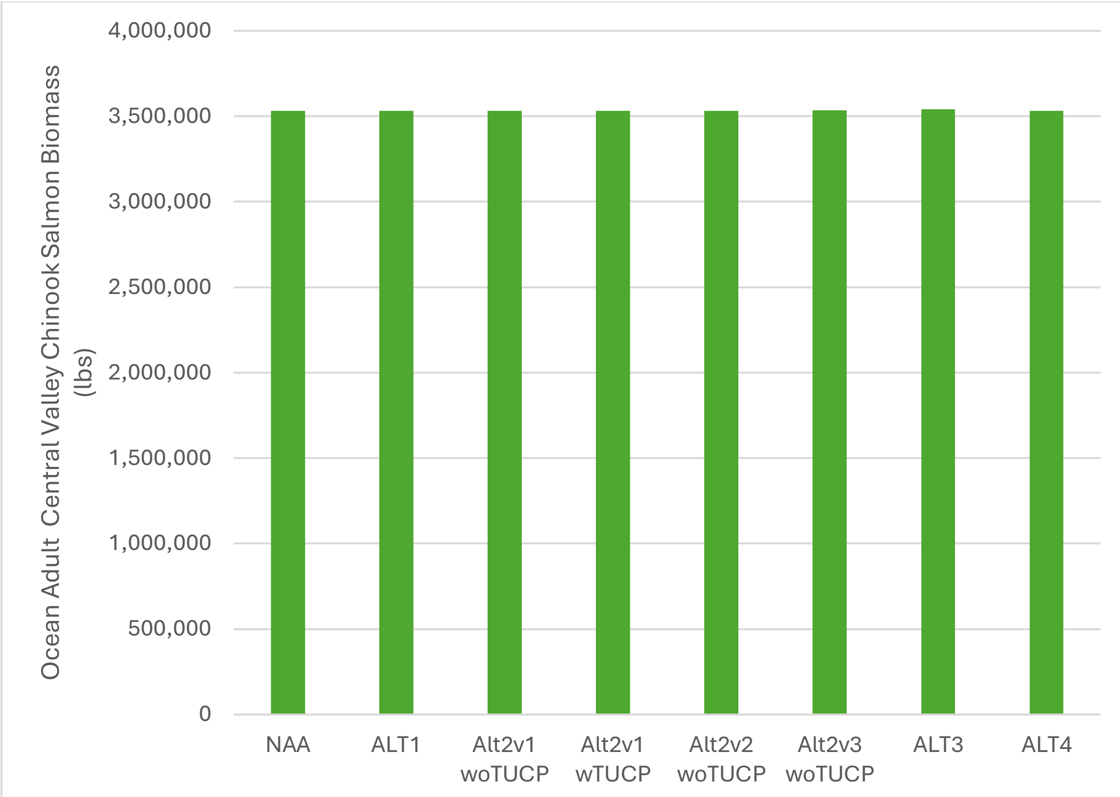

Figure 0-34 Estimates of adult Central Valley Chinook salmon abundance and biomass in the Pacific Ocean under each alternative.

Coho salmon, fall-run and spring-run Chinook salmon impacts under all the alternatives would be minor in comparison to the No Action Alternative. These salmon populations are extremely important to the Yurok Tribe and Hoopa Valley Tribe as part of their lives, cultural traditions, ceremonies, and community health (Bureau of Reclamation 2012). Salmon populations in the Trinity River would not be negatively affected under the alternatives; therefore, there would be no fisheries-related adverse effects to revenue and disposable incomes in the Trinity River Region.

Changes in Trinity Reservoir levels (Figure 0-35) under the alternatives could affect recreational visitation and consequently recreation spending in Trinity County. No adverse effects to regional economy from recreational visitation are expected under Alternatives 1, 3, and 4 compared to the No Action Alternative. Under Alternative 2, some adverse and short-term impacts to regional economy would be expected to occur as a result of lower reservoir elevations.

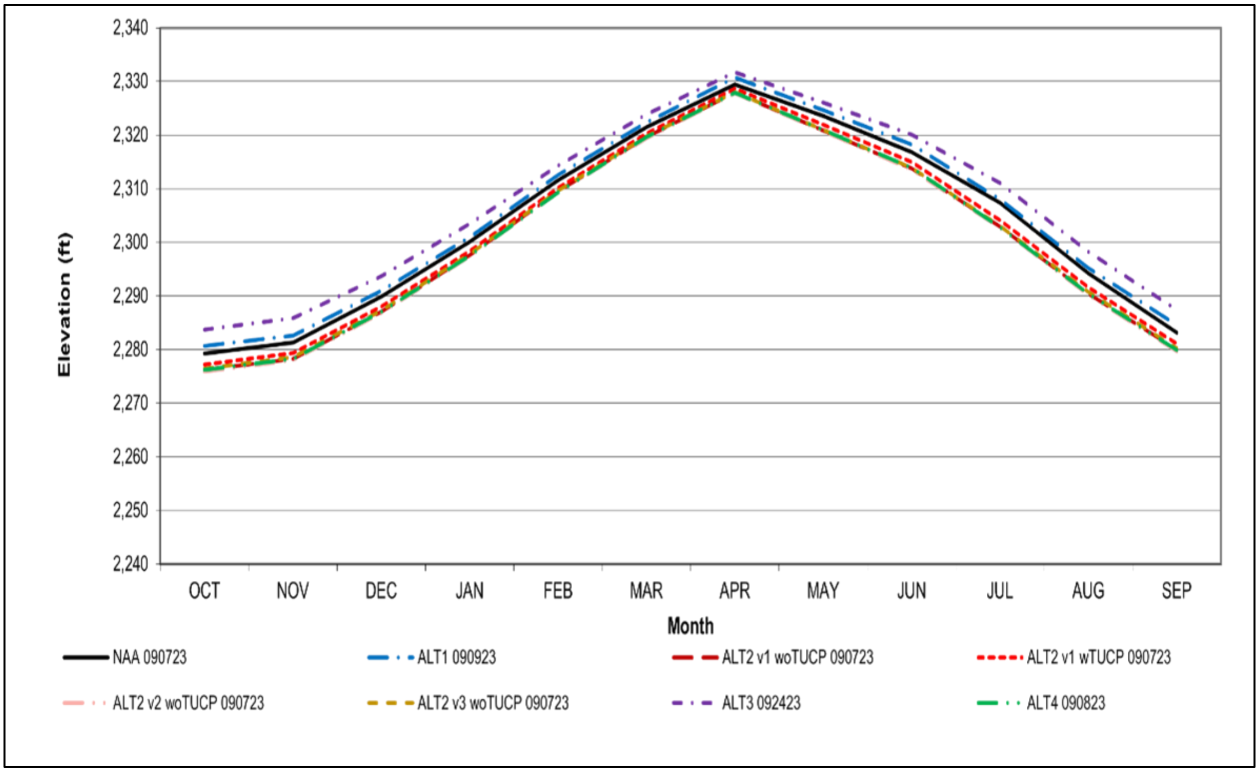

Figure 0-35. Trinity Reservoir Long-Term Average Water Level Elevation

The changes to hydropower generation from CVP and SWP operations under the alternatives could affect the regional economy through changes in electricity costs that are passed on to consumers. Alternative 1 is expected to result in more hydropower used for water supply and less available to offset electricity costs. Alternative 2 is expected to use less CVP hydropower for water supply and free more hydropower to reduce electricity costs and may result in increased regional economic activity but use more electricity for the SWP that would result in a decrease regional economic activity. Alternative 3 would result in more hydropower available in the regional economy from CVP and SWP operations. Alternative 4 is expected to result in more hydropower in the regional economy from CVP operations and use more electricity for SWP operations.

0.3.7 1.3.7 Power

Analysis considers CVP and SWP hydroelectric generation facilities, CVP and SWP energy use to move water, and transmission activities. Net generation is the difference between energy generation and use; a negative net generation means more energy is used than generated. When net generation values are negative, the CVP or SWP would purchase power from other generation facilities. Because California's energy system must always be balanced, purchasing power from other generation facilities would imply that additional generation is needed. Reservoir elevations and flow patterns through pumping facilities from the CalSim 3 model (Appendix F, Model Documentation) is used with Long-Term Generation (LTGen) and SWP power tools, as described in Attachment 1, Power Model Documentation. These tools estimate average annual peaking power capacity, energy use, and energy generation at CVP and SWP facilities.

The increase in CVP generation would be less than increases of annual energy use under Alternative 1, resulting in reductions in annual net generation. Under the Alternatives 2 and 4 there would be increases or no change in CVP annual generation for both the long-term average and dry and critically dry years, resulting in increases or no change in CVP annual net generation compared with the No Action Alternative. Under Alternative 3, there would be no change in CVP annual long-term generation and an increase in CVP annual generation for dry and critically dry years, resulting in the largest increase in CVP annual net generation of all the alternatives because of the greater decreases in annual energy use. Figure 0-36 provides a comparison of the long-term average annual CVP energy use, generation, and net generation for the action alternatives compared to the No Action Alternative.

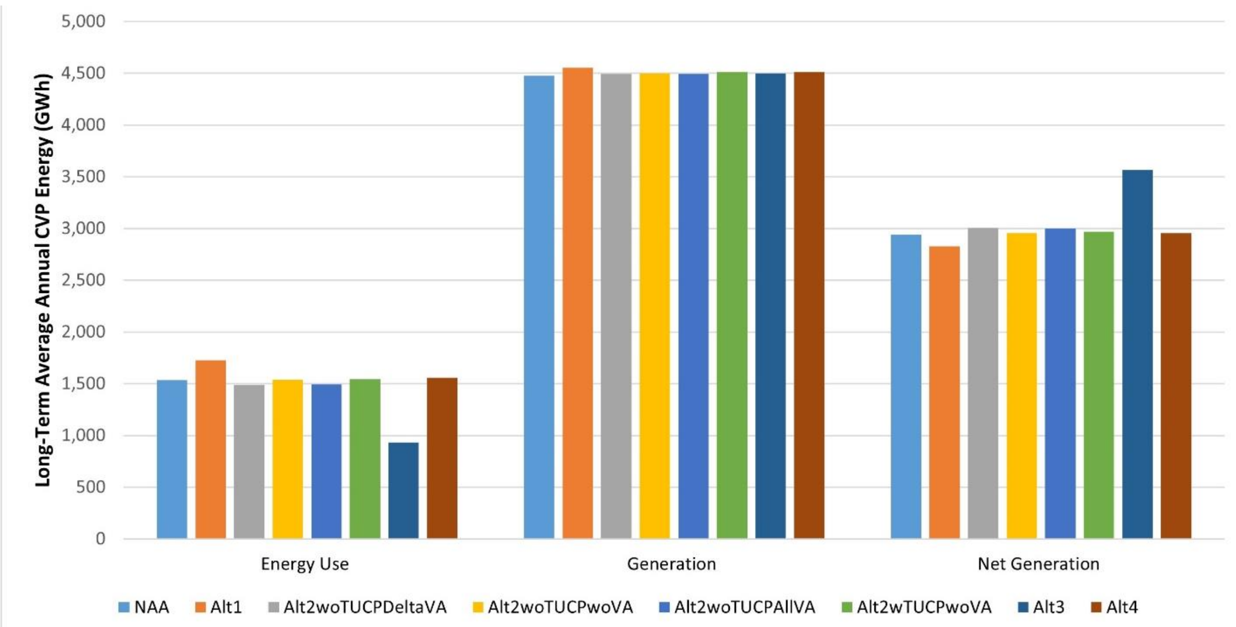

Figure 0-36. Comparison of Simulated Long-Term Average Annual CVP Energy Use, Generation and Net Generation

Under Alternative 1 the increase in SWP annual generation would be less than increases of SWP annual energy use, resulting in the greatest reduction in SWP annual net generation of all the alternatives. Under Alternatives 2 and 4 there would be slight increases in energy use, decreases in SWP annual generation, or there would be no change for both year types resulting in slight decreases in SWP annual net generation compared with the No Action Alternative. Under Alternative 3, there would be a decrease for SWP annual long-term average generation, and a decrease in SWP annual generation for dry and critically dry years, resulting in substantial increases in SWP annual net generation compared with the No Action Alternative because of the greater decreases in annual energy use than under the other alternatives. Figure 0-37 provides a comparison of the long-term average annual SWP energy use, generation, and net generation for the action alternatives compared to the No Action Alternative.

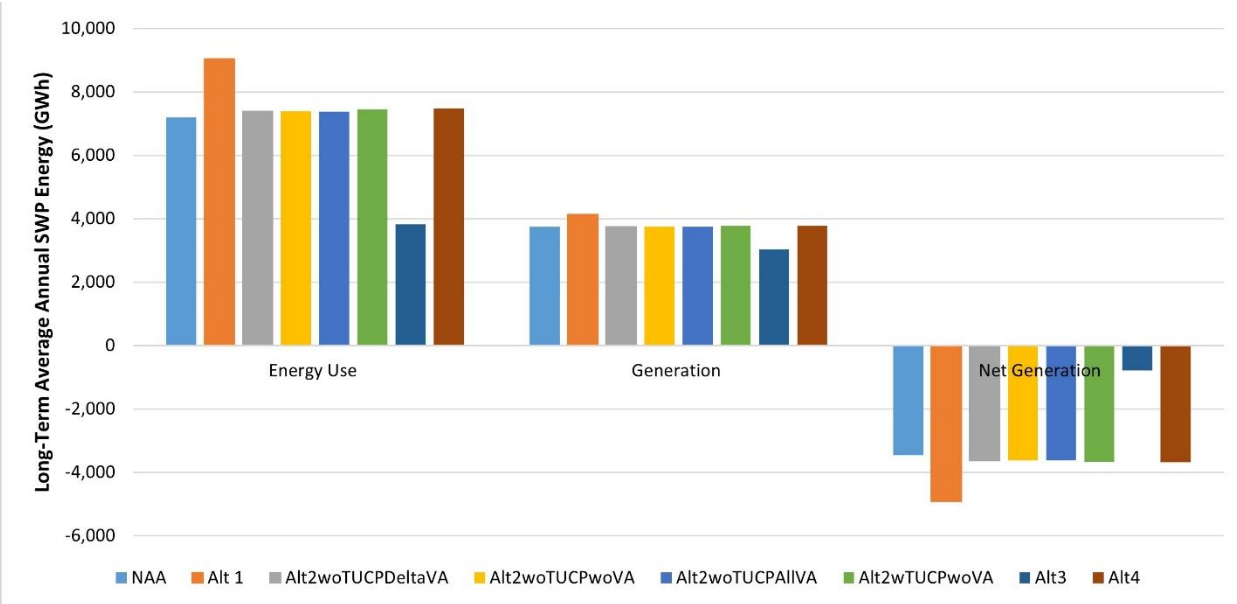

Figure 0-37. Comparison of Stimulated Long-Term Average Annual SWP Energy Use, Generation, and Net Generation

Reductions in monthly CVP net generation would not require the procurement of additional generation energy because generation would be positive in all months under all of the alternatives. Monthly reductions (greater than 5%) in CVP long-term average net generation for the action alternatives compared with the No Action Alternative would be greatest in January through March and September through October under Alternative 1. Alternatives 2 through 4 would not have reductions in CVP long-term average net generation greater than 5%, with several months having an increase in CVP net generation, with the greatest monthly increases under Alternative 3. Figure 0-36 provides a comparison of the long-term monthly CVP net generation and percent change for the action alternatives compared to the No Action Alternative.

All alternatives would have negative SWP net generation in all months except for Alternative 3 where January through May would have positive net generation. Negative SWP net generation would require the procurement of additional generation elsewhere within the California energy system. Monthly reductions in SWP long-term average net generation would be greater under Alternative 1 than the other alternatives with the largest reduction occurring in January through March and July. Alternative 2 phases would vary in the months with the greatest reduction in SWP annual long-term net generation. However, June, September, and November would not have reductions greater than 5% in those months. Under Alternative 3, monthly SWP long-term net generation would increase in all months compared with the No Action Alternative. Under Alternative 4, the greatest decreases in monthly SWP long-term net generation would occur in February, April, and May compared with the No Action Alternative. Figure 0-37 provides a comparison of the long-term monthly SWP net generation and percent change for the action alternatives compared to the No Action Alternative.

0.4 Issues in Dispute

40 CFR § 1502.12 provides that the EIS shall identify issues in dispute, "including issues raised by agencies and the public." Public dispute is not the same as scientific dispute but many of the disagreements regarding choices to be made between alternatives stem from disputes about the science, including strongly held views raised by non-scientists. This section summarizes areas of uncertainty and the existing information where the science is inconclusive or disputed may warrant further study.

Topics focus on substantial disputes over the size, location, nature, or consequences of the alternatives and their effects.

- Old and Middle River Management: Over the last twenty years, there has been substantial dispute over CVP and SWP export operations and the management of entrainment through restriction on the magnitude of reverse flows in Old and Middle rivers during certain periods of the year, and the environmental effects of those flow changes.

- Winter and Spring Delta Outflow: Substantial dispute exists over the CVP and SWP management of the magnitude of winter and spring Delta outflow and effects of differing flows on the ecosystem and listed species during these seasons.

- Summer and Fall Habitat Actions: Substantial dispute exists over the operation of the CVP and SWP to create and/or maintain low salinity zone habitat for Delta smelt in late summer and fall, along with the operation of the Suisun Marsh Salinity Control Gates, and the effects of differing flows on habitat and food availability and quality.

- Shasta Coldwater Pool Management: Substantial dispute exists over storing and retaining stored water in Shasta Reservoir to meet temperature management, contractual demands, and the needs in consecutive drought and dry years under changing climates.

- Folsom Flow and Temperature: Dispute exists over the management of stored water within Folsom Reservoir during certain water year types. During dryer years it is challenging for Reclamation to address the tradeoffs for minimum releases and the use of available cold-water pool in Folsom Reservoir for water supply, power production and steelhead and fall-run Chinook salmon in the American River and a margin of safety on water levels for M&I intakes.

- New Melones Stepped Release Plan: Substantial dispute exists over the CVP management of stored water within New Melones Reservoir. It is challenging for Reclamation to address the tradeoffs for minimum releases for instream demands and water quality and the need to consider multi-year storage and refill needed to maintain sufficient reservoir levels for water temperature management.

- Central Valley Tributary Habitat Restoration: There has been substantial dispute over the effectiveness of tributary habitat restoration for meeting the needs of endangered fish species in addition to and/or in lieu of additional flows.

- Delta Habitat Restoration: There has been substantial dispute over the effectiveness of tidal habitat restoration for meeting the needs of endangered fish in addition to and/or in lieu of additional flows.

0.5 Issues to be Resolved

0.5.1 Preferred Alternative

While Reclamation has identified a preferred alternative in this EIS, selection of a final alternative will not be final until the Record of Decision. The decision on the alternative to implement will consider public comments and updates in a Final EIS.

0.5.2 Trinity River Division

The alternatives in this EIS, including the No Action Alternative, incorporate the continued implementation of the 2000 Trinity River Mainstem Fishery Record of Decision (2000 Trinity ROD) and the 2017 Long-Term Plan to Protect Adult Salmon in the Lower Klamath River Record of Decision. Changes or impacts described for resources associated with the Trinity Reservoir levels and Trinity River flows have been previously analyzed under the environmental compliance that led to those two Records of Decision.

Reclamation is separately and concurrently coordinating with the Hoopa Valley Tribe and the Yurok Tribe as joint leads (40 CFR part 1501) on Trinity River-specific considerations to develop potential Trinity River-specific alternatives for an updated operation for releases to the Trinity River and diversions from the Trinity River Basin to the Central Valley. Reclamation also is developing a biological assessment for listed species that are specific to the Trinity River Division and plans to request formal consultation with the appropriate federal resource agencies. Reclamation expects to update the analysis presented in this document to reflect changes in Trinity River Division operations if there are different impacts as a result of decision on the Trinity River Division.

0.6 Mitigation Measures

NEPA requires federal agencies to consider appropriate mitigation measures to avoid or minimize specific impacts. Consideration and adoption of mitigation is a continuous process through completion of the EIS and Record of Decision. The Council on Environmental Quality defines mitigation to include avoidance, minimization, rectification, reduction over time, and compensation for impacts (Section 1508.20).

Because of the central focus of the alternatives on operations of the CVP and SWP in compliance with Federal law, including the Endangered Species Act, the alternatives themselves include many species-related conservation measures that are considered avoidance and minimization measures integrated as part of the alternatives. These measures are considered avoidance and minimization measures because they are intended to avoid impacts or limit the degree and magnitude of the impacts. Hence, additional mitigation is often not identified for fish and aquatic species, except for very specific instances.

In addition to the avoidance and minimization measures and the additional mitigation associated with the alternatives discussed in this EIS, there are independent but related programs and activities that address some of the impacts inherent in the long-term operations of the CVP and SWP. The scope and complexity of agency actions in the Central Valley involve multiple activities that are implemented separately from the long-term operation. These "independent related actions" with their independent NEPA and section 7 consultations, where warranted, are part of the affected environment but are not part of the operation of the CVP and SWP to store, release, divert, route, and blend water. Nevertheless, because of the ongoing and long-term operation of the CVP and SWP, some of these actions rectify and reduce and compensate impacts associated with operation of these facilities. Avoidance and minimization measures, additional mitigation and independent related actions are discussed in detail in *Appendix D Mitigation Measures*.

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Chapter 1 Introduction

An Environmental Impact Statement (EIS) helps inform the public and decisions-makers on potential federal actions by examining a range of reasonable alternatives and the potential effect on the environment. The U.S. Department of the Interior, Bureau of Reclamation (Reclamation) manages the Central Valley Project (CVP). The California Department of Water Resources (DWR) manages the State Water Project (SWP). This EIS describes and analyzes alternatives for the long-term operation of the CVP to store, release, blend releases, route and divert water and the long-term operation of SWP facilities in the Sacramento–San Joaquin Delta (Delta).

Reclamation last signed a Record of Decision on Feb. 18, 2020, for the *Reinitiation of Consultation on the Coordinated Long-Term Operation of the Central Valley Project and State Water Project*. On January 20, 2021, President Biden issued "*Executive Order* 13990 *on Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*", directing the Department of Interior to review all existing regulations, orders, guidance documents, policies, and any other similar agency actions (agency actions) promulgated, issued, or adopted between January 20, 2017, and January 20, 2021, that are or may be inconsistent with, or present obstacles to, the policy set forth in section 1 of the order. This included the National Marine Fisheries Service (NMFS) *Biological Opinion on Long Term Operation of the Central Valley Project and the State Water Project* (October 21, 2019) and U.S. Fish and Wildlife Service (USFWS) *Biological Opinion for the Reinitiation of Consultation on the Coordinated Operations of the Central Valley Project and State Water Project* (October 21, 2019). Reclamation incorporates the 2019 EIS analysis by reference.

To address the review by Executive Order 13990 and to voluntarily reconcile CVP operating criteria, as appropriate with operational requirements of the SWP under the California Endangered Species Act, Reclamation reinitiated consultation with USFWS and NMFS on September 30, 2021. Although Reclamation and DWR strive for a coordinated operation of the CVP and SWP, Reclamation and the CVP are not subject to requirements under the California Endangered Species Act.

On February 28, 2022, Reclamation posted a Notice of Intent to Prepare an Environmental Impact Statement and Hold Public Scoping Meetings on the 2021 Endangered Species Act Reinitiation of Section 7 Consultation on the Long-Term Operation of the Central Valley Project and State Water Project (87 Federal Register [FR] 11093).

1.1 Project Background

Reclamation's mission is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. Reclamation is the largest wholesale water supplier in the United States, and the nation's second largest producer of hydroelectric power. Its facilities also provide substantial flood control, recreation, and fish and wildlife benefits.

The CVP consists of 20 dams and reservoirs that together can store nearly 12 million acre-feet (MAF) of water. Reclamation holds over 270 contracts and agreements for water supplies that depend upon CVP operations. Through operation of the CVP, Reclamation delivers water in 29 of California's 58 counties in the following approximate amounts: 5 MAF of water for farms; 600 thousand acre-feet (TAF) of water for municipal and industrial (M&I) uses; and an average of 355 TAF of Level 2 CVP water for wildlife refuges (plus additional supplies from other sources). Reclamation operates the CVP under water rights granted by the state of California, including those intended to protect agricultural and fish and wildlife beneficial uses in the Delta. On average, the CVP generates approximately 4.5 million megawatt hours of electricity annually.

Reclamation operates the CVP in coordination with DWR's operation of the SWP, pursuant to applicable law and provisions of the *Agreement Between the United States of America and the State of California for Coordinated Operation of the Central and State Water Project* and its associated amendments. The mission of DWR is to manage the water resources of California, in cooperation with other agencies, to benefit the state's people and to protect, restore, and enhance the natural and human environment.

DWR holds contracts with 29 public agencies in the Feather River Area, North Bay Area, South Bay Area, San Joaquin Valley, Central Coast, and Southern California for water supplies from the SWP. The SWP delivers on average 2.6 MAF of contracted water supplies annually. Two contractors from the North Bay Area receive water from the Barker Slough Pumping Plant in the Delta. DWR pumps water at the Banks Pumping Plant in the Delta for delivery to the remaining 24 public water agencies in the SWP service areas south of the Delta.

1.2 Scope of Analysis for Resource Areas

The action alternatives evaluated in this EIS include a range of operational changes for long-term operation of the CVP and SWP. Reclamation hosted six virtual scoping meetings between March 8 and March 17, 2022, presenting information about the CVP, SWP, and the National Environmental Policy Act (NEPA) process and then inviting comments. Attendance at the six meetings included members of the public, landowners, and representatives from public agencies. Written comments were also accepted during the scoping period from February 28 through March 30, 2022. Major areas of public comments included:

- Project Purpose, Scope, and Analysis
- Endangered Species Act
- Biological Resources
- Agriculture
- Groundwater
- Water Quality
- Water Storage and Conveyance

- Cultural and Tribal Consultation
- Pertinent Regulations
- Socioeconomics
- Climate Change and Drought
- Recreation
- Scoping Process
- Water Rights and Water Contracts
- Water Conservation Strategies

Reclamation has framed this EIS to address the issues identified through public scoping.

1.3 Selection of Preferred Alternative

Reclamation has identified Alternative 2B as the preferred alternative. Alternative 2B was developed through a multi-agency consensus process including California Department of Fish and Wildlife, DWR, NMFS, and USFWS. The preferred alternative best meets the Purpose and Need, including the goals of Executive Order 13990 because NMFS and USFWS reached consensus on an alternative for Reclamation to submit for consultation. Alternative 2 incorporates the Delta criteria proposed in DWR's Incidental Take Permit for the Delta facilities of the SWP to harmonize operations of the CVP and SWP.

1.4 References

National Marine Fisheries Service. 2019. *Biological Opinion on Long Term Operation of the Central Valley Project and the State Water Project*.

U.S. Fish and Wildlife Service. 2019. *Biological Opinion for the Reinitiation of Consultation on the Coordinated Operations of the Central Valley Project and State Water Project*.

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Chapter 2 Purpose and Need

2.1 Purpose and Need

The U.S. Department of the Interior, Bureau of Reclamation (Reclamation) operates the Central Valley Project (CVP), and the California Department of Water Resources operates the State Water Project (SWP) under the 1986 Coordinated Operation Agreement, as amended in 2018, between the federal government and the State of California, as authorized by Public Law 99-546. On September 30, 2021, Reclamation requested to reinitiate consultation on the Long-Term Operation of the CVP and SWP under section 7 of the Endangered Species Act (ESA) due to anticipated modifications to the previous Proposed Action that may cause effects on ESA-listed species or designated critical habitat not analyzed in the current 2019 Biological Opinions. Modifications would address the review of the 2019 Biological Opinions required by Executive Order 13990 *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*, and voluntarily harmonize CVP operating criteria, as appropriate, with requirements for the SWP under the California Endangered Species Act.

The purpose of the action considered is to continue the operation of the CVP and the SWP, for authorized purposes, in a manner that:

- Meets requirements under federal Reclamation law; other federal laws and regulations; and State of California water rights, permits, and licenses pursuant to Section 8 of the Reclamation Act;
- Satisfies Reclamation contractual obligations and agreements; and
- Implements authorized CVP fish and wildlife project purposes and meets federal trust responsibilities to Tribes, including those in the Central Valley Project Improvement Act.

Operation of the CVP and SWP is needed to meet multiple authorized purposes including flood control and navigation; water supply; fish and wildlife mitigation, protection, and restoration and enhancement; and power generation. Operation of the CVP and SWP also provides recreation and water quality benefits.

2.2 Study Area Location and Description

The study area includes areas that could be affected directly or indirectly by the action alternatives. The study area includes CVP service areas and CVP dams, power plants, diversions, canals, gates, and related federal facilities located on Clear Creek, the Trinity, Sacramento, American, Stanislaus, and San Joaquin rivers, and in the Sacramento–San Joaquin Delta (Delta).

- A portion of the water from the Trinity River Basin is stored in Trinity Reservoir behind Trinity Dam, re-regulated in Lewiston Lake, and diverted through a system of tunnels and powerplants into Whiskeytown Reservoir on Clear Creek and then into the Sacramento

River through Spring Creek upstream of Keswick Dam. Water is also released from Lewiston Dam to the Trinity River where it flows to the Klamath River.

- A portion of the water from the upper Sacramento River is stored in Shasta Reservoir and re-regulated in Keswick Reservoir. Water in Shasta Reservoir may be diverted at Shasta Dam or released into the Sacramento River. Water from the upper Sacramento River, imports from the Trinity River Basin, releases from other reservoirs owned or operated by local agencies, and other inflows that enter the Sacramento River, and may be diverted into the Tehama-Colusa and Corning Canals at the Red Bluff Pumping Plant.
- A portion of the water from the American River is stored in Folsom Reservoir and re-regulated in Lake Natoma. Water in Folsom Reservoir may be diverted at Folsom Dam, be diverted into the Folsom South Canal, or be released into the American River.
- A portion of the water from the Stanislaus River is stored in New Melones Reservoir. Water in New Melones Reservoir may be released into the Stanislaus River.
- A portion of the water from the upper San Joaquin River is stored in Millerton Reservoir behind Friant Dam. Water is diverted into the Madera and Friant-Kern Canals or released into the San Joaquin River.
- The Sacramento River and San Joaquin River carry water to the Delta. As water moves down the mainstem of the Sacramento River, gates at the Delta Cross Channel are operated for water quality and flood management.
- Water in the Delta may be pumped into the Contra Costa Canal at Rock Slough and delivered to Contra Costa Water District. The C.W. Bill Jones Pumping Plant is at the southern end of the Delta, lifting water into the Delta-Mendota Canal (DMC). CVP water is conveyed in the DMC for direct diversion or for delivery to the San Luis Reservoir. Water from the San Luis Reservoir is also conveyed through the San Luis Canal and Pacheco Tunnel. The DMC-California Aqueduct Intertie connects the CVP and SWP conveyance facilities after export from the Delta. Prior to the Jones Pumping Plant, the Tracy Fish Collection Facility salvages salmonids and other species.

The study area includes SWP service areas downstream of the Feather River and SWP facilities in the Delta, Cache Slough Complex, and Suisun Marsh. Operations of the Oroville Reservoir and Oroville Dam are not addressed as part study area.

- In the Cache Slough Complex the Barker Slough Pumping Plant lifts water into the North Bay Aqueduct.
- In Montezuma Slough, the Suisun Marsh Salinity Control Gates are tidally operated to maintain fresh water in Montezuma Slough and the Suisun Marsh.
- The Harvey O. Banks Pumping Plant at the southern end of the Delta, behind Clifton Court Forebay, lifts water into the California Aqueduct, which conveys water to the San Luis Reservoir for storage and to the South Bay Aqueduct for deliveries to the SWP contractors. The DMC-California Aqueduct Intertie connects the CVP and SWP conveyance facilities after export from the Delta. Prior to the Banks Pumping Plant, the Skinner Delta Fish Protection Facility salvages salmonids and other species.

- When the systems have capacity, the SWP also pumps water through the Harvey O. Banks Pumping Plant and conveys it through the California Aqueduct to the Cross-Valley Canal for CVP water service contractors.

Figure 2-1, Study Area Map, shows these areas.

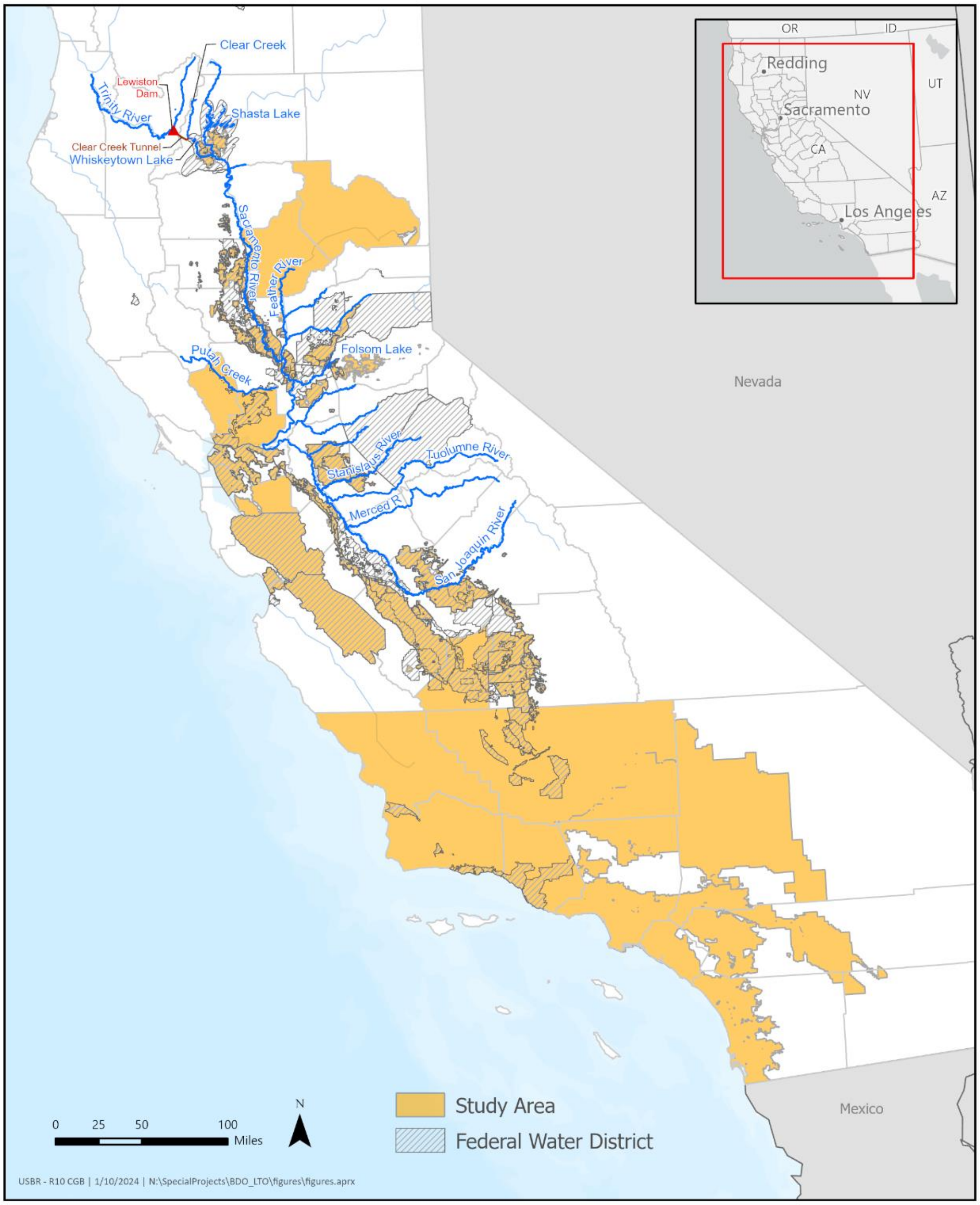

Figure 2-1. Study Area Map

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Chapter 3 Draft Alternatives

The Bureau of Reclamation (Reclamation) formulated draft alternatives through the National Environmental Policy Act scoping process, coordination with public water agencies pursuant to the Water Infrastructure Improvement for the Nation Act, interagency coordination teams, outreach to interested parties, and Reclamation's decades of experience in operating the Central Valley Project (CVP). A Notice of Intent (87 Federal Register 11093–11095), published February 28, 2022, sought public comments. Reclamation requested comments by mail and by email and held six virtual public meetings, as described in *Chapter 1 – Introduction.* Reclamation prepared a Scoping Report that included comments received (Reclamation 2022).

Previous consultations with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) identified measures to protect species listed under the Endangered Species Act and those measures primarily differentiate alternative approaches. Exploratory modeling simulated potential water operations under layers of operational objectives with results informing potential modifications and limitations on the seasonal operation of the CVP and State Water Project (SWP).

Reclamation coordinated with agencies and interested parties to develop the alternatives described below. Reclamation must consider potentially reasonable alternatives beyond its own jurisdiction and consider the jurisdictions of other agencies (Federal and otherwise) when determining what reasonable alternatives should be considered.

- Alternative 1 (Water Quality Control Plan (D-1641, 90-5, etc.)): Alternative 1 consists of operation to water right terms and conditions, including obligations for water quality control plan objectives for the Bay-Delta, water quality and minimum flows on CVP tributaries, and water right settlements. The needs of listed fish would rely upon habitat restoration and facility improvements completed since the 2008 and 2009 biological opinions rather than on additional flows.
- Alternative 2 (Multi-Agency Consensus): Alternative 2 consists of actions developed with the California Department of Fish and Wildlife, DWR, NMFS, and USFWS to harmonize operational requirements of CVP with California Endangered Species Act requirements for the SWP. It includes actions and approaches for the CVP and SWP identified by the state and federal fish agencies, in addition to the water supply and power generation objectives of Reclamation and DWR.
- Alternative 3 (Modified Natural Hydrograph): Alternative 3 consists of operation to increased Delta outflow up to 65% of unimpaired inflow and to carryover storage requirements in addition to other measures. This alternative was developed in coordination with the NGO community.
- Alternative 4 (Risk Informed Operation): Alternative 4 consists of modified Shasta and Folsom Dam operations for a different balance between water made available for

diversion and storage to protect against subsequent dry years. It scales Delta operations based on effects to listed fish populations.

The following sections summarize the No Action Alternative and the four potential Action Alternatives. Appendix E *Draft Alternatives*, provides the full description of the range of alternatives.

3.1 Common Components

This section describes information applicable to the No Action Alternative and all action alternatives, "common components". Common components describe where interagency coordination, review of literature, and scoping comments did not identify substantial disagreement with the physical and biological science defining those actions nor substantial disagreement with the potential resource tradeoffs. Variable components are included in potential action alternatives.

Reclamation operates the CVP for the congressionally authorized purposes of: (1) river regulation, improvement of navigation, and flood control; (2) irrigation and domestic uses, and fish and wildlife mitigation, protection, and restoration; and (3) power, and fish and wildlife enhancement. DWR operates the SWP to provide flood control and water for power generation, agricultural, municipal, industrial, recreational, and environmental purposes. Public Law 99-546 authorized the 1986 Coordinated Operation Agreement (COA, as amended in 2018), which sets procedures for Reclamation and DWR to share joint responsibilities for meeting Delta standards and other legal uses of water. Operation of the CVP and SWP also provides recreation and water quality benefits.

Facilities, authorizing legislation, and requirements under the regulations, contracts, and agreements are described in Appendix C of this EIS. Alternatives are organized as follows:

1. **Watersheds:** basin-by-basin description of facilities and the proposed operation for fish and wildlife, water supply, and power generation including proposed conservation measures to promote the recovery and/or to minimize or compensate for adverse effects of operation on federally listed species.
2. **Monitoring:** the long-term evaluation of performance to assess overall effectiveness over time. Although each watershed has unique requirements, Reclamation and DWR integrate monitoring across watersheds; therefore, monitoring is organized together.
3. **Special Studies:** science-based efforts to address uncertainties in the actions that affect a reasonable balance among competing demands for water, including the requirements of fish and wildlife, agricultural, municipal, and industrial uses of water, and power contractors to inform subsequent decision making.
4. **Drought:** actions to recognize extreme dry conditions may occur during operations. The boom-and-bust nature of California hydrology and the resulting effect on species warrants special consideration for operation during droughts. Although each drought is unique, contingency planning can facilitate a response.
5. **Governance:** ongoing engagement by Reclamation and DWR with USFWS, NMFS and CDFW following completion of Biological Opinions and a Record of Decision.

6. **Adaptive Management:** science and decision analytic-based approach to evaluate and improve actions, with the aim to reduce uncertainty over time and increase the likelihood of achieving and maintaining a desired management objective.

3.1.1 Sacramento River

Reclamation operates and maintains the Shasta Division of the CVP for flood control and navigation, municipal and industrial (M&I) and agricultural water supplies, fish and wildlife, hydroelectric power generation, Sacramento River water quality, and Delta water quality. Facilities include the Shasta Dam and Power Plant, Keswick Dam and Power Plant, and a Temperature Control Device (TCD) on the upstream face of Shasta Dam. Major facilities in the Sacramento Division of the CVP include the Red Bluff Pumping Plant, the intake for the Tehama-Colusa Canal and the Corning Canal (Figure 3-1).

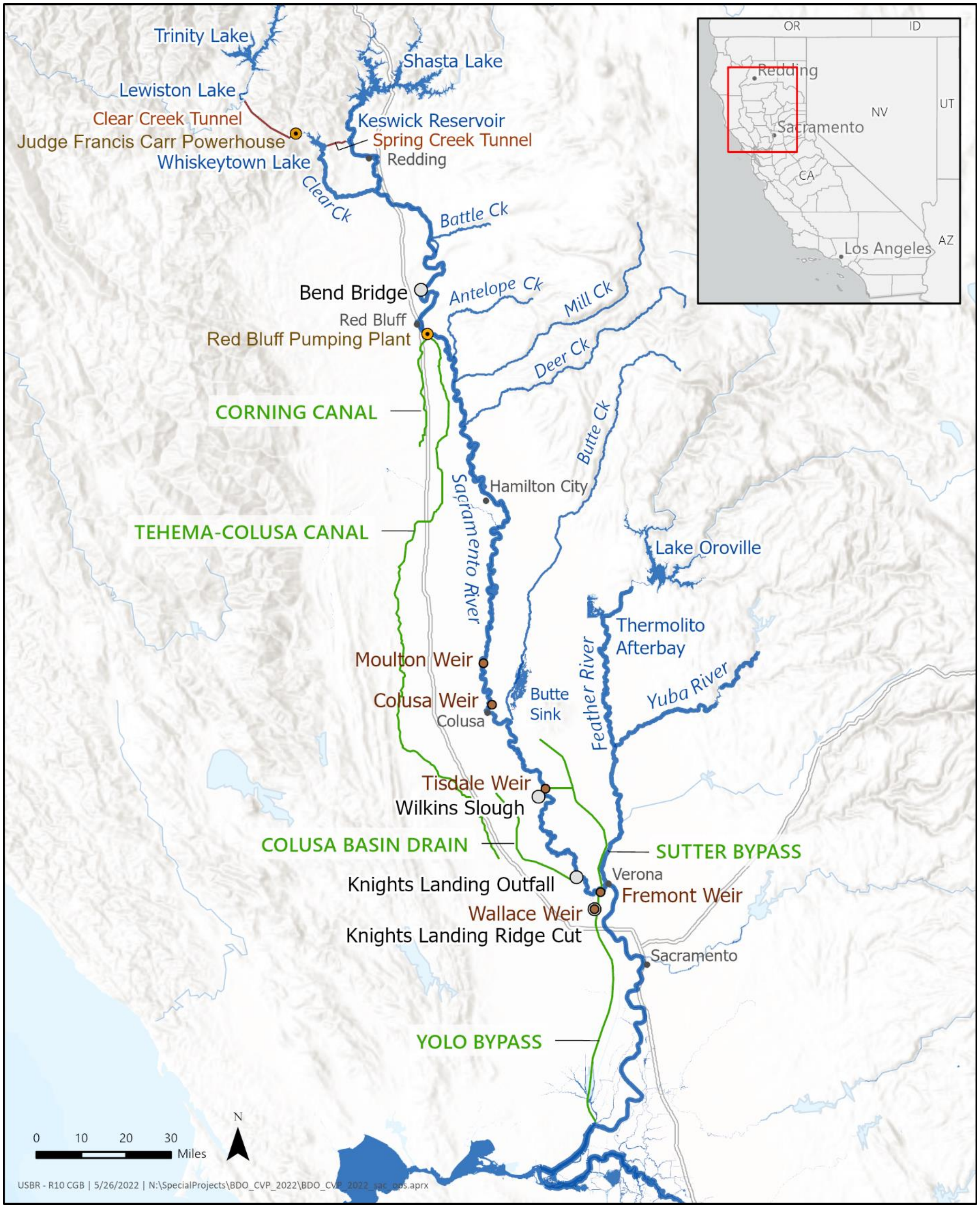


Figure 3-1. Sacramento River Facilities in the Shasta and Sacramento Divisions of the CVP and Flood Control Weirs and Bypasses.

3.1.1.1 Seasonal Operations

Reclamation operates Shasta Dam in the winter primarily for flood control and minimum flows in the Sacramento River and in the Delta. With flashboards installed on top of the drum gates that raise the elevation to 1,067 feet, the maximum capacity of Shasta Reservoir is 4.552 million acre-feet (MAF). For the flood season, the U.S. Army Corps of Engineers (USACE) provides a flood control diagram that specifies by date a top of conservation pool storage. Flood operational criteria target flow rates below 100,000 cubic feet per second (cfs) at Bend Bridge for the protection of downstream populations; therefore, reservoir elevations may temporarily exceed the top of the conservation pool and encroach into flood space in order to limit downstream flows. In the winter, when not releasing for flood control, Reclamation seeks to store inflows to Shasta Reservoir and releases minimum flows necessary to meet downstream requirements. California State Water Resources Control Board (SWRCB) WRO 90-5 provides a target for minimum releases from Keswick Reservoir from September through February, the 1937 Act includes consideration for navigation at Wilkins Slough, and D-1641 provides flow standards in the Delta. Reclamation generally maintains flows of 5,000 cfs at Wilkins Slough year-round and these flows may be reduced in drought years. Reclamation may make releases above the minimum to maintain fall-run Chinook salmon redds in wetter hydrologic year types when storage levels are higher in Shasta Reservoir.

In the spring, when not operating for flood control, Reclamation seeks to maximize storage of inflow to optimize the filling of CVP reservoirs by the end of the flood control season (end of May). Higher storage improves the ability to meet downstream water temperature objectives and increases the ability to make releases later in the year for water supply. Accretions (runoff, return flows and flows from non-project creeks into the Sacramento River below Shasta Dam) also contribute to meeting both instream demands and Delta outflow requirements. Wetter years with high accretions may allow Reclamation to store more water in the spring and operate mostly for flood control. Drier years with lower accretions may require Reclamation to make releases from Shasta Reservoir for downstream requirements throughout the spring season. Toward the middle to end of spring, instream diversion demands increase on the mainstem Sacramento River and require releases above minimum flows at Keswick Reservoir. Reclamation operates to flow objectives at Wilkins Slough to: (1) support diversion by Sacramento River Settlement (SRS) Contractors with a prior entitlement to water in the Sacramento River; (2) for deliveries to Central Valley Project Improvement Act (CVPIA) wildlife refuges; and (3) for deliveries to CVP water service contractors at the Red Bluff Pumping Plant. The majority of these diversions typically occur mid-April through November with variations depending on hydrology.

Delta salinity and outflow requirements may necessitate additional releases from Shasta Reservoir. When system-wide demands require augmenting flows in the system, Reclamation coordinates imports from the Trinity Basin, releases by DWR from Oroville Reservoir, and releases from Folsom Reservoir. Each reservoir has factors to consider including instream requirements, amounts in storage, forecasted inflow, and refill potential. The 1986 Coordinated COA and 2018 Addendum describe the CVP portion of Delta outflow requirements. Reclamation balances releases for the CVP portion of Delta outflow requirements between Shasta and Folsom reservoirs to maximize storage in each reservoir and minimize negative impacts between CVP tributaries. When increased releases are necessary to meet Delta needs, Reclamation generally first adjusts exports, then releases from Folsom Reservoir while releases from Shasta Reservoir travel down the Sacramento River. Once releases from Shasta Reservoir arrive in the Delta (about five days' travel time), releases from Folsom Reservoir can be reduced to balance the demands on each reservoir. When Reclamation can export water from the Delta during periods of excess flow, Reclamation can store more water in San Luis Reservoir south of the Delta. Maximizing exports in the spring reduces the reliance on stored water later in the year for meeting late season demands.

Summer operational considerations include releases for temperature control, instream diversion demands, Delta outflows, Delta salinity, and exports. In-river temperatures downstream of Keswick Dam can be controlled via two methods. The first is thermal mass, by changing release volume or shifting releases between Trinity Basin imports and Shasta Reservoir, and the second is selective withdrawal of colder water through the TCD. Determination of which method to use is made daily as operators balance releases from multiple reservoirs to meet downstream needs. Releases in the summer meet water temperature objectives, support essential features of critical habitat and support water supply deliveries. Releases from Shasta Reservoir typically begin increasing in April as storm frequency decreases, air temperatures increase, and system-wide demands increase. Peak releases from Shasta Reservoir typically occur June through August and begin to decrease from the peak sometime in August or September. Occasionally, in very wet years, high storage levels through the summer may result in a need to release higher than normal flows in early fall to meet flood control requirements for the next year. Consideration of fall conditions may also warrant measures for drought protection and rebalancing of storage between reservoirs.

In the fall, Reclamation's objective is to reduce Keswick Dam releases and rebuild storage in Shasta Reservoir. Reclamation balances fall operations based on highly variable conditions, including water temperature control (dependent on winter-run Chinook salmon emergence timing), maintenance of winter-run Chinook salmon redds (dependent on spawning depths), instream diversion demands on the mainstem of the Sacramento River upstream and downstream of Wilkins Slough (dependent on seasonal planting and wildlife refuges), fall-run Chinook salmon redd dewatering minimization (dependent on late-summer flows and fall spawning timing), and release stabilization through the fall-run Chinook salmon egg and alevin incubation. The remaining coldwater pool in Shasta Reservoir is usually limited in the fall at the end of the water temperature management season. Release reductions from Shasta Reservoir early in the fall include the following considerations: (1) winter-run Chinook salmon eggs and alevin incubation; (2) whether significant instream diversion demands (e.g., rice decomposition) remain on the mainstem of the Sacramento River between Keswick Dam and Wilkins Slough,: (3) Delta smelt habitat; and, (4) Delta requirements that may require upstream reservoir releases for Delta outflow objectives from the SWRCB. If early fall flows drop substantially after fall-run Chinook salmon spawn at high river stages, their redds may be dewatered when flows are later reduced to rebuild storage.

3.1.1.2 Rice Decomposition Smoothing

Rice decomposition smoothing could minimize impacts to fall-run Chinook salmon by minimizing fry stranding and redd dewatering as flows drop in the winter. Reclamation will release flows based on Sacramento Valley Water Service Contractors demand and SRS Contractors coordinated rice decomposition smoothing diversion schedule. SRS Contractors and CVP Water Service Contractors will synchronize their diversions to lower peak rice decomposition demand. The diversion schedule considers dewatering risk for winter-run Chinook salmon redd locations.

3.1.2 Clear Creek

As a component of the Trinity Division of the CVP, Reclamation operates and maintains Whiskeytown Dam on Clear Creek, with a capacity of 241,100 acre-feet, for irrigation and other beneficial uses, hydroelectric power generation, fish and wildlife, recreation, and upper Sacramento River temperature control and water rights requirements. Whiskeytown Lake provides reregulation of trans-basin imports from the Trinity River.

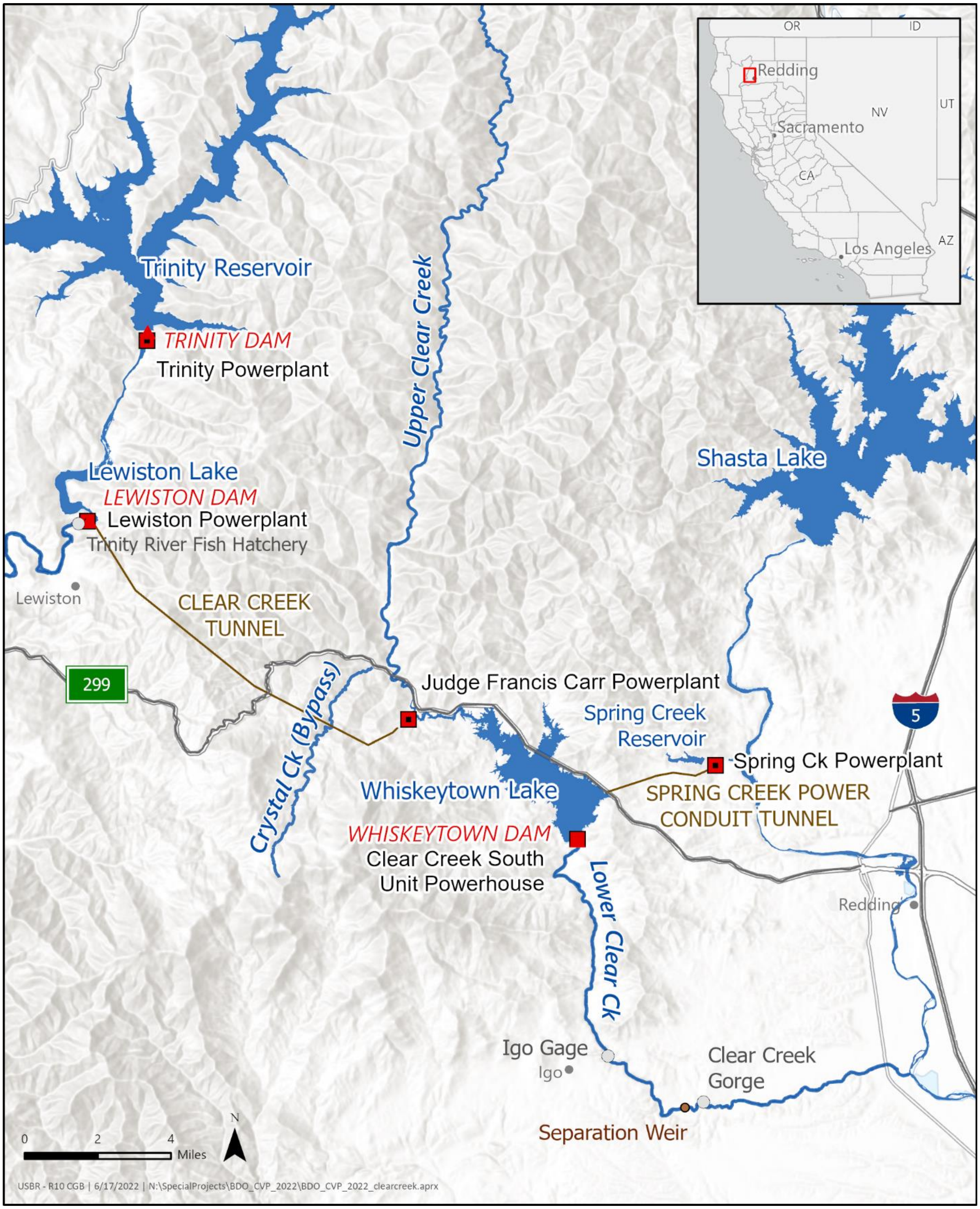


Figure 3-2. Clear Creek Facilities in the Trinity Division of the CVP.

3.1.2.1 Seasonal Operations

In the winter and spring, Whiskeytown Reservoir is operated to regulate flows for flood management. Starting in November, Reclamation will draw down Whiskeytown Reservoir by approximately 35 thousand acre-feet (TAF) to create flood management space, generally refilling in April or May. On occasion, imports of Trinity River water to Whiskeytown Reservoir may be suspended to avoid aggravating high flow conditions in the Sacramento Basin. Heavy rainfall events occasionally result in uncontrolled Gloryhole Spillway discharges to Clear Creek, through the Whiskeytown Gloryhole.

During the summer and early fall, Reclamation operates to provide lake elevations as full as practical for recreation. Whiskeytown Reservoir is a major recreational destination with recreational facilities administered by the National Park Service. Summer and fall imports help maintain Whiskeytown Lake elevations, provide cool water for releases to Clear Creek for water temperature control objectives, decrease residence time in Lewiston Lake for Trinity River temperature control, and help maintain water temperature objectives in the Sacramento River by supplying water to Keswick Reservoir.

3.1.2.2 Ramping Rates

Reclamation will limit down ramping rates to no lower than 25 cfs per hour due to operational limitation of Whiskeytown Dam infrastructure. Reclamation may vary from these ramping requirements during flood control or develop a faster ramping rate on a case-by-case basis.

3.1.2.3 Segregation Weir

Reclamation will place a segregation weir on Clear Creek between the Clear Creek Gorge Cascade and Clear Creek Road Bridge in late August through early November. Placement of the weir would occur before fall-run Chinook salmon enter Clear Creek to minimize hybridization with spawning spring-run Chinook salmon and redd superimposition. Removal of the weir would occur after the peak of fall-run Chinook salmon spawning when the risk of redd superimposition is very low. The weir location and timing protect most of the spring-run Chinook salmon utilizing Clear Creek, while minimizing effects to other salmonids.

3.1.3 American River

Reclamation operates and maintains the American River Division of the CVP for flood control, M&I and agricultural water supplies, hydroelectric power generation, fish and wildlife protection, recreation, and Delta water quality. Facilities include Folsom Dam, its reservoir (977 TAF capacity), power plant, temperature control shutters on the power plant, and the Joint Federal Project auxiliary spillway, as well as the Nimbus Dam, Lake Natoma, Nimbus Power Plant, and Folsom South Canal. The CVP additionally delivers water to the Freeport Regional Water Project Intake.

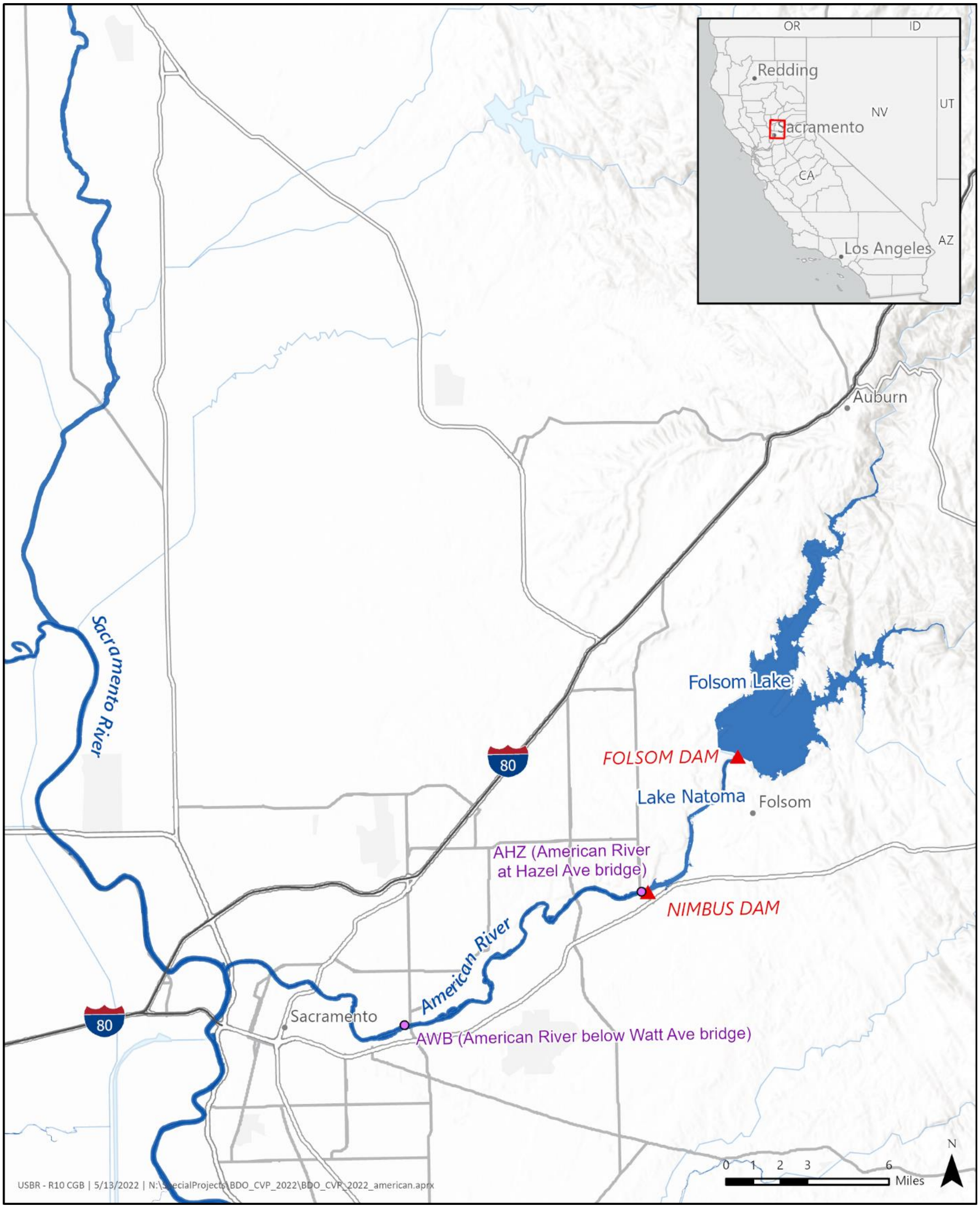


Figure 3-3. Facilities in the American River Division of the CVP.

3.1.3.1 Seasonal Operations

Reclamation operates Folsom Reservoir in the winter primarily for flood control and minimum flows in the lower American River and Delta. During non-flood control operations, Reclamation stores Folsom Reservoir inflows that exceed releases for minimum instream flows and Delta water quality requirements. Reclamation seeks consistent steady releases to minimize potential redd dewatering, redd scouring, and juvenile stranding for steelhead and fall-run Chinook salmon, but Delta outflow requirements may require varying releases.

In the spring, when not operating to flood control requirements, Reclamation seeks to maximize capture of the spring runoff to fill as close to full as possible, while also considering conditions in the lower American River for fisheries needs. The American River Minimum Flow Standard includes both minimum releases and, in some years, a pulse flow to cue juvenile salmonids to emigrate. Reclamation also operates for water supply and Delta outflow requirements. As the closest reservoir to the Delta, increased releases from Folsom Reservoir are frequently called on to address Delta water quality objectives under D-1641. When releases from upstream CVP and SWP reservoirs meet Delta outflow objectives, Folsom Dam releases can be reduced and system-wide reservoirs balanced.

Reclamation is implementing a pilot program that considers an end-of-December (EOD) planning minimum of 300 TAF (Water Forum Memorandum of Understanding, March 2021). When developing the operational forecast, Reclamation would consider an EOD Folsom Reservoir storage of at least 300 TAF. In some years, operational constraints may result in an EOD storage of less than 300 TAF. If, based on the May forecast, Reclamation does not anticipate meeting 300 TAF at EOD, it will be reported at the May American River Group (ARG) meeting. In September, storage is typically at its lowest after releases and diversions for summer demands.

In the summer, Reclamation typically releases flows above the minimum instream flow requirements for instream temperature control, Delta outflow, and water supply. Reclamation manages water temperatures through the volume of water released and shutter elevations, in consideration of projected meteorological conditions, balancing the Folsom Reservoir coldwater pool for instream temperature control during the summer for steelhead and the need to preserve cold water for fall-run Chinook salmon.

In the fall, operations focus on water temperature control management. Limited coldwater pool and limited storage require balancing releases and shutter operations to maximize the ability to maintain suitable water temperatures for steelhead rearing and fall-run Chinook salmon spawning. If reservoir inflows are greater than the release needs, Reclamation stores the surplus water.

3.1.3.2 Ramping Rates

Reclamation will ramp down releases in the American River below Nimbus Dam as shown in Table 3-1Table 3-1 and at night, if possible.

Table 3-1. Lower American River Ramping Rates.

Daily Rate of Change (cfs)	Amount of Decrease in 24 Hours (cfs)	Maximum Change per Step (cfs)
20,000 to 16,000	4,000	1,350
16,000 to 13,000	3,000	1,000
13,000 to 11,000	2,000	700
11,000 to 9,500	1,500	500
9,500 to 8,300	1,200	400
8,300 to 7,300	1,000	350
7,300 to 6,400	900	300
6,400 to 5,650	750	250
5,650 to 5,000	650	250
<5,000	500	100

cfs = cubic feet per second.

3.1.4 Delta

Reclamation operates and maintains the Delta Division of the CVP for M&I and agricultural water supplies, hydroelectric power generation, fish and wildlife protection, recreation, and Delta water quality. The major CVP features are the Delta Cross Channel, Contra Costa Canal and Rock Slough Intake facilities, Tracy Fish Collection Facility (Tracy Fish Facility) and C. W. "Bill" Jones Pumping Plant (Jones Pumping Plant), and Delta-Mendota Canal.

Reclamation operates and maintains the San Luis Unit of the West San Joaquin Division for M&I and agricultural water supplies, hydroelectric power generation, fish and wildlife protection, recreation, and water quality. The major CVP and SWP features are the O'Neill Forebay, San Luis Reservoir, Bernice Frederic Sisk Dam, William R. Gianelli Pumping-Generating Plant, San Luis Canal, Dos Amigos Pumping Plant, and Los Banos and Little Panoche detention dams and reservoirs. The major CVP-only facilities include the Coalinga Canal O'Neill Pumping-Generating Plant, and Pleasant Valley Pumping Plant.

Reclamation operates the San Felipe Division for M&I and agricultural water supplies, fish and wildlife protection, and recreation. The major CVP features are the Pacheco Pumping Plant, Tunnel, and Conduit.

The Delta-Mendota Canal/California Aqueduct Intertie is used to move water between the California Aqueduct and the Delta-Mendota Canal.

The main SWP-only Delta features are the Barker Slough Pumping Plant (BSPP), Suisun Marsh facilities (including the Suisun Marsh Salinity Control Gate [SMSCG], Roaring River Distribution System [RRDS], Morrow Island Distribution System, Goodyear Slough Outfall Gates), Clifton Court Forebay (CCF), and John E. Skinner Delta Fish Protective Facility

(Skinner Fish Facility), Harvey O. Banks Pumping Plant (Banks Pumping Plant) and the California Aqueduct.

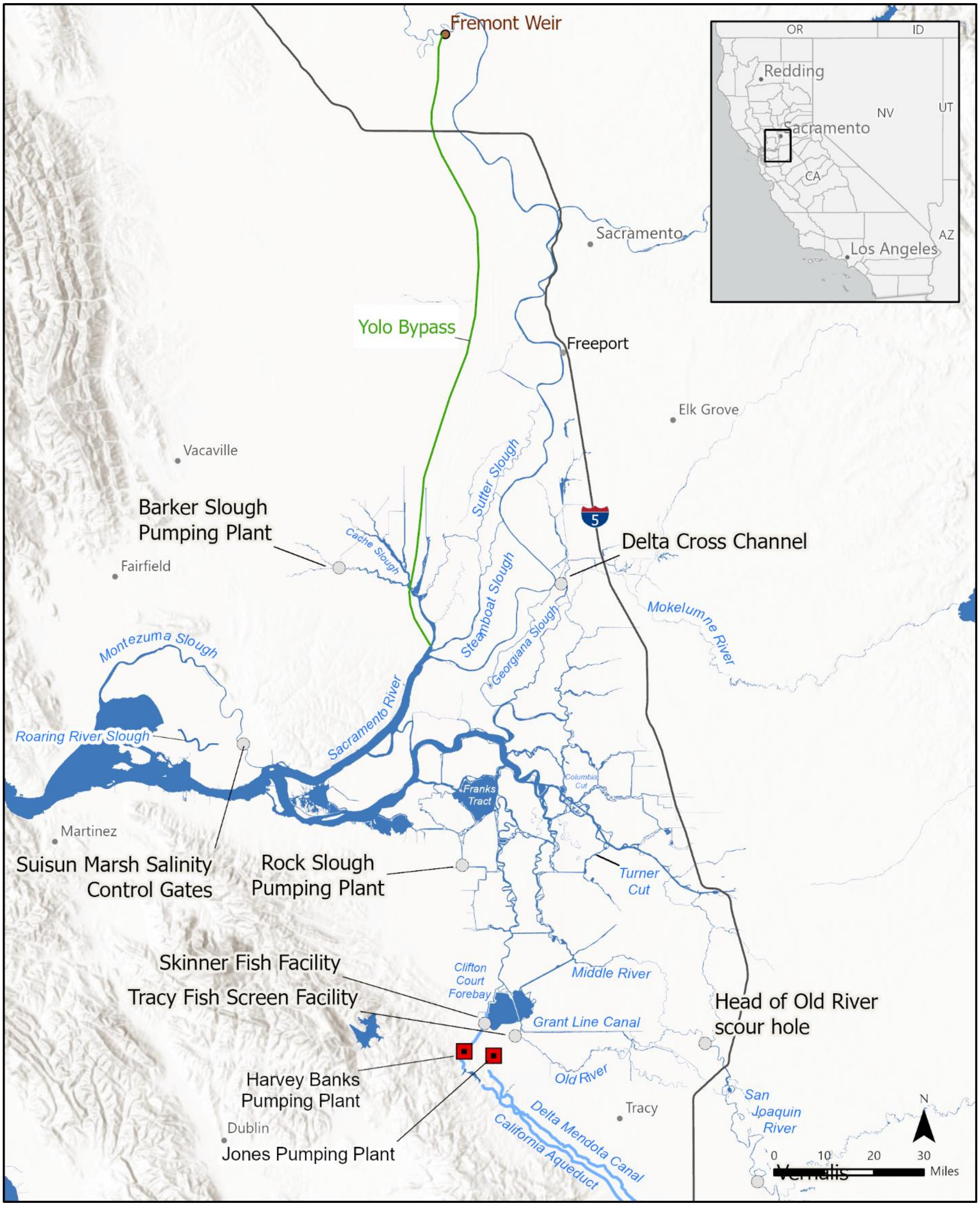


Figure 3-4. Map of the Delta Division Facilities.

3.1.4.1 Seasonal Operations

In the winter and spring, Reclamation and DWR typically export excess water. Excess water conditions occur when releases from upstream reservoirs plus unregulated flow exceed Sacramento Valley in-basin uses and exports. Actions to minimize entrainment of listed fish into the south Delta and at the Jones and Banks pumping plants limit the export of excess water. Exports during the winter and spring reduce the reliance on conveying previously stored water in the summer and fall for south-of-Delta water supply needs. In dry conditions, Reclamation and DWR may need to increase releases from upstream reservoirs beyond what is needed to meet minimum flow requirements to meet water quality or outflow requirements in the Delta.

During the summer, the CVP and SWP convey previously stored water through the Delta for export at the Jones Pumping Plant, Banks Pumping Plant, and other Delta facilities. Delta operations during the summer typically focus on maintaining salinity and meeting Delta outflow objectives while maximizing exports with the available water supply. In addition, the CVP and SWP make upstream reservoir releases for water temperature management and instream flows, which may be available for export after outflow, salinity, and in-Delta needs have been met.

In the fall, operations are adjusted to meet salinity, Delta outflow requirements, and peak demands from CVPIA wildlife refuges. Upstream and in-Delta demands typically decrease and accretions within the system typically increase. When water is available and not required for salinity and Delta outflow requirements, late summer and fall provide an opportunity to export water and start filling San Luis Reservoir for the next water year. When conditions are dry, there is little opportunity for exports. Releases from upstream reservoirs generally decrease to conserve water in storage for the next year. On occasion, releases for flood conservation pool or redds protection may occur and result in additional flows into the Delta.

The Banks Pumping Plant pumps water directly from CLC. The CLC radial gates are closed during critical periods of the ebb and flood tidal cycle for water quality and water levels in the south Delta. During July through September, the maximum daily diversion limit from the Delta into the CLC is increased from 6,990 cfs to 7,490 cfs, and the maximum averaged diversion limit over any three days is increased from 6,680 cfs to 7,180 cfs. Except for Alternative 2b, from mid-December through mid-March, diversions into CLC may be increased by one-third of the San Joaquin River flow at Vernalis when those flows exceed 1,000 cfs. Further, the Banks Pumping Plant will pump up to 195,000 acre-feet for the CVP in accordance with the 2018 COA Addendum.

3.1.4.2 Delta Cross Channel Gate Closures

Reclamation operates the Delta Cross Channel (DCC) Gates to reduce juvenile salmonid entrainment risk beyond actions described in D-1641. From October 1 to November 30, Reclamation closes the DCC gates if monitoring indicates a higher risk of fish presence. Reclamation may additionally close the DCC Gates to support Mokelumne River pulse flows and adult Chinook salmon migration. From December 1 to January 31, the DCC Gates are closed, except to prevent exceeding a D-1641 water quality threshold. From February 1 to May 20, the DCC Gates are closed, consistent with D-1641. From May 21 to June 15, Reclamation closes the DCC Gates for a total of 14 days, consistent with D-1641.

3.1.4.3 Tracy Fish Collection Facility

When south Delta hydraulic conditions allow and conditions are within the original design criteria for the Tracy Fish Facility, the secondary channel is operated to achieve water approach velocities for striped bass of approximately 1 to 2.5 feet per second (fps) from June 1 through October 31 and for salmon of approximately 3 fps from November 1 through May 31.

Salvage of fish at the Tracy Fish Facility occurs 24 hours per day, 365 days per year. Fish are salvaged in flow-through holding tanks, monitored by a 30-minute fish count every 120 minutes, and transported by truck to release sites near the confluence of the Sacramento and San Joaquin rivers. Larval smelt sampling commences upon detection of a spent female at the Tracy or Skinner fish facilities or when a water temperature trigger of 53.6°F (12°C) at nearby California Data Exchange Center stations is met. Salvage and operations data necessary to calculate loss are made available daily by 10 a.m.

The CVP uses two release sites: (1) on the Sacramento River near Horseshoe Bend; and (2) on the San Joaquin River immediately upstream of Antioch Bridge.

3.1.4.4 John E. Skinner Delta Fish Protective Facility

DWR will operate the facility to screen fish from the Banks Pumping Plant as described in the Tracy Fish Facility operational description above.

3.1.4.5 Water Transfers

Reclamation and DWR will operate the CVP and SWP to facilitate transfers through providing water in streams for delivery to alternative diversion points, conveying water across the Delta for export, or storing water for delivery at a future time. Seasonal operations describe deliveries up to contract totals. Included in this consultation is transfers of water, up to contract totals, between CVP contractors within counties, watersheds, or other areas of origin (e.g., Accelerated Water Transfers). In accordance with Section 3405(a)(1)(M) of the CVPIA, these transfers are deemed to have met the historic use and consumptive use/irretrievably lost to beneficial use requirements, CVPIA Sections 3405(a)(1)(A) and 3405(a)(1)(I), respectively.

Transfers not meeting these requirements, including out of basin transfers (e.g. North to South Water Transfers, Exchange Contractors Transfers, Warren Act Transfers), follow the *Draft Technical Information for Preparing Water Transfer Proposals, as updated in 2019* (Water Transfers White Paper). The actions taken by contractors to make water available for these water transfers (i.e., reducing consumptive use by crop idling and shifting, reservoir storage releases, or groundwater substitution) have separate environmental compliance and are **not** a component of this EIS. However, the specific timing and operations associated with the conveyance of the water to be transferred **is** a component to all alternatives analyzed in this EIS. Updated in 2019, the paper provides detailed information on establishing water transfers, and how to complete a particular transfer and document it in a way to prevent harm to other legal users of water.

Reclamation and DWR will provide a transfer window across the Delta from July 1 through November 30. When pumping capacity is needed to move CVP or SWP water, Reclamation and DWR may restrict water transfers.

3.1.4.6 Agricultural Barriers

DWR would continue to operate three agricultural barriers to maintain water levels for agricultural diversions in parts of the South Delta

3.1.4.7 Clifton Court Forebay Weed Management

DWR would continue to apply copper-based aquatic herbicides and algaecides to control aquatic weeds and algal blooms and use mechanical harvesters on an as-needed basis in the CLC, but would also apply Aquathol® K aquatic herbicide and peroxygen-based algaecides (e.g., PAK 27) and extend the treatment window beyond July 1 to August 31. DWR could apply Aquathol K, a chelated copper herbicide (copper-ethylenediamine complex and copper sulfate pentahydrate), a copper carbonate compound, or other copper-based herbicides. Algaecides may include peroxygen-based algaecides (e.g., PAK 27).

3.1.4.8 Suisun Marsh – Roaring River Distribution System Fall Flood-Up

The Roaring River Distribution System diversion rates have been controlled to maintain a maximum approach velocity of 0.2 fps at the intake fish screen except for a five-week contiguous period (five-week flood-up window) when Roaring River Distribution System diversion rate will be controlled to maintain a maximum approach velocity of 0.7 fps for fall flood-up operations. The dates of the five-week annual flood-up window may change annually due to waterfowl season dates changing each year and corresponding flood-up needs but will occur during the months of September through November.

3.1.5 Stanislaus River

Reclamation operates and maintains the Eastside Division of the CVP for flood control, M&I and agricultural water supplies, hydroelectric power generation, fish and wildlife protection, recreation, and water quality. Reclamation's facilities include the New Melones Dam, Reservoir (2.4 MAF capacity), and Powerplant.

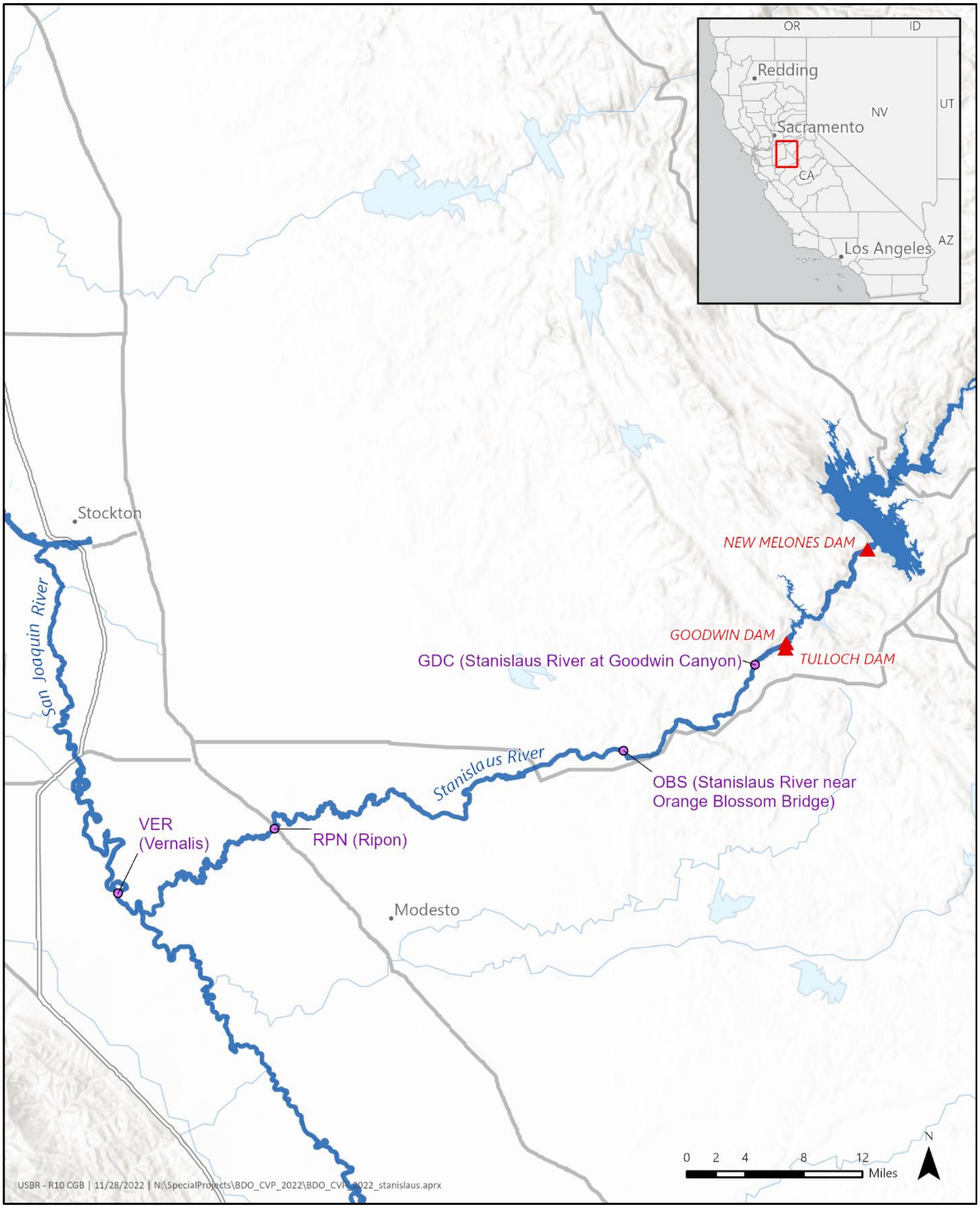


Figure 3-5. Map of the Stanislaus River and Eastside Division.

3.1.5.1 Seasonal Operations

In the winter and spring, Reclamation will operate to D-1641 and for flood control in accordance with the USACE Standard Operation and Maintenance Manual for the Lower San Joaquin River Levees Lower San Joaquin River and Tributaries Project, California (April 1959). Operating to flood control constraints is relatively infrequent because New Melones Reservoir is a larger reservoir relative to its annual inflow. Reclamation seeks to minimize potential redd dewatering, redd scouring, and juvenile stranding for steelhead.

During the summer, Reclamation is required to maintain applicable dissolved oxygen (DO) standards on the lower Stanislaus River for species protection. Reclamation operates to a 7.0 milligrams per liter DO requirement at Ripon from June 1 to September 30.

In the fall, Reclamation operates to a D-1641 fall pulse flow requirement in October for fish attraction. Otherwise, Reclamation operates to base flow requirements in order to rebuild storage. If necessary, releases might be made for DO at Ripon or electrical conductivity concerns at Vernalis, but these types of releases are rare.

3.1.5.2 Ramping Rates

Reclamation will coordinate releases on the Stanislaus River as shown in Table 3-2 using the. "60-20-20" index based on a 90% exceedance forecast.

Table 3-2. Goodwin Dam Ramping Rates.

Goodwin Release Range (cfs)	Standard Rate of Increase (cfs per 2 hours)	Standard Rate of Decrease (cfs per 2 hours)	C and D Rate of Increase (cfs per 2 hours)	C and D Rate of Decrease (cfs per 2 hours)
≥ 4,500	250	250	250	250
2,000 to 4,499	500	250	500	250
500 to 1,999	250	100	500	200
300 to 499	100	50	200	100

cfs = cubic feet per second; C = Critical water year (60-20-20 Index); D = Dry water year(60-20-20 Index).

Reclamation, through the Stanislaus Watershed Team (SWT), may develop a faster down ramping rate on a case-by-case basis.

3.1.6 San Joaquin River

Reclamation operates the Friant Division for flood control, M&I and agricultural water supplies, and fish and wildlife purposes. Friant Dam provides flood control on the San Joaquin River, downstream releases to meet senior water rights requirements above Gravelly Ford, Restoration Flows under Title X of Public Law 111-11, and diversions into the Madera and Friant-Kern Canals. The Friant Division facilities include Friant Dam, Millerton Reservoir, and the Friant-Kern and Madera Canals.

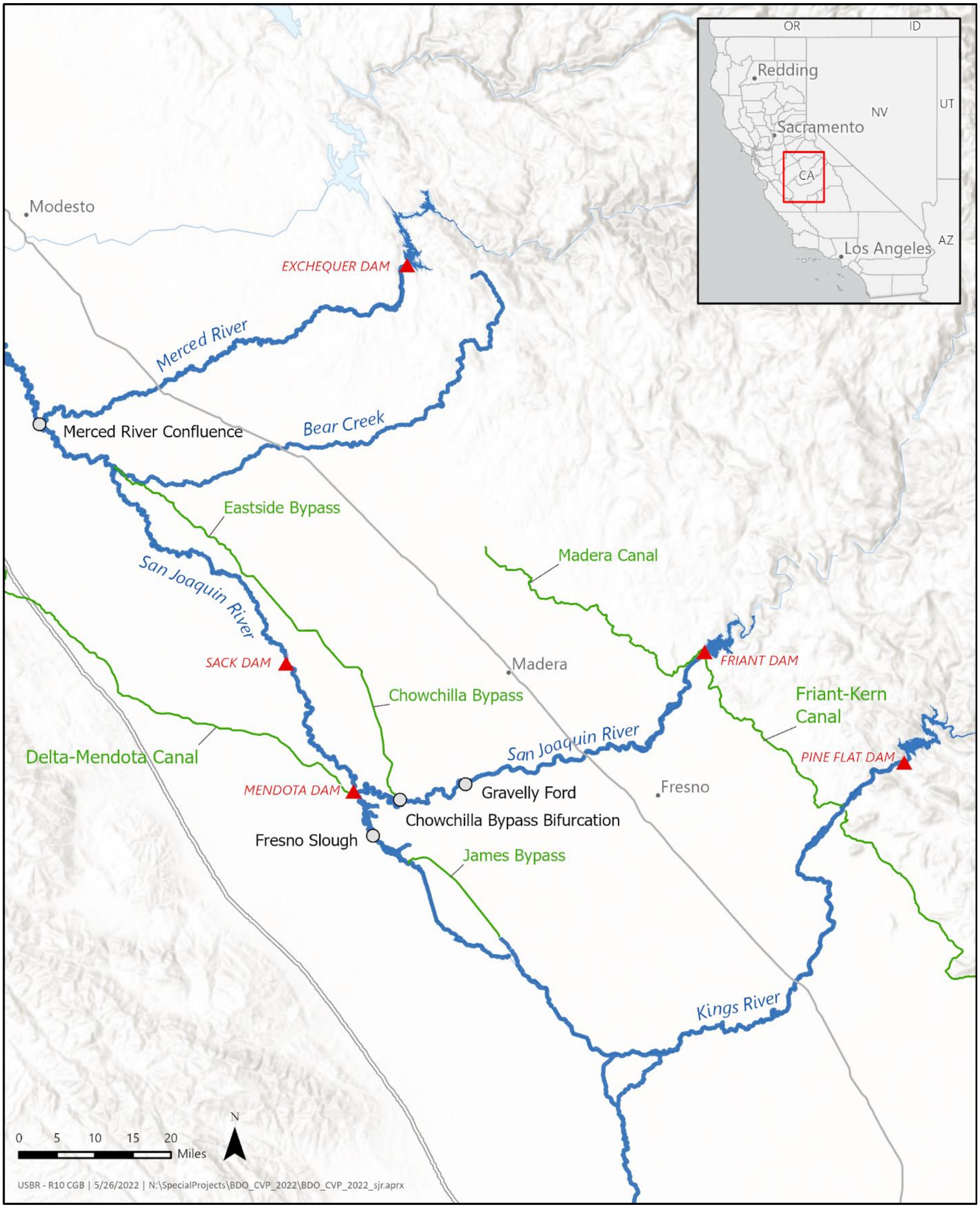


Figure 3-6. Map of the Friant Division and San Joaquin River.

Reclamation will operate the Friant Division consistent with the San Joaquin River Restoration Program Record of Decision.

3.2 No Action Alternative

Under the No Action Alternative, Reclamation would operate the CVP consistent with the 2020 Record of Decision, implementing the Proposed Action consulted upon for the 2019 Biological Opinions and the reasonable and prudent measures in the incidental take statements. DWR would operate the SWP consistent with the 2020 Record of Decision and its 2020 Incidental Take Permit. Pursuant to 43 Code of Federal Regulations Section 46.30, the 2020 Record of Decision for the CVP and SWP and the 2020 Incidental Take Permit for the SWP represent current management direction or intensity for the purposes of the No Action Alternative.

Reclamation would continue to operate each tributary with the same primary purposes as described in the Common Components seasonal operations. The No Action Alternative variable components are summarized below and described in greater detail in Appendix E, *Draft Alternatives*.

3.2.1 Sacramento River

3.2.1.1 Ramping Rates

Ramping rates for Keswick Dam between July 1 and March 31 would be reduced between sunset and sunrise according to Table 3-3.

Table 3-3. Ramping Rates for Keswick Dam, July 1–March 31, Implemented Sunset to Sunrise.

Keswick Release (cfs)	Max per Night	Max per Hour
≥6,000	15%	2.5%
4,000–5,999	200 cfs	100 cfs
3,250–3,999	100 cfs	N/A

Note: Ramping rates do not apply during flood control or if needed for facility operational concerns.
cfs = cubic feet per second.

3.2.1.2 Fall and Winter Refill and Redd Maintenance

Under the No Action Alternative, Reclamation would maintain fall-run Chinook salmon redds in consideration of rebuilding storage and coldwater pool for the subsequent year.

Table 3-4 shows examples of possible Keswick Dam releases based on Shasta Reservoir storage condition; these are refined through future modeling efforts as part of the seasonal operations planning.

Table 3-4. Keswick Dam Example Release Schedule for EOS Storage.

Keswick Release (cfs)	Shasta EOS Storage (MAF)
3,250	≤2.2
4,000	≤2.8
4,500	≤3.2
5,000	>3.2

EOS = end-of-September; cfs = cubic feet per second; MAF = million acre-feet.

Reclamation would minimize adverse effects to shallow late-spawning winter-run Chinook salmon redds by conducting a risk analysis based on the probability of sufficient coldwater in a subsequent year, and a conservative distribution and timing of subsequent winter-run Chinook salmon.

3.2.1.3 Spring Pulse Flows

Reclamation would release spring pulse flows of up to 150 TAF to help spring-run Chinook salmon juvenile out-migration when the projected total May 1 Shasta Reservoir storage indicates a likelihood of sufficient cold water to support summer coldwater pool management, and the pulse does not interfere with the ability to meet performance objectives or other anticipated operations of the reservoir.

3.2.1.4 Water Temperature Management

Reclamation would operate the Shasta Dam TCD to provide water temperature management while minimizing impacts on power generation. Reclamation would address coldwater management using a tiered strategy to target downstream water temperatures based on projected total storage and coldwater pool. The tiered strategy manages limited coldwater resources to achieve desired fisheries objectives by conserving use of the coldwater pool to when egg incubation stages have the highest DO demands. Figure 3-7 provides a decision tree explaining the decision points for Shasta Reservoir temperature management.

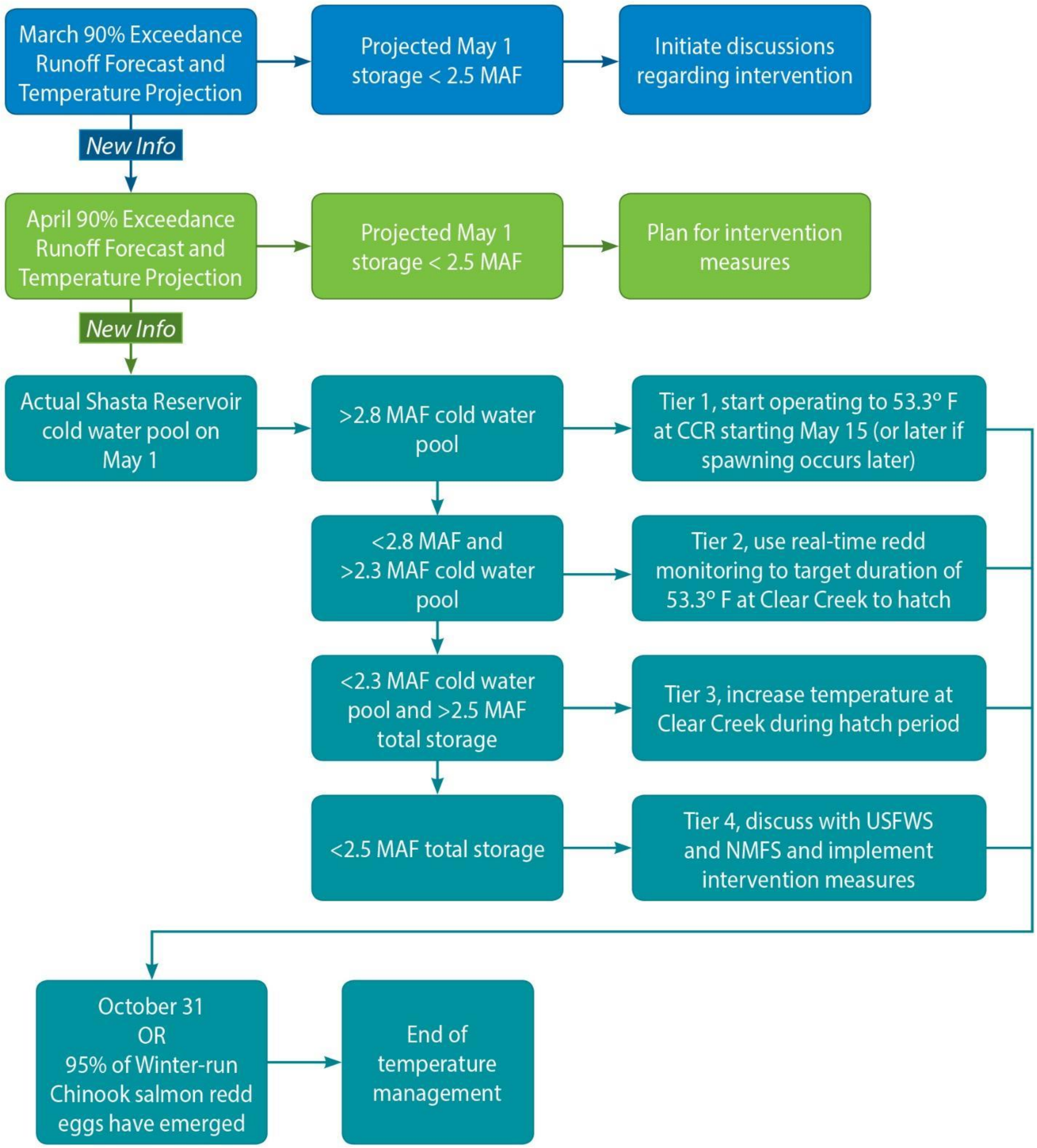


Figure 3-7. Decision Tree for Shasta Reservoir Temperature Management.

Figure 3-8 provides an approximate expected performance for tiers based on total storage and coldwater pool in Shasta Reservoir.

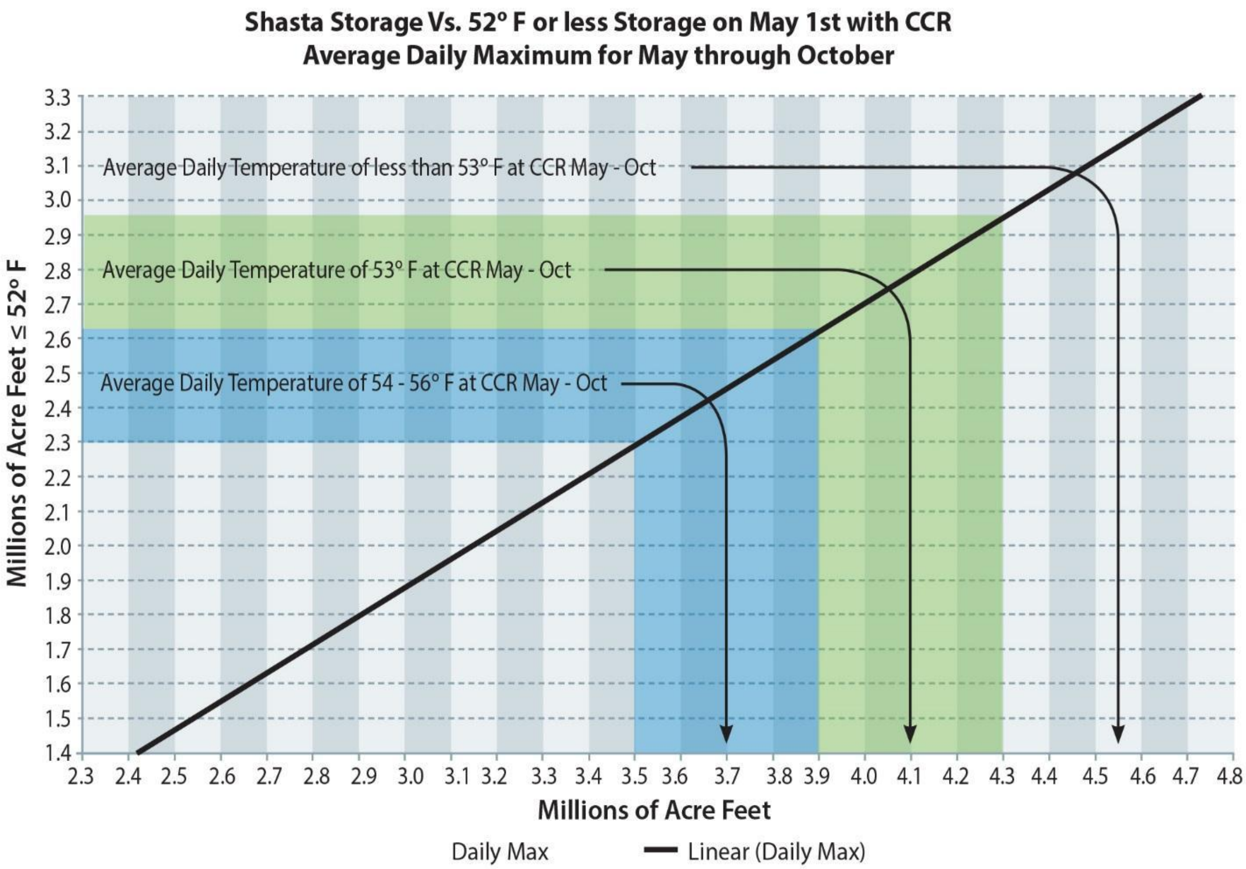


Figure 3-8. Relationship between Temperature Compliance, Total Storage in Shasta Reservoir, and Coldwater Pool in Shasta Reservoir.

3.2.1.5 Winter-Run Chinook Salmon Supplementation

Reclamation would rely upon increased use of Livingston-Stone National Fish Hatchery (NFH) during droughts to increase production of winter-run Chinook salmon. Increased production would aim to offset temperature dependent mortality and low survival on the Sacramento River and in the Delta.

3.2.1.6 Raised Shasta Dam

The No Action Alternative anticipated a separate process and EIS for the Shasta Dam Raise; therefore, no further discussion will be provided in this EIS.

3.2.1.7 Spawning and Rearing Habitat Restoration

The No Action Alternative reflects the 2020 Record of Decision evaluation of habitat restoration in concert with operations. Reclamation's habitat programs will continue through separate environmental compliance and future restoration plans as independent programs; therefore, no further discussion will be provided in this EIS.

3.2.2 Clear Creek

3.2.2.1 Minimum Instream Flows

Reclamation would release Clear Creek flows in accordance with the August 11, 2000 Instream Flow Preservation Agreement between Reclamation, USFWS, and CDFW and the April 15, 2002 SWRCB permit. Reclamation would release a minimum base flow in Clear Creek of 200 cfs from October through May and 150 cfs from June through September in all water year types except critical water year types. In critical years, Clear Creek base flows may be reduced below 150 cfs based on available water from Trinity Reservoir. Additional flow may be required for water temperature management during the fall.

3.2.2.2 Pulse Flows

Reclamation would create pulse flows for both channel maintenance and spring attraction flows. For spring attraction flows, Reclamation would release 10 TAF up to the safe release capacity (approximately 900 cfs, depending on reservoir elevation and downstream capacity), in all water year types except for critical water year types. For channel maintenance flows, Reclamation would release 10 TAF from Whiskeytown Dam up to the safe release capacity, in all water year types except dry and critical (based on the Sacramento Valley Index [SVI]).

3.2.2.3 Water Temperature Management

Reclamation would manage Whiskeytown Reservoir releases to meet a daily average water temperature of 60°F at the Igo gage from June 1 through September 15 and 56°F or less at the Igo gage from September 15 to October 31. In critical or dry water year types, Reclamation would operate as close to these water temperatures as possible.

3.2.2.4 Spawning and Rearing Habitat Restoration

The No Action Alternative reflects the 2020 Record of Decision evaluation of habitat restoration in concert with operations. Reclamation's habitat programs will continue through separate environmental compliance and future restoration plans as independent programs; therefore, no further discussion will be provided in this EIS.

3.2.3 American River

3.2.3.1 Minimum Instream Flows (Minimum Release Requirement)

Reclamation would implement the minimum release requirement (MRR) proposed by the Sacramento Area Water Forum in 2017, as modified by the 2020 Record of Decision, based on the month and annual hydrology, Figure 3-9 and Figure 3-10.

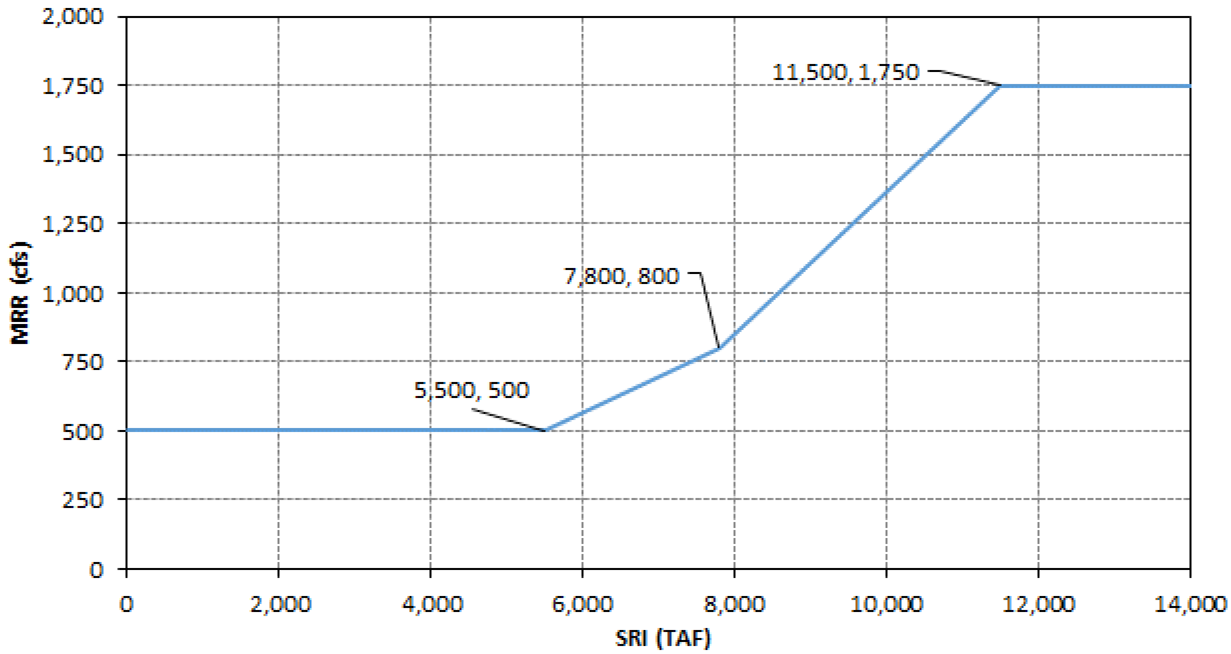


Figure 3-9. January Relationship Between the Sacramento River Index or American River Index and the Minimum Release Requirement.

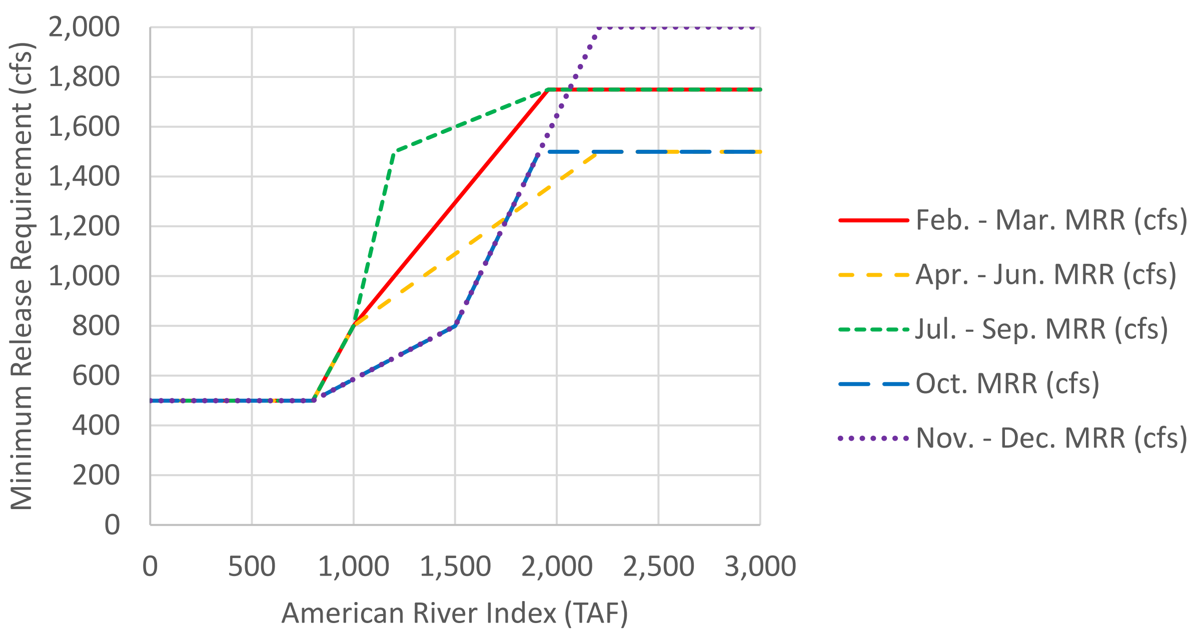


Figure 3-10. February through December Relationship Between the American River Index and the Minimum Release Requirement.

Reclamation will use the 90% exceedance from the Sacramento River Index in January and the American River Index in February through December to develop the MRR (with certain spills subtracted).

3.2.3.2 Spring Pulse Flows

Reclamation will implement a spring pulse in years that the MRR for March is between 1,000 cfs and 1,500 cfs. The peak flow of the pulse flow would be three times the March MRR, even if implemented in April or May, but no higher than 4,000 cfs and lasting two days.

Reclamation, through ARG, will develop a pulse flow schedule and may facilitate an additional spring pulse flow event if water is made available from non-CVP sources, or if there is flexibility to shape planned releases in a more variable schedule.

3.2.3.3 Redd Dewatering Adjustments

Reclamation, through Governance, will schedule MRR releases consistent with the implementation of redd dewatering protective adjustments to limit potential redd dewatering January through May. Table 3-5, with linear interpolation, shows the minimum flow for steelhead redds through May.

Table 3-5. Steelhead Redd Dewatering Protective Adjustment-based MRR for February through May.

January or February MRR (cfs)	Steelhead Redd MRR through May (cfs)
≤700	500
800	520
900	580
1,000	640
1,100	710
1,200	780
1,300	840
1,400	950
1,500	1,030
1,600	1,100
1,700	1,180
1,800	1,250

cfs= cubic feet per second; MRR = minimum release requirement.

3.2.3.4 Water Temperature Management

Reclamation will implement the Automated Temperature Selection Procedure (ATSP), Appendix M of the Initial Alternatives Report in developing the Temperature Management Plan (TMP). Each ATSP schedule determines a monthly series of water temperature targets (for daily average water temperature) at the Watt Avenue bridge. Schedule 1 has a water temperature upper limit of 63°F from May through September, and 56°F in October and November. Schedules 2 through 77 each represent a change in a single month's upper temperature limit by 1.0°F. Schedule 78 has a water temperature upper limit of 72°F from May through November. The ATSP may be modified as follows:

- For Schedule 28 or higher (greater than 65°F at Watt Avenue Bridge, May through September), the TMP may consider a water temperature location at Hazel Avenue.
- For greater than 65°F at Hazel Avenue bridge for May through September, the TMP will include an evaluation of whether modified Folsom Reservoir operations could support an improved temperature schedule (e.g., an alternate release schedule over the summer).
- For greater than 68°F at Hazel Avenue for May through September, the TMP will include an evaluation of whether modified Folsom Reservoir operations could support an improved temperature schedule (e.g., an alternate release schedule over the summer) and evaluate a power bypass during the summer and/or fall.
- For greater than 56°F at Hazel Avenue in November, the TMP will evaluate a power bypass.

3.2.3.5 Spawning and Rearing Habitat Restoration

The No Action Alternative reflects the 2020 Record of Decision evaluation of habitat restoration in concert with CVP operations. Reclamation's habitat programs will continue through separate environmental compliance and future restoration plans as independent programs; therefore, no further discussion will be provided in this EIS.

3.2.4 Delta

3.2.4.1 Old and Middle River Reverse Flow Management

From the onset of old and middle river (OMR) management to the end, Reclamation and DWR would operate to an OMR index no more negative than a 14-day moving average of -5,000 cfs unless a storm event occurs. Onset occurs after a "First Flush" event or after January 1 if more than 5% of listed salmonid species are present. Reclamation and DWR would manage to more positive OMR for turbidity bridge avoidance, larval and juvenile Delta smelt protections, cumulative loss thresholds, and single year loss thresholds. DWR would additionally manage to daily loss thresholds and additional smelt protections. OMR would end when salmonids have exited the Delta and/or upon exceeding water temperature thresholds.

Reclamation and DWR would maximize exports by incorporating real-time monitoring of fish distribution, turbidity, temperature, hydrodynamic models, and entrainment models into the decision support for OMR management to focus protections for fish when necessary and provide flexibility where possible.

3.2.4.2 Start of OMR Management

Reclamation and DWR would start OMR management when one or more of the following conditions have occurred:

- **Integrated Early Winter Pulse Protection (First Flush Turbidity Event):** Reclamation and DWR would reduce exports for 14 consecutive days so that the 14-day averaged OMR index for the period would not be more negative than -2,000 cfs, in response to "First Flush" conditions in the Delta. "First flush" may be triggered between December 1 and January 31 and include:
  - Running 3-day average of the daily flows at Freeport is greater than 25,000 cfs; and
  - Running 3-day average of the daily turbidity at Freeport is 50 Nephelometric Turbidity Unit (NTU) or greater; or
  - Real-time monitoring indicates a high risk of migration and dispersal into areas at high risk of future entrainment.
- This "First Flush" may only be initiated once during the December through January period and would not be required if:
  - Spent female Delta smelt are collected in a monitoring survey.
- **Salmonids Presence:** After January 1, if more than 5% of any one or more salmonid species (wild young-of-year winter-run Chinook salmon, wild young-of-year spring-run Chinook salmon, or Central Valley steelhead) are estimated to be present in the Delta as determined by their appropriate monitoring working group.

3.2.4.3 Additional Real-Time OMR Restrictions and Performance Objectives

Reclamation and DWR would manage to a more positive OMR than -5,000 cfs based on the following conditions:

- **Turbidity Bridge Avoidance (South Delta Turbidity):** After the Integrated Early Winter Pulse Protection or February 1 (whichever comes first) and until a ripe or spent female is detected or April 1 (whichever is first), Reclamation and DWR would manage exports in order to maintain daily average turbidity in Old River at Bacon Island at a level of less than 12 Formazin Nephelometric Units (FNU). This action seeks to avoid the formation of a turbidity bridge from the San Joaquin River shipping channel to the south Delta fish facilities. If the daily average turbidity at Bacon Island could not be maintained at less than 12 FNU, Reclamation and DWR would manage exports to achieve an OMR no more negative than -2,000 cfs until the daily average turbidity at Bacon Island drops below 12 FNU. However, if five consecutive days of OMR less negative than -2,000 cfs do not reduce turbidity at Bacon Island below 12 FNU, Reclamation and DWR could determine that OMR restrictions to manage turbidity are infeasible, and will instead implement an OMR target that is deemed protective, based on turbidity, adult Delta smelt distribution, and salvage, but no more negative than -5,000 cfs.

- **Larval and Juvenile Delta Smelt:** Reclamation and DWR operationalized the USFWS Delta Smelt lifecycle model through the use of real-time monitoring for the spatial distribution of Delta smelt.
- **Cumulative Loss Threshold:** Reclamation and DWR would avoid exceeding 10-year cumulative loss thresholds over the duration of the 2019 Biological Opinions for:
    - Natural winter-run Chinook salmon (cumulative loss = 8,738)
    - Hatchery winter-run Chinook salmon (cumulative loss = 5,356)
    - Central Valley Steelhead from December through March (cumulative loss = 6,038)
    - Natural Steelhead from April 1 through June 15 (cumulative loss = 5,826)
  - Natural steelhead would be separated into two time periods to protect San Joaquin origin fish that historically appear in the Mossdale trawls later than Sacramento origin fish. The loss threshold and loss tracking for hatchery winter-run Chinook salmon does not include releases into Battle Creek. Loss for Chinook salmon are based on length-at-date criteria.
  - The cumulative loss thresholds would be based on cumulative historical loss from 2010 through 2018. Reclamation's and DWR's performance objectives are intended to avoid loss such that this cumulative loss threshold (measured as the 2010-2018 average cumulative loss multiplied by 10 years) would not be exceeded by 2030.
- **Single-Year Loss Threshold:** In each year, Reclamation and DWR would avoid exceeding an annual loss threshold equal to 90% of the greatest salvage loss that occurred in the historical record from 2010 through 2018 for each of:
    - Natural winter-run Chinook salmon (loss = 1.17% of juvenile production estimate [JPE])
    - Hatchery winter-run Chinook salmon (loss = 0.12% of JPE)
    - Natural Steelhead from December through March (loss = 1,414)
    - Central Valley Steelhead from April through June 15 (loss = 1,552)
  - During the year, if Reclamation and DWR would exceed the annual loss from 2010 through 2018, Reclamation and DWR would review recent fish distribution information and operations at the Water Operations Management Team (WOMT) and seek technical assistance on future planned operations. Any agency could elevate from WOMT to a Directors discussion, as appropriate.
  - During the year, if Reclamation and DWR exceed 50% of the annual loss threshold, Reclamation and DWR would restrict OMR to a 14-day moving average OMR index of no more negative than -3,500 cfs, unless Reclamation and DWR determine that further OMR restrictions are not required to benefit fish movement because a risk assessment shows that the risk is no longer present

based on real-time information. The -3,500 cfs OMR operational criterion adjusted and informed by this risk assessment would remain in effect for the rest of the season. Reclamation and DWR would seek NMFS technical assistance on the risk assessment and real-time operations.

- During the year, if Reclamation and DWR exceed 75% of the annual loss threshold, Reclamation and DWR would restrict OMR to a 14-day moving average OMR index of no more negative than -2,500 cfs, unless Reclamation and DWR determine that further OMR restrictions are not required to benefit fish movement because a risk assessment shows that the risk is no longer present based on real-time information. The -2,500 cfs OMR operational criterion adjusted and informed by this risk assessment would remain in effect for the rest of the season. Reclamation and DWR would seek NMFS technical assistance on the risk assessment and real-time operations.
- Risk assessments (identified above): Reclamation and DWR would evaluate and adjust OMR restrictions under this section by preparing a risk assessment that considers several factors including, but not limited to, real-time monitoring, historical trends of salmonids exiting the Delta, entering the south Delta, fish detected in salvage, and relevant environmental conditions. Risks will be measured against the potential to exceed the next single year loss threshold. Reclamation and DWR would share its risk assessment and supporting documentation with USFWS and NMFS, seek their technical assistance, discuss the risk assessment and future operations with WOMT at its next meeting, and elevate to the Directors as appropriate.

Reclamation and DWR would continue monitoring and reporting the salvage at the Tracy and Skinner fish facilities. Reclamation and DWR would continue the release and monitoring of yearling Coleman NFH Late-fall-run Chinook salmon as yearling spring-run Chinook salmon surrogates.

3.2.4.4 Real-Time Decision-Making and Salvage Thresholds

When real-time monitoring demonstrates that criteria in “Additional Real-Time OMR Restrictions and Performance Objectives” are not supported, then Reclamation and DWR may confer with the Directors of NMFS, USFWS, and CDFW to operate to a more negative OMR. Upon mutual agreement, the Directors of NMFS and USFWS may authorize Reclamation and DWR to operate to a more negative OMR than the Additional Real-Time OMR Restrictions, but no more negative than -5,000 cfs. This process would be separate from the risk analysis process referenced above.

Figure 3-11 shows OMR management in a decision tree.

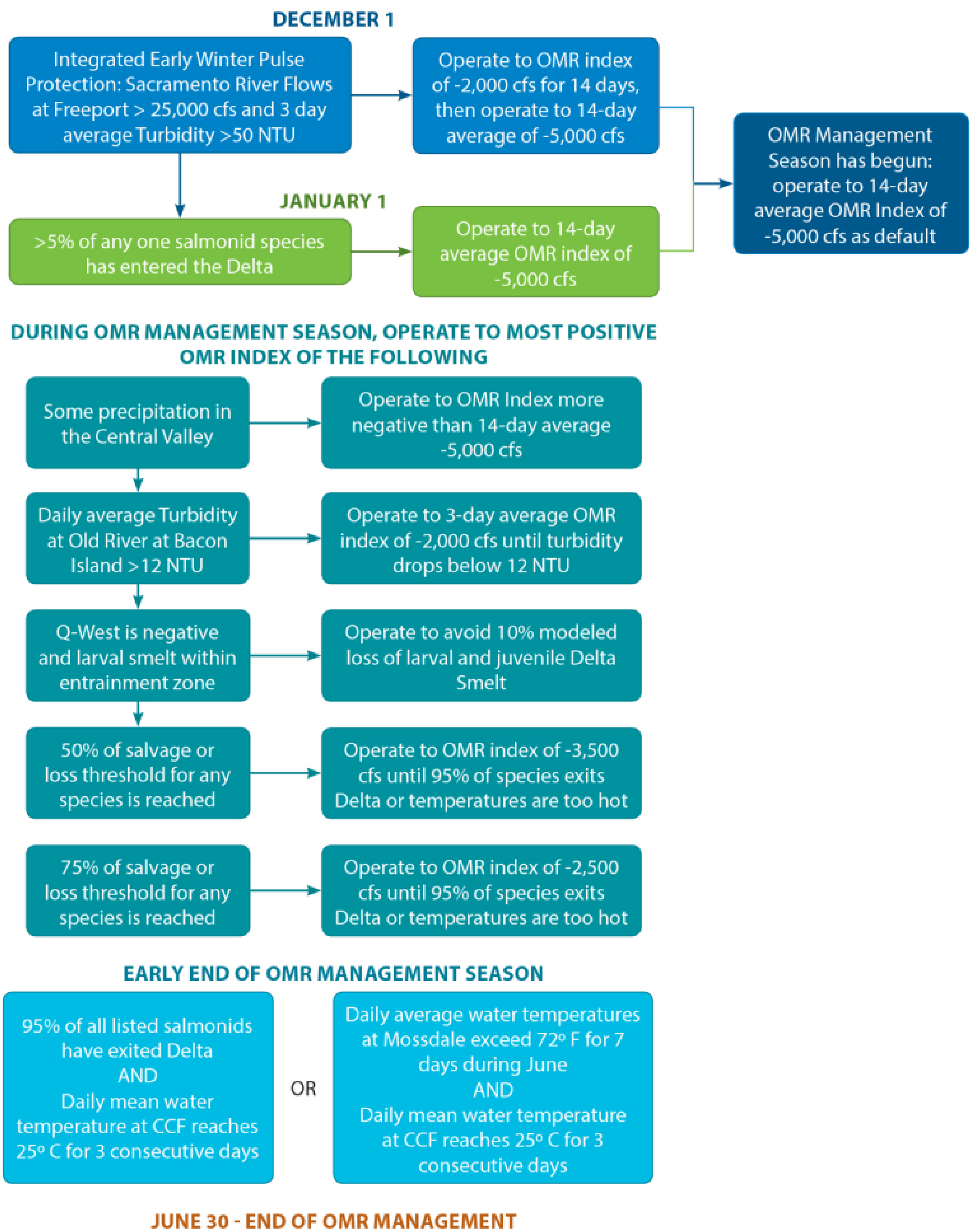


Figure 3-11. Decision Tree for OMR Reverse Flow Management.

3.2.4.5 Storm-Related OMR Flexibility

Reclamation and DWR could operate to a more negative OMR up to a maximum (otherwise permitted) export rate of 14,900 cfs (which could result in a range of OMR values) at Banks and

Jones pumping plants to capture peak flows during storm-related events. Reclamation and DWR would continue to monitor fish in real-time and would operate in accordance with the Additional Real-Time OMR Restrictions thresholds.

Under the following conditions, Reclamation and DWR would not pursue storm-related OMR flexibility for capturing peak flows from storm-related events:

- Integrated Early Winter Pulse Protection (above) or Additional Real-Time OMR Restrictions (above) are triggered. Under such conditions, Reclamation and DWR would have already determined that more restrictive OMR is required.
- An evaluation of environmental and biological conditions indicates more negative OMR would likely cause Reclamation and DWR to trigger an Additional Real-Time OMR Restriction (above).
- Salvage of yearling Coleman NFH late-fall-run Chinook salmon (as yearling Spring-Run Chinook Salmon surrogates) exceeds 0.5% within any of the release groups.
- Reclamation and DWR identify changes in spawning, foraging, sheltering, or migration behavior beyond those anticipated to occur under OMR management.

Reclamation and DWR would continue to monitor conditions.

3.2.4.6 End of OMR Management

OMR criteria may control operations until June 30 (for Delta smelt and Chinook salmon), until June 15 (for Steelhead/Rainbow Trout), or when the following species-specific off ramps have occurred, whichever is earlier:

- **Delta Smelt:** When the daily mean water temperature at the CLC reaches 77°F for 3 consecutive days.
- **Salmonids:**
  - When more than 95% of salmonids have migrated past Chipps Island, as determined by their monitoring working group, or
  - After daily average water temperatures at Mossdale exceed 71.6°F for 7 days during June (the 7 days do not have to be consecutive).

3.2.4.7 Spring Delta Outflow

Reclamation would operate to D-1641, subject to entrainment protections. DWR would operate to the SWP 2020 Incidental Take Permit.

3.2.4.8 Barker Slough Pumping Plant

The BSPP would continue to operate and maintain under applicable regulatory requirements and remove sediment and aquatic weeds as needed. The annual maximum diversion is 125 TAF and the maximum daily diversion rate for the BSPP is 175 cfs. Reclamation and DWR would implement Delta smelt entrainment minimization measures in coordination with USFWS.

3.2.4.9 Delta Smelt Supplementation

Reclamation proposes to continue to fund a two-phase process that would lead to annual supplementation of the wild Delta smelt population with propagated fish within three to five years starting in 2019.

The University of California, Davis Fish Conservation and Culture Laboratory (FCCL), which maintains the refugial population of Delta smelt and generates additional captive-bred fish for research, and keeps enough progeny alive to repeat the process for multiple generations.

3.2.4.10 Delta Smelt Summer and Fall Habitat

Reclamation and DWR would improve Delta smelt food supply and habitat through Delta smelt summer and fall habitat actions (SFHAs) that manage X2 to 80 kilometer (km) in September and October of wet and above normal years, operate the SMSCG in below normal and above normal years, and undertake food enhancement actions developed through structured decision making. DWR would operate the SMSCG based on 4 parts per thousand at Belden's Landing.

Reclamation and DWR would use structured decision-making to implement SFHAs. In the summer and fall (June through October) of below normal, above normal, and wet years, based on the SVI, the environmental and biological goals are, to the extent practicable, the following:

- Maintain low salinity habitat in Suisun Marsh and Grizzly Bay when water temperatures are suitable;
- Manage the low salinity zone to overlap with turbid water and available food supplies; and
- Establish contiguous low salinity habitat from Cache Slough Complex to Suisun Marsh.

Measures include operation of the SMSCG and various food enhancement actions.

3.2.4.11 Bernice Frederic Sisk Dam Raise and Reservoir Expansion

The No Action Alternative does not include the Sisk Dam Raise and Reservoir Expansion as an operational component of the CVP.

3.2.4.12 Tidal Habitat Restoration

Reclamation and DWR would complete the 8,000 acres required by the 2020 Record of Decision and additional 396.3 acres as required by the Incidental Take Permit for the SWP.

DWR and Reclamation have or will carry out tidal habitat restoration acre targets identified from the 2008 and 2019 USFWS Biological Opinions (8,000 acres) and the 2020 State Incidental Take Permit (396.3) to complete mitigation requirements for Delta smelt and longfin smelt (per the 2020 Incidental Take Permit). Currently, twelve restoration projects have been identified to satisfy the total acreage requirement of 8,396.3 acres (Table 3-6). The twelve projects are in different phases of completion: (1) constructed (3,584 acres), (2) in construction (3.490 acres) or (3) planned (1,662 acres). All twelve restoration projects are located in the northern arc of the upper estuary (area of highest Delta smelt occupation) and are designed to enhance food production and rearing habitat for delta smelt and longfin smelt (per the 2020 Incidental Take Permit for the SWP).

Table 3-6. Tidal Habitat Restoration.

Project	Estimated Acres	Phase
Arnold Slough	138	Constructed
Decker Island	113	Constructed
Lower Yolo Ranch	1,713	Constructed
Tule Red	590	Constructed
Winter Island	544	Constructed
Wings Landing	190	Constructed
Yolo Flyway Farms	296	Constructed
Bradmoor Island	490	Under construction
Lookout Slough	3,000	Under construction
Prospect Island	1,500	Construction planned in 2024
Chipps Island	687	Construction planned in 2024

All planned actions presented in Table 3-6 have separate environmental compliance (either programmatically or site-specific) and no further analysis of impacts will be performed in this document. State and Federal agencies would analyze impacts for the site specific and programmatic tidal habitat restoration compliance separate from the Long-Term Operation of CVP and SWP.

3.2.5 Stanislaus River

Reclamation has worked with water users and related agencies to develop an operating plan for New Melones Reservoir to meet the multiple objectives on the system.

3.2.5.1 3.2.5.1 Minimum Instream Flows

Reclamation would operate to the New Melones Stepped Release Plan (SRP) with the default schedule shown in Figure 3-12. SRP flows would be Reclamation's contribution to D-1641's Vernalis standards.

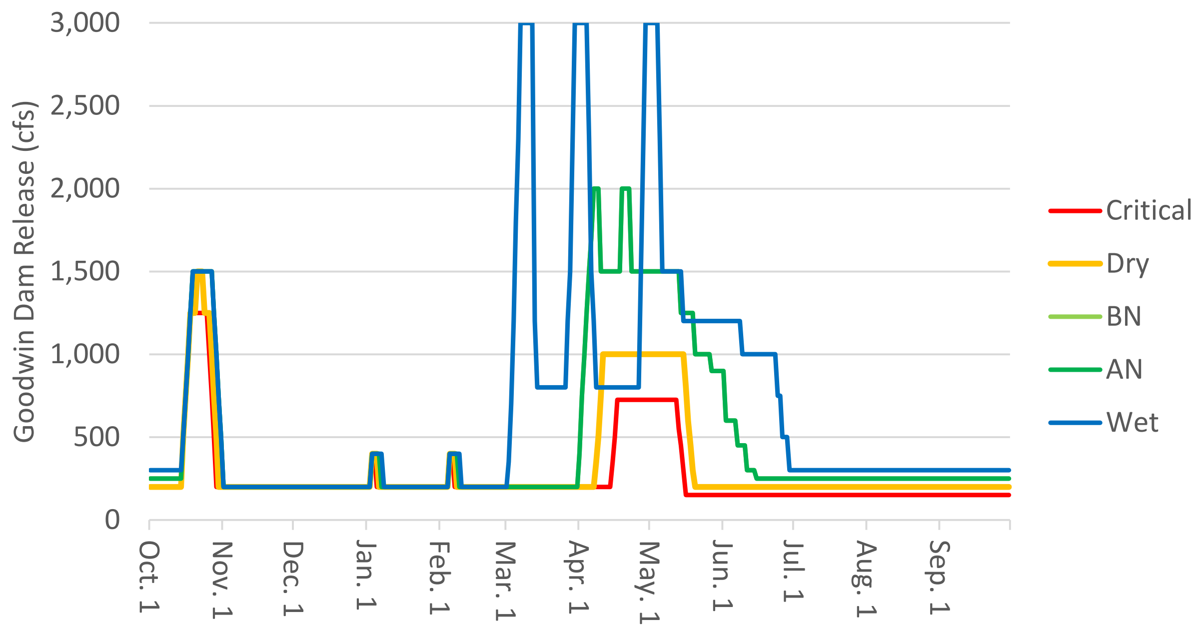


Figure 3-12. 2019 New Melones Stepped Release Plan by San Joaquin River Index.

Reclamation would operate New Melones Reservoir (as measured at Goodwin Dam) in accordance with an SRP that varies by hydrologic condition and water year type as shown in Table 3-7.

Table 3-7. New Melones Stepped Release Plan Annual Releases by Water Year Type.

Water Year Type	Annual Release (TAF)
Critically Dry	184.3
Dry	233.3
Below Normal	344.6
Above Normal	344.6
Wet	476.3

TAF = thousand acre-feet.

3.2.5.2 Winter Instability Flows

Reclamation releases additional flow in January and February to simulate natural variability in the winter hydrograph and to enhance access to varied rearing habitats. Reclamation, through Governance, schedules the winter instability flow volume in consideration of timing flows to coincide with a natural storm event which may naturally cue outmigration.

3.2.5.3 Spring Pulse Flows

Reclamation will release additional flows starting as early as March through as late as June. Reclamation, through Governance, will schedule spring pulse flow volumes consistent with volumes in the SRP.

3.2.5.4 Fall Pulse Flows

Reclamation will release additional flows in October. Reclamation, through Governance, will schedule fall pulse flow volumes consistent with the volumes in the SRP.

3.2.5.5 Spawning and Rearing Habitat Restoration

The No Action Alternative reflects the 2020 Record of Decision evaluation of habitat restoration in concert with operations. Reclamation's habitat programs will continue through separate environmental compliance and future restoration plans as independent programs; therefore, no further discussion will be provided in this EIS.

3.2.6 San Joaquin River

The No Action Alternative reflects the 2020 Record of Decision evaluation of habitat restoration in concert with operations. Reclamation's habitat programs will continue through separate environmental compliance and future restoration plans as independent programs; therefore, no further discussion will be provided in this EIS.

3.2.7 Monitoring

The 2020 Record of Decision included a list of anticipated real-time monitoring and programs permitted through other efforts.

3.2.8 Special Studies

The No Action Alternative includes studies that are now ongoing or completed programs. Examples include:

- DCC Gate Improvements
- San Joaquin Basin Steelhead Telemetry Study
- San Joaquin Basin Steelhead Collaborative
- San Joaquin River Scour Hole Predation Reduction
- Shasta TCD Performance Evaluation
- Water Temperature Modeling Platform
- Temperature Management Study
- Yellow-Billed Cuckoo Baseline Surveys

3.2.9 Drought

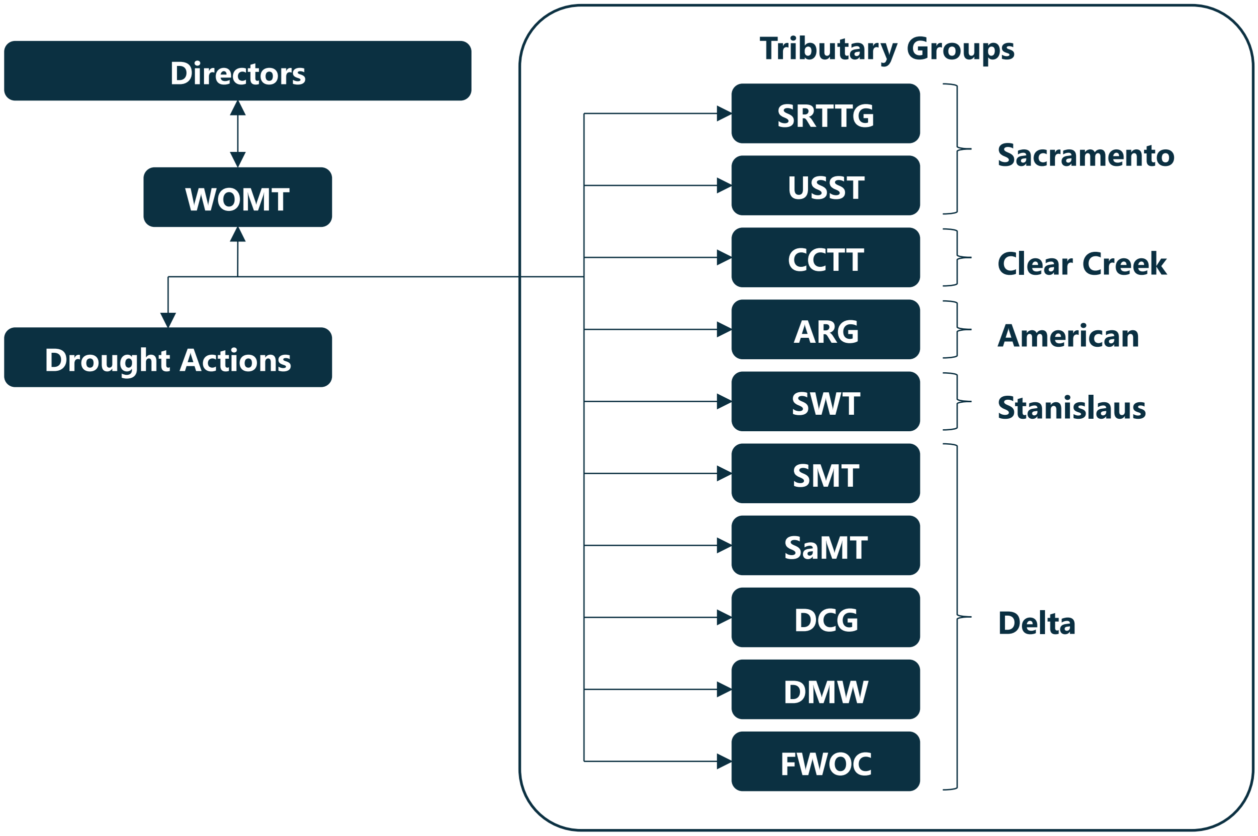
The 2020 Record of Decision included actions to address drought. These include:

- Drought Toolkit
- Agency Directors Meeting
- Agency Meet and Confer

- SRS Contractors Meet and Confer

3.2.10 Governance

The No Action Alternative includes a WOMT supported by tributary groups that developed plans for scheduling flows and targeting water temperatures.



WOMT = Water Operations Management Team; SRTTG = Sacramento River Temperature Task Group; USST = Upper Sacramento River Scheduling Team; CCTT = Clear Creek Technical Team; ARG = American River Group; SWT = Stanislaus Watershed Team; SMT = Smelt Monitoring Team; SaMT = Salmon Monitoring Team; DCG = Delta Coordination Group; DMW = Delta Monitoring Workgroup; FWOC = Fish and Water Operations Call.

Figure 3-13. No Action Alternative Governance Structure.

3.3 Alternative 1 – Water Quality Control Plan

Alternative 1 (Water Quality Control Plan) operates the CVP and SWP to D-1641 and tributary specific water right requirements and agreements. Alternative 1 does not include the operational restrictions in the USFWS and NMFS 2008 and 2009 Biological Opinions Reasonable and Prudent Alternatives or 2019 Biological Opinions for the management of exports, Delta salinity, and releases from upstream facilities. Comparisons using analyses of Alternative 1 inform the effectiveness of non-flow measures versus addressing stressors by restrictions on water operations. Large investments in habitat restoration have occurred and continue, yet long-lead times for landscape level changes and salmonid lifecycles mean that many projects remain in progress with few generations of fish to assess benefits, except on Clear Creek.

Reclamation would continue to operate each tributary with the same primary purposes as described in the Common Components seasonal operations. This alternative differs from No Action as summarized below and described in greater detail in Appendix E, *Draft Alternatives*.

3.3.1 Sacramento River

3.3.1.1 Ramping Rates

Under WRO 90-5, the release rate (ramping) from Keswick Dam from September through February shall not decrease more than the following rates to minimize stranding of salmon.

- Releases shall not be decreased more than 15% in a 12-hour period.
- Releases shall not be decreased more than 2.5% in a 1-hour period.

3.3.1.2 Minimum Instream Flows

Reclamation will operate to the minimum flows set forth in WRO 90-5 as follows:

- March 1 through August 31 – minimum flows of 2,300 cfs
- September 1 through February 28 – minimum flows of 3,250 cfs

In addition, the agreement contains a schedule providing for flow reductions in critically dry years.

However, releases may be greater since Reclamation operates Shasta and Keswick dams in coordination with other CVP and SWP facilities to comply with D-1641's minimum flow requirements near Rio Vista and Delta outflow requirements.

3.3.1.3 Winter and Spring Pulse Flows

Alternative 1 does not include specific winter or spring pulse flows.

3.3.1.4 Water Temperature Management

Under Alternative 1, Reclamation would make releases based on Delta requirements under D-1641, settlement contracts, and making use of available water supply for deliveries to CVP water service contractors while reducing the potential for spill. Reclamation would operate the TCD on Shasta Dam, consistent with WRO 90-5, to target 56°F at the most downstream location feasible from May 15 through October 30 each year.

3.3.2 Clear Creek

3.3.2.1 Minimum Instream Flows

Reclamation would release minimum flows per the August 11, 2000 Instream Flow Preservation Agreement executed by Reclamation, USFWS, and CDFW are shown below in Table 3-8.

Table 3-8. Minimum Instream Flows.

Period	Normal Year (cfs)	Critical Year (cfs)
January–October	50	50
November–December	100	70

cfs = cubic feet per second.

3.3.2.2 Pulse Flows

Alternative 1 does not include specific winter or spring pulse flows.

3.3.2.3 Water Temperature Management

Under Alternative 1, while there is no specific requirement in any SWRCB WROs, Reclamation would target Whiskeytown Dam releases to not exceed the mean daily temperatures at Igo gauge of:

- 61°F from June 1 through August 15.
- 60°F from August 16 through September 15.
- 56°F from Sept 15 through Nov 15.

In dry, critical, or import curtailment years, Reclamation may not be able to meet these water temperatures and will operate Whiskeytown Dam as close to these water temperatures as practicable within the constraints of minimum instream flows.

3.3.3 American River

3.3.3.1 Minimum Instream Flows

D-893 established that the minimum allowable flows in the lower American River at H Street Bridge, in the interest of fish conservation, should not ordinarily fall below 250 cfs between January 1 and September 15 or below 500 cfs at other times.

3.3.3.2 Spring Pulse Flows

Alternative 1 does not include spring pulse flows.

3.3.3.3 Redd Dewatering Adjustments

Alternative 1 does not include redd dewatering adjustments.

3.3.3.4 Water Temperature Management

Reclamation would operate the Folsom Dam temperature control shutters in the same manner as in the No Action Alternative.

3.3.4 Delta

3.3.4.1 Old and Middle Flow Management

Alternative 1 does not include OMR criteria.

3.3.4.2 Spring Delta Outflow

Under Alternative 1, Reclamation and DWR would operate to D-1641. The absence of OMR flow management would result in lower Delta outflows under Alternative 1. Additionally, DWR would not operate to the spring outflow in the 2020 Incidental Take Permit for the SWP.

3.3.4.3 Delta Smelt Summer and Fall Habitat

Alternative 1 does not include SFHA. Reclamation and DWR would operate to achieve X2 westward locations required by D-1641's outflow and salinity objectives. Reclamation and DWR would operate the SMSCG per the Suisun Marsh Preservation Agreement.

3.3.4.4 Delta Smelt Supplementation

Alternative 1 does not include Delta Smelt Supplementation.

3.3.4.5 Sisk Dam Raise and Reservoir Expansion

Upon completion of construction, Reclamation would operate an expanded San Luis Reservoir in accordance with D-1641. The raising of the Bernice Frederic Sisk Dam will increase reservoir storage capacity by 130 TAF. Reclamation and San Luis and Delta-Mendota Water Authority completed a final Supplemental EIS/Environmental Impact Report in December 2020 to raise the dam crest by 10 feet and increase the maximum water surface elevation in the reservoir by 10 feet. The Department of Interior Principal Assistant Secretary for Water and Science executed a Record of Decision for the project in October 2023.

3.3.5 Stanislaus River

3.3.5.1 Minimum Instream Flows

Under Alternative 1, Reclamation would operate to the 1987 Stipulation with CDFW, as shown in Figure 3-14.

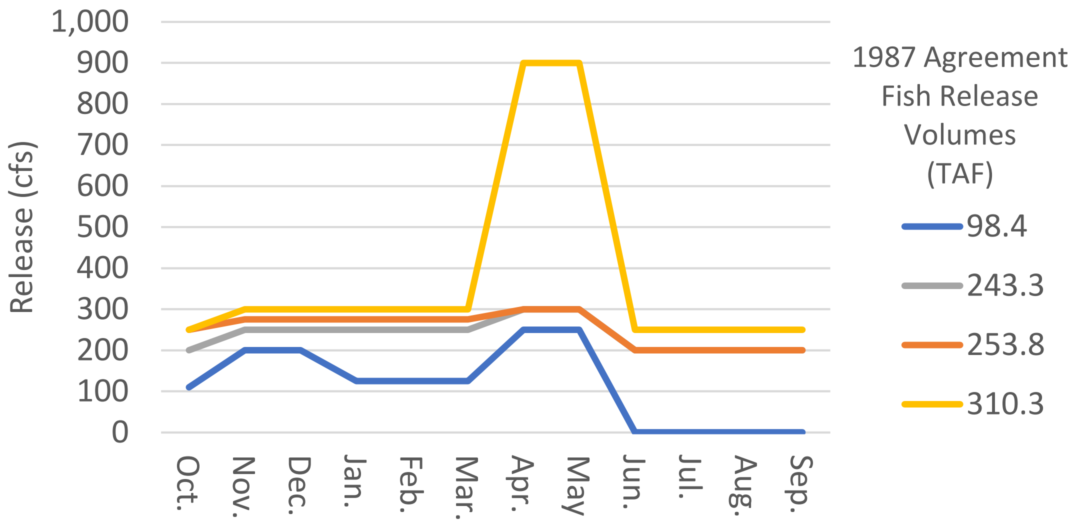


Figure 3-14. Minimum Instream Flows under the CDFW Agreement.

Monthly flows are linearly interpolated from the annual volume (the lines in Figure 3-14). June through September flows will be higher due to releases for DO, which are assumed to be approximately 255 cfs in June, 265 cfs in July, 283 cfs in August, and 249 cfs in September.

Reclamation would release water from New Melones Reservoir to meet D-1641 salinity and flow objectives at Vernalis (not including the pulse flows during the April 15 – May 16 period). The flow requirement is based on the required location of X2 and the 60-20-20 Index as summarized in Table 3-9.

Table 3-9. D-1641 Vernalis Flow Objectives (average monthly cfs).

60-20-20 Index	Flow Required if X2 is West of Chipps Island	Flow Required if X2 is East of Chipps Island
Wet	3,420	2,130
Above Normal	3,420	2,130
Below Normal	2,280	1,420
Dry	2,280	1,420
Critical	1,140	710

3.3.5.2 Winter Instability Flows

Alternative 1 does not include winter instability flows.

3.3.5.3 Spring Pulse Flows

Alternative 1 does not include spring pulse flows.

3.3.5.4 Fall Pulse Flows

Alternative 1 does not include fall pulse flows.

3.3.6 San Joaquin River

Same as the No Action Alternative. Reclamation would continue implementation of the San Joaquin River Restoration Program as an independent related activity.

3.3.7 Monitoring

Under Alternative 1, Reclamation and DWR would undertake monitoring to address water quality control plan requirements and incidental take of federally listed species.

Alternative 1 includes the monitoring of the CVP and Delta SWP facilities into the Long-Term Operation. This allows subsequent changes to existing monitoring programs to be coordinated and included in future consultations of the long-term operation of the CVP and SWP to allow for a more uniform analysis and improved accounting of impacts associated with the operation of the CVP and SWP.

3.3.8 Special Studies

This alternative does not identify specific species studies; however, Reclamation's science enterprise will continue through separate environmental compliance and future plans as independent programs.

3.3.9 Drought

Under Alternative 1, Reclamation and DWR would implement elements of a drought toolkit such as the Drought Barrier on West False River. Reclamation and DWR may request a Temporary Urgency Change Petitions (TUCP) to meet public health and safety needs when dry conditions prevent meeting D-1641. Reclamation and DWR would not apply for TUCPs to preserve storage in upstream reservoirs beyond water required to maintain public health and safety.

3.3.10 Governance

Under Alternative 1, the Directors would meet as necessary to administer the drought toolkit. Reclamation and DWR would still participate in other programs (e.g., Collaborative Science and Adaptive Management Program, Delta Plan Interagency Implementation Committee)., all of which include CDFW, USFWS, and NMFS.

3.4 Alternative 2 – Multi-Agency Consensus

Alternative 2 (Multi-Agency Consensus) represents actions and tradeoffs made to reach consensus among Reclamation, CDFW, DWR, NMFS, and USFWS. It includes actions and approaches identified by the state and federal fish agencies.

Reclamation would continue to operate each tributary with the same primary purposes as described in the Common Components seasonal operations. This alternative differs from No Action as summarized below and described in greater detail in Appendix E, *Draft Alternatives*.

In addition to the description below of Alternative 2, the analysis of alternative is further broken down into three additional Phases. These phases are intended to further demonstrate the flexibility and impacts of these components, some of which are outside Reclamation's direct control.

Alternative 2b is derived from Alternative 2, but includes components developed by CDFW and DWR recently during DWR's current Incidental Take Permit application process for the SWP.

These components are not included in water operations modeling. Components that are expected to result in changes from the analysis provided for Alternative 2 are evaluated qualitatively in each resource chapter. *Appendix E – Alternatives* include additional description of each of the components of Alternative 2B.

3.4.1 Sacramento River

3.4.1.1 Ramping Rates

Ramping rates are the same as the No Action with the additional requirement of operational coordination with a Shasta Operations Team (SHOT) and deviations would be initially discussed through the Sacramento River Group (SRG) prior to coordination through the SHOT.

3.4.1.2 Fall and Winter Baseflows for Shasta Refill and Redd Maintenance

Alternative 2 updates the table for December through February releases to require more storage in Shasta Reservoir for higher release as shown in Table 3-10.

Table 3-10. Keswick Dam December through February Default Release Schedule determined by EOS Storage.

Keswick Release (cfs)	Shasta EOS Storage (MAF)
3,250	≤2.4
4,000	≤2.8
4,500	≤3.2
5,000	>3.2

EOS = end-of-September; cfs = cubic feet per second; MAF = million acre-feet. These may be refined through future modeling and/or analysis efforts as part of the seasonal operations planning.

Alternative 2 additionally includes governance that may modify releases through the SRG and SHOT. Alternative 2 additionally includes coordination with the SRG to consider planned summer flows that are smoothed out to minimize the net difference between the flow at spawning versus emergence.

3.4.1.3 Minimum Instream Flows

In response to major storm events, Reclamation, after coordination through the SRG and SHOT, and also through adaptive management, may determine that lower flows achieve the same biological effects as the minimum flow of 3,250 cfs at Keswick Dam. If these flows are determined to meet the same biological intent, Reclamation may temporarily reduce below 3,250 cfs to preserve storage.

3.4.1.4 Sacramento River Pulse Flows

To increase outmigration survival of Chinook salmon, Reclamation would release up to 150 TAF in pulse flow(s) each water year, typically in the spring, to benefit Chinook salmon in the Sacramento River watershed when the pulse does not interfere with the ability to meet water temperature objectives or other anticipated operations of the reservoir.

3.4.1.5 Sacramento River Settlement Contractors Voluntary Agreement Spring Pulse Flows

Alternative 2 includes advancing up to 100 TAF in releases from Shasta Reservoir for a spring-pulse in consideration of actions by SRS Contractors to make the water available later in the year.

3.4.1.6 Adult Migration and Holding Temperature Objectives

Under a circumstance where conditions may cause water temperatures to rise to concerning levels prior to the final TMP, Reclamation will begin water temperature management as early as March 1 to target water temperatures of 58.0° F daily average at the Sacramento River above the Clear Creek Gage (CCR).

3.4.1.7 Water Temperature and Storage Management

Reclamation is proposing to change the balance between risks of flood control releases for Shasta Reservoir and place a higher priority on maintaining storage for drought protection. The strategy is framed around a framework adapted from the multi-year drought sequence experienced in Victoria, Australia (Mount et al. 2016, “Victorian Objectives”) that establishes different objectives depending on hydrologic conditions and identifies actions that can be taken for fishery management and drought protection.

The framework establishes management “Bins” to manage water temperature and storage to meet the Victorian Objectives described above with the general characteristics described below.

- **Bin 1 Enhance:** ≥3.7 MAF End-of-April (EOA) Shasta Reservoir Storage
    - **Bin 1A:** ≥3.0 MAF End-of-September (EOS) Shasta Reservoir Storage
        - Minimal restrictions on water supply
        - Target 53.5°F water temperatures downstream of CCR
        - Rebalancing of CVP reservoirs with light impacts to the rest of the system to achieve up to 3.0 MAF EOS storage in Shasta Reservoir
        - Target of 53.5°F water temperatures downstream of CCR
- **Bin 2 Recover and Maintain:** ≥3.0 MAF EOA Shasta Reservoir Storage
    - **Bin 2A:** ≥2.2 MAF EOS Shasta Reservoir Storage

        - Target of 53.5°F water temperatures at CCR
    - **Bin 2B:** ≥2.0 MAF EOS Shasta Reservoir Storage
        - Rebalancing of CVP reservoirs with moderate impacts to the rest of the system to achieve up to 2.2 MAF EOS Shasta Reservoir storage
        - Potential water transfer modifications to meet temperature and storage goals to achieve up to 2.2 MAF EOS Shasta Reservoir storage
        - Situation-specific adjustments to D-1641 and other drought toolkit actions
        - Target of 53.5°F water temperatures at CCR during the winter-run Chinook salmon spawning and egg incubation period
- **Bin 3 Protect:** <3.0 MAF EOA Shasta Reservoir Storage
    - **Bin 3A:** ≥2.0 MAF EOS Shasta Reservoir Storage
        - Reduce CVP water supply with the storage objective of 2.0 to 2.2 MAF
        - Rebalancing of CVP reservoirs with moderate impacts to the rest of the system to achieve at least 2.0 MAF EOS Shasta Reservoir storage
        - Potential water transfer modifications to meet temperature and storage goals to achieve at least 2.0 MAF EOS Shasta Reservoir storage
        - Situation-specific adjustments to D-1641 and other drought toolkit actions
        - Target of 53.5°F water temperatures upstream of CCR for the most critical period during the winter-run Chinook salmon spawning and egg incubation period to avoid critical loss of winter-run Chinook salmon population
    - **Bin 3B:** ≤2.0 MAF EOS Shasta Reservoir Storage
        - Reduce Shasta releases for water supply (CVP allocations) to only that needed for meeting public health and safety demands, including minimum salinity levels in the Delta
        - Target of 53.5°F water temperatures upstream of CCR for the most critical period during the winter-run spawning and egg incubation period to avoid critical loss of winter-run population
        - Rebalancing of CVP reservoirs with moderate impacts to the rest of the system to achieve up to 2.0 MAF EOS Shasta Reservoir storage
        - Potential water transfer modifications to meet temperature and storage goals to achieve up to 2.0 MAF EOS Shasta Reservoir storage
        - Requesting significant relaxations to D-1641, limitations in water available under contract and other actions from the drought toolkit

- There is confidence that a TMP will include a strategy to provide winter-run Chinook spawning temperatures that avoid critical losses of egg and fry production, maintain key spawning refuges in upstream areas and avoid catastrophic impacts to the brood year.

Each bin may include a range of actions determined through the SHOT such as: reducing the minimum Wilkins Slough flow to improve biological goals while meeting obligation to senior water right holders; limitations on October and November releases; changes to fall-run redd maintenance flows; temperature target locations, temperature shaping; rebalancing of CVP reservoirs; flows and timing that may increase the likelihood of a bin 2 or 3 year the following year.

3.4.1.8 Sacramento River Settlement Contractors Resolution

Pursuant to *A Resolution Regarding Salmon Recovery Projects in the Sacramento River Watershed, Actions Related to Shasta Reservoir Annual Operations, and Engagement in the Ongoing Collaborative Sacramento River Science Partnership Effort.*, the SRS Contractors will continue to participate in, and act as project champions for future Sacramento Valley Salmon Recovery Program projects, subject to the availability of funding, regulatory approvals, acceptable regulatory assurances, and full performance of the SRS Contracts.

The SRS Contractors will meet and confer with Reclamation, NMFS, and other agencies as appropriate to determine if there are any role for the SRS Contractors in connection with Reclamation's operational decision-making for Shasta Reservoir annual operations in those years. This determination will include consideration of what actions are feasible, consistent with the terms of the SRS Contracts. In addition to the 25% reduction during Shasta critical years as set forth in the SRS Contracts, the types of actions that may be considered include, but are not necessarily limited to: (1) the scheduling of spring diversions by the SRS Contractors; (2) voluntary, compensated water transfers by the SRS Contractors subject to Reclamation approval; and (3) smoothed SRS Contractor diversion for rice straw decomposition during the fall months.

Decisions related to implementation of these Shasta-related voluntary actions will be carried out through SHOT.

3.4.2 Clear Creek

3.4.2.1 Minimum Instream Flows (Seasonally Variable Hydrograph)

Reclamation will release water through Whiskeytown Dam to provide intra-annual variation to emulate natural processes. As provided in Figure 3-15 and Table 3-11, flows will oscillate over a one-year period, with releases transitioning from 300 cfs in the winter, down to 100 cfs in the summer, and back to 300 cfs by the following winter. In critical years, Reclamation will target an average 150 cfs based on available water from Trinity Reservoir and attempt to maintain above 100 cfs.

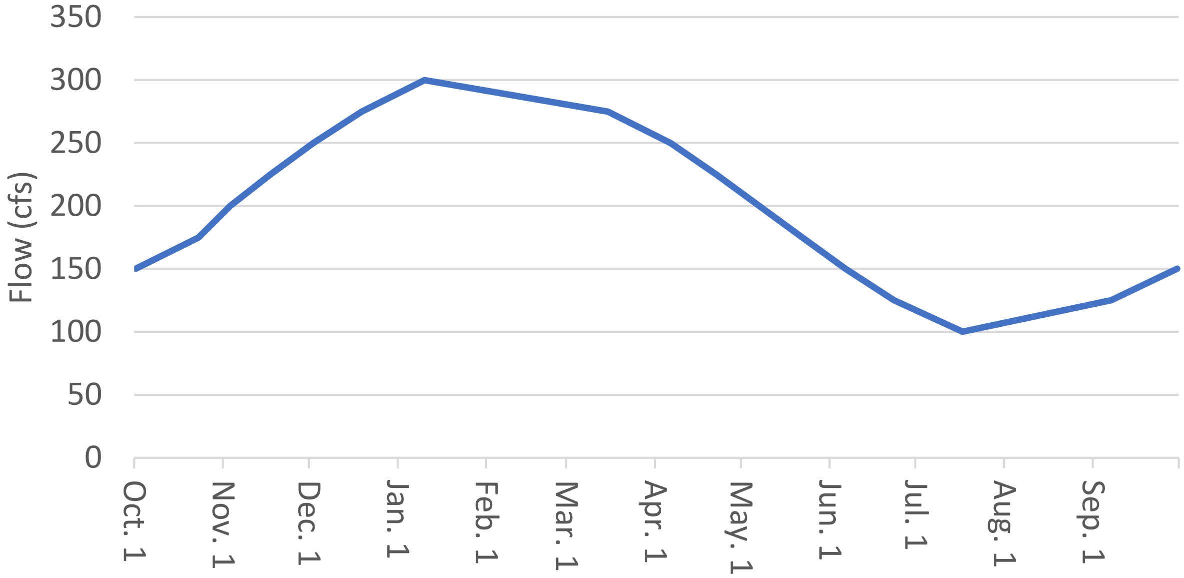


Figure 3-15. Clear Creek Seasonally Variable Hydrograph Minimum Flows, Except Critical Years.

Table 3-11. Proposed Annual Clear Creek Flows Changes.

Date	From (cfs)	To (cfs)
October 1	125	150
October 23	150	175
November 3	175	200
November 17	200	225
December 2	225	250
December 19	250	275
January 10	275	300
March 15	300	275
April 6	275	250
April 22	250	225
May 7	225	200
May 22	200	175
June 6	175	150
June 23	150	125
July 17	125	100
September 7	100	125

cfs = cubic feet per second.

Reclamation, through the Clear Creek Technical Team (CCTT) , may modify the timing and flow rates provided in Figure 3-15 and Table 3-11 by February 1 and updated through May on a case-by-case basis. The flow schedule is subject to agreement by Redding Electric Utility for use of their facilities.

3.4.2.2 Pulse Flows

Except in years with significant uncontrolled spill, Reclamation will release up to 10,000 acre-feet from Whiskeytown Dam for channel maintenance, spring attraction flows, and to meet other physical and biological objectives. In critical years, Reclamation will release up to 5,000 acre-feet. Reclamation, through CCTT, will develop pulse flow schedules.

Due to unknowns in winter precipitation, Clear Creek pulse flows are not to occur prior to the February Sacramento Valley Index (SVI) reporting. The full pulse flow volume (10,000 acre-feet) will be available if the SVI is greater than 5.4, at the SVI updates (i.e., dry or wetter years). If the SVI updates are equal to or less than 5.4 (critical years), Reclamation would limit releases of pulse flows to 5,000 acre-feet.

3.4.2.3 Water Temperature Management

Reclamation will target Whiskeytown Dam releases to not exceed the mean daily temperatures at Igo gauge:

Table 3-12. Igo Guage Mean Daily Temperature Target

Daily Temperature Target	Timing
61°F	June 1 through August 15
60°F	August 16 through September 15
56°F	September 16 through November 15

Reclamation may not be able to meet these water temperatures and will operate Whiskeytown Dam as close to these water temperatures as practicable.

3.4.3 American River

Operations on the American River are the same as the No Action Alternative.

3.4.4 Delta

3.4.4.1 Old and Middle River Flow Management

OMR will be calculated using the equation provided in Hutton 2008. If an equation is developed that results in a better representation of OMR flows, and Reclamation, CDFW, DWR, NMFS, and USFWS agree, then that equation will be updated in calculating the OMR index.

If neither the “First Flush” Action occurs nor the Adult Delta Smelt Entrainment Protection Action is reached, the OMR management season starts automatically on January 1. Once initiated, the OMR index on a 14-day running average will be no more negative than -5,000 cfs until the end of the OMR management season.

3.4.4.2 Winter-Run [and Spring-Run] Early Season Migration

DWR and Reclamation will reduce exports to achieve a 7-day average OMR value no more negative than -5,000 cfs for seven consecutive days when the genetically verified 7-day rolling sum of winter-run and spring-run Chinook salmon loss, calculated daily, exceeds the following thresholds:

- From November 1–November 30: 0.0132% of the Red Bluff juvenile winter-run Chinook salmon Brood Year Total at the end of the second biweekly period in October.
- From December 1–December 31: 0.0265% of the Red Bluff juvenile winter-run Chinook salmon Brood Year Total estimated at the end of the second biweekly period in November.

3.4.4.3 Start of OMR Management

The OMR management season starts any time after December 1 if a "First Flush" Action occurs (i.e., immediately following completion of the "First Flush" Action) or any time after December 20 if the turbidity threshold in the Adult Delta Smelt Entrainment Protection Action is reached. Reclamation and DWR will reduce CVP and SWP exports for 14 consecutive days, anytime between December 1 and the last day of February, to maintain a 14-day average OMR index no more negative than -2,000 cfs within three days of when the same No Action criteria are met.

- Three-day running average of daily flows at Freeport is greater than, or equal to, 25,000 cfs, and
- Three-day running average of daily turbidity at Freeport is greater than, or equal to, 50 FNU

3.4.4.4 Real-time Adjustments

Reclamation and DWR will manage to a more positive OMR than -5,000 cfs on a 14-day average under the following conditions:

Delta Smelt Adult Entrainment Protection Action (Turbidity Bridge)

If after a "First Flush" Action or after December 20, whichever occurs first, daily average turbidity remains or becomes elevated to 12 FNU or higher at each of three turbidity sensors in the OMR corridor creating a continuous bridge of turbidity from the lower San Joaquin River to the CVP and SWP export facilities, Reclamation and DWR will manage exports to achieve a five-day average OMR flow that is no more negative than -3,500 cfs until the daily average turbidity in at least one of the three turbidity sensors is less than 12 FNU for two consecutive days, thereby indicating a break in the continuous Turbidity Bridge.

If the three turbidity sensors remain over 12 FNU at the end of a High Flow Off-Ramp or any time after five consecutive days, then Reclamation and DWR, through WOMT, may prepare an assessment to determine if another Turbidity Bridge Action is warranted.

The Turbidity Bridge Action ends when the three-day continuous average water temperatures at Jersey Point or Rio Vista reach 53.6ºF (12ºC).

When daily average San Joaquin River flows at Vernalis are greater than 10,000 cfs, the Turbidity Bridge is off ramped. While off ramped, the OMR Index will be managed to no more negative than -5,000 cfs on a 14-day average. The Turbidity Bridge would be reinstated when daily average San Joaquin River flows at Vernalis drop below 8,000 cfs.

Delta Smelt Larval and Juvenile Protection Action

Larval and juvenile Delta smelt protections start upon the end of the Adult Delta Smelt Entrainment Protection Action. Reclamation and DWR will operate south Delta exports to a 7-day average OMR index no more negative than -5,000 cfs when the average Secchi disk depth in the most recent survey is greater than one meter. If the average Secchi disk depth in the most recent survey is less than 1 meter, then Reclamation and DWR will operate to an OMR index no more negative than -3,500 cfs until the average Secchi depth has increased to more than one meter.

Longfin Smelt Adult Entrainment Protection Action

If cumulative water year salvage of Longfin smelt with fork length ≥60 millimeter (mm) at the CVP and SWP facilities exceeds the savage threshold, then:

- From December 1 to the start of the OMR management season, Reclamation and DWR shall operate to an OMR flow no more negative than -5,000 cfs on a seven-day average for seven consecutive days. If salvage of Longfin smelt ≥60 mm continues following the 7-day period where OMR is no more negative than -5,000 cfs, then WOMT may determine if OMR management should be initiated.
- From the start of the OMR management season to the end of February, Reclamation and DWR shall operate to an OMR flow no more negative than -3,500 cfs on a seven-day average for seven consecutive days. If salvage of Longfin smelt ≥60 mm continues following the 7-day period where OMR is no more negative than -3,500 cfs, then Reclamation and DWR, through WOMT, may prepare an assessment to determine if additional Longfin smelt entrainment protection action is warranted, as informed by available quantitative tools and real-time data.

Longfin Smelt Larval and Juvenile Protection Action

From January 1 through the end of OMR management season (see below), if:

- The seven-day average QWEST (the average daily flow traveling past Jersey Point, which represents the net flow in the lower San Joaquin River) is < +1,000 cfs, and;
- Larval and juvenile longfin smelt catch in the most recent Smelt Larval Survey (SLS) or 20-mm survey at stations 809 and 812 exceeds the catch threshold set by the San Francisco Bay Study longfin smelt index

Reclamation and DWR will restrict the 7-day average OMR flow to no more negative than -3,500 cfs for seven days. This OMR action may be off-ramped if larval and juvenile longfin smelt combined catch per unit effort at stations 809 and 812 is less than 5% of the total catch across the stations identified in Table 3-13 for the same SLS or 20-mm survey used to on-ramp the action.

If the Water Year cumulative juvenile longfin smelt salvage at the CVP and SWP facilities exceeds 50% of the average annual salvage observed from 2009 through the water year preceding the current water year, then Reclamation and DWR shall operate to a seven-day average OMR of -3,500 cfs for 14 days.

If the Water Year cumulative juvenile Longfin smelt salvage at the CVP and SWP facilities during this period exceeds 75% of the average annual salvage observed from 2009 through the water year preceding the current water year, then Reclamation and DWR shall operate to a seven-day average OMR of -2,500 cfs for 14 days.

Table 3-13. San Francisco Bay Study Longfin Smelt Index Catch Threshold.

San Francisco Bay Study Longfin Smelt Index	Catch Threshold at 809 & 812
0–149	10
150–299	20
300–499	30
500–999	40
≥1000	50

Source: California Department of Fish and Wildlife 1999.

Table 3-13. SLS and 20-mm Survey Stations.

Station Number
306
308
323
338
340
344
411
602
501
519
606
508
705
520

Station Number
809
812
716
723
711

High-flow Offramps for Larval and Juvenile Delta Smelt and Longfin Smelt

When daily average Sacramento River flows at Rio Vista are greater than 55,000 cfs, or daily average San Joaquin River flows at Vernalis are greater than 8,000 cfs, then the Larval and Juvenile Delta smelt and Longfin smelt Protection Actions are off ramped.

Winter-Run Chinook Salmon Loss Thresholds

Reclamation and DWR will manage OMR to avoid exceeding the following annual loss thresholds:

- Natural winter-run Chinook salmon (loss = 0.5% of JPE)
- Hatchery winter-run Chinook salmon (loss = 0.12% of JPE)

If cumulative loss of either natural or hatchery winter-run Chinook salmon in a brood year exceeds 50% of the annual loss thresholds, then DWR and Reclamation will restrict south Delta exports to maintain a seven-day average OMR value no more negative than -3,500 cfs for seven consecutive days. Once exceeded, each winter-run Chinook salmon observed in salvage would trigger another operation to an OMR limit of -3,500 cfs for seven days.

If the cumulative loss of either natural or hatchery winter-run Chinook salmon in a brood year exceeds 75% of the annual loss thresholds, then DWR and Reclamation will restrict south Delta exports to maintain a 7-day average OMR value no more negative than the -2,500 cfs for seven consecutive days when the Winter-run Chinook Salmon Machine Learning Model and associated OMR Conversion Tool predict that the change to -2,500 cfs will shift the model output to a classification of absence with a minimum probability of absence prediction of 0.559 for 1 of 30 sub-models for any of the seven most recent prediction days.

If genetic analysis of natural older juvenile Chinook salmon observed in salvage at the SWP or CVP indicates that any given Chinook salmon is not genetically winter-run or spring-run Chinook salmon, these fish will not count towards the loss threshold exceedance.

If the weekly distributed loss threshold is exceeded on any single day by the 7-day rolling sum of winter-run Chinook salmon loss, then DWR and Reclamation will reduce exports to achieve a 7-day average OMR no more negative than -3,500 cfs for seven consecutive days.

Table 3-14. Historical (Water Years 2017–2021) Presence of Winter-run Chinook Salmon Entering the Delta (Column B), Exiting the Delta (Column C), in the Delta (Column D = Column B–Column C) and in the Delta Scaled to 100% (Column E).

Week (starting January 1) (A)	Historical Cumulative entering the Delta (Sherwood Harbor) (B)	Historical Cumulative exiting the Delta (Chipps Island) (C)	Historical Present in Delta (D)	Historical Present in Delta (Scaled to 100%) (E)
1/1–1/7	2.47%	1.65%	0.82%	0.32%
1/8–1/14	2.47%	1.65%	0.82%	0.32%
1/15–1/21	4.94	1.65%	3.29%	1.30%
1/22–1/28	4.94%	1.65%	3.29%	1.30%
1/29–2/4	19.75%	2.20%	17.55%	6.91%
2/5–2/11	38.27%	4.95%	33.32%	13.13%
2/12–2/18	43.21%	5.49%	37.72%	14.86%
2/19–2/25	46.91%	9.89%	37.02%	14.59%
2/26–3/4*	50.62%	18.13%	32.49%	12.80%
3/5–3/11	55.56%	30.77%	24.79%	9.77%
3/12–3/18	77.78%	38.46%	39.32%	15.49%
3/19–3/25	85.19%	64.84%	20.35%	8.02%
3/26–4/1	93.83%	90.11%	3.72%	1.47%
4/2–4/8	98.77%	99.45%	0%	0%
4/9–4/15	100.00%	100.00%	0.00%	0.00%
4/16-End of Winter–run OMR Season	100.00%	100.00%	0.00%	0.00%

Notes: Data from genetically identified winter-run Chinook salmon entering the Delta (Sherwood Harbor Trawl) and exiting the Delta (Chipps Island Trawl) are used to estimate the percentage of winter-run Chinook salmon present in the Delta each week. Presence prior to January 1 each year is included in the first week of presence.
OMR = old and middle river.
[a] The week of February 26–March 4 includes 8 days during leap years

Steelhead Weekly Distributed Loss Thresholds

DWR and Reclamation will reduce exports to achieve a seven-day average OMR value no more negative than -3,500 cfs for seven consecutive days when the seven-day rolling sum of steelhead salvage, calculated daily, exceeds the weekly loss threshold of 120 fish.

Spring-Run Chinook Salmon and Surrogate Threshold

From November 1 through the end of the OMR flow management period of each water year, if a cumulative loss threshold is exceeded, Reclamation and DWR will reduce south Delta exports to achieve a 7-day average OMR index of no more negative than -5,000 cfs in November and December, and no more negative than -3,500 cfs beginning January 1 (or whenever the OMR management begins) through the end of OMR flow management season, or June 30, whichever occurs first. The cumulative loss threshold for coded wire tagged spring-run Chinook salmon surrogate groups at the CVP and SWP salvage facilities is 0.25% for each release group from Coleman National Fish Hatchery and the Feather River Fish Hatchery..

3.4.4.5 Storm-Flex

During the OMR management season, Reclamation and DWR, through WOMT, may prepare an assessment to evaluate operating to an OMR index no more negative than -6,250 cfs between the start of OMR management season and the larval and juvenile delta smelt Protection Action onramp or the last day of February, whichever occurs first, to capture peak flows during storm-related events.

If conditions indicate an entrainment protection condition is likely to trigger, Reclamation and DWR will reduce south Delta exports to achieve a 14-day average OMR index no more negative than -5,000 cfs, unless a further reduction in exports is required. If an entrainment protection condition is triggered, Reclamation and DWR will cease storm-flex and implement the entrainment protection condition.

3.4.4.6 End of OMR Management Season

Reclamation and DWR will conclude the management of OMR for salmonids on June 30 or:

- the three consecutive days of water temperature at the CLC is 77.0°F or higher; and
- daily mean water temperature at Mossdale and Prisoner's Point has exceeded 72.0°F for seven non-consecutive days in June.

3.4.4.7 Spring Delta Outflow

Reclamation and DWR will take actions intended to supplement Delta outflow per the terms of the voluntary agreements (VA). Reclamation and DWR will operate consistent with the VAs approved by the SWRCB and executed agreements by VA Parties.

Actions that will support the additional Delta outflow include: (1) Reclamation and DWR south of Delta export modifications; (2) Reclamation reoperating upstream reservoirs to advance and allow for scheduling of water made available by contractors in CVP watersheds; and (3) passing Delta inflow from water made available by VA Parties. Volumes are reflected in the Memorandum of Understanding signed by VA parties in March 2022.

3.4.4.8 Delta Smelt Summer and Fall Habitat

Similar to the No Action Alternative, Reclamation and DWR will maintain a 30-day average X2 ≤80 km for September through October in above normal and wet years.

Under Alternative 2, DWR will operate the SMSCG in summer and fall (June through October) for 60 days using a seven-day tidal -seven-day open operation (7-7) schedule to maximize the number of days that Belden's Landing three-day average salinity is equal to, or less than, 4 practical salinity units. In dry years following below normal years, DWR will operate SMSCG for 30 days using 7-7 operation to maximize the number of days Belden's Landing three-day salinity is equal to, or less than 6 practical salinity units.

3.4.4.9 Delta Smelt Supplementation

Reclamation and DWR will support a minimum production of 150,000 fish by water year 2025, and a minimum of 200,000 fish by water year 2026, if feasible, that are at least 200 days post-hatch or equivalent.

Reclamation and DWR, through the Culture and Supplementation of Smelt Steering Committee, will continue to collaborate on the development of a program consistent with USFWS' Supplementation Strategy (U.S. Fish and Wildlife Service 2020).

3.4.4.10 Barker Slough Pumping Plant

In addition to the No Action description, DWR proposes additional protective measures for Delta and longfin smelt at the BSPP in combination with other diversions. Cumulative BSPP diversions for the January 1 to March 31 period, at design capacity, are limited to approximately 26 TAF.

- Maximum Spring Diversions: Cumulative BSPP diversions for the March to June period, at design capacity, is 42 TAF.
- From January 1 to March 31 of dry and critical water years, DWR proposes to operate to a maximum seven-day average diversion rate at BSPP less than 100 cfs.
- DWR, at its sole expense, from March 1 to April 30 of dry and critical water years, if catch of larval Delta smelt (length less than 25 mm) in 20-mm Survey at station 718 exceeds 14% of the total catch of larval Delta smelt across the North Delta (20-mm Survey stations 716, 718, 719, 720, 723, 724, and 726), then DWR proposes to operate to a maximum seven-day average diversion rate at BSPP less than 60 cfs.
- DWR, at its sole expense, from May 1 to June 30 of dry and critical water years, if catch of larval Delta smelt (length less than 25mm) in 20-mm Survey at station 716 exceeds 5% of the total catch of larval Delta smelt across the North Delta (20-mm Survey stations 716, 718, 719, 720, 723, 724, and 726), then DWR proposes to operate to a maximum seven-day average diversion rate at BSPP less than 100 cfs.

3.4.4.11 Bernice Frederic Sisk Dam Raise and Reservoir Expansion

Same as Alternative 1.

3.4.4.12 Tidal Habitat Restoration

Tidal habitat restoration is a commitment from the 2009 Biological Opinion, carried into the 2020 Record of Decision. All planned actions, as described in the No Action Alternative, have separate environmental compliance (either programmatically or site-specific) and no further analysis of impacts will be performed in this document. State and Federal agencies would analyze impacts for the site specific and programmatic tidal habitat restoration compliance separate from the Long-Term Operation of CVP and SWP.

3.4.4.13 Longfin Smelt Culture Program

DWR will continue to fund the Longfin Smelt culture program to achieve the following objectives: 1) fully close the Longfin Smelt life cycle in captivity, 2) initiate and maintain a genetically managed refugial population, and 3) produce fish to meet the needs of research and management projects as coordinated with the Longfin Smelt Science Plan.

3.4.5 Stanislaus River

3.4.5.1 Minimum Instream Flows

Minimum instream flows (i.e., Goodwin Dam releases) will be in accordance with the 2023 New Melones SRP (2023 SRP, Figure 8) to increase the potential outmigration response of juvenile steelhead and increase the annual total volume of water for all year types, as shown in Figure 3-16. The SRP includes the ability to shape monthly and seasonal flow volumes.

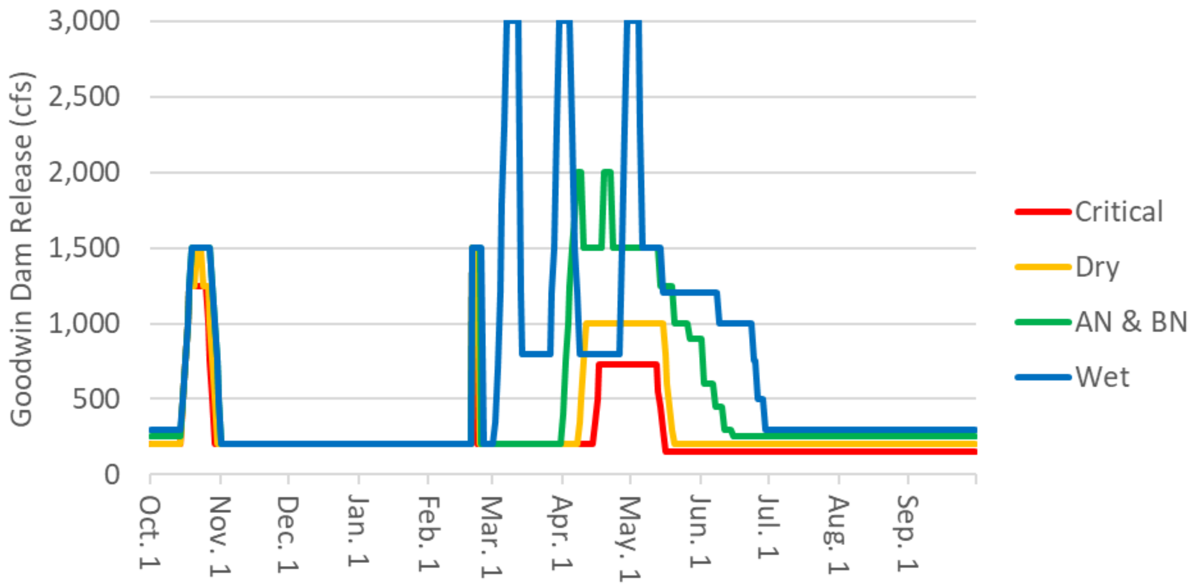


Figure 3-16. 2019 New Melones Stepped Release Plan with Modified Winter Instability Flows.

3.4.5.2 Winter Instability Flows

Reclamation, through the Stanislaus Watershed Team, schedules the winter instability flow volume, including combining the additional January and February releases, in consideration of timing flows to coincide with a natural storm event which may naturally cue outmigration. Modifications would use a single pulse and increase peak releases from 400 cfs to 1,500 cfs.

3.4.5.3 Fall Pulse Flows

In addition to description of the No Action Alternative, Reclamation may release additional flows in October and/or November.

3.4.6 San Joaquin River

Same as the No Action Alternative. Reclamation would continue implementation of the San Joaquin River Restoration Program as an independent related activity.

3.4.7 Monitoring

Same as Alternative 1.

3.4.8 Special Studies

Alternative 2 identifies special studies similar to the No Action Alternative and adds additional studies including:

- **Steelhead Lifecycle and JPE:** Reclamation and DWR will update the JPE framework including steelhead telemetry, steelhead lifecycle monitoring, and produce a steelhead JPE.
- **Spring-Run Chinook salmon Lifecycle and JPE:** Reclamation and DWR will support continued development of a SR-JPE framework for CVP and SWP tributaries and the Delta, and from the framework, propose a SR-JPE Plan for implementation, including an approach for modeling a SR-JPE and the monitoring program to support that approach.
- **Tidal Habitat Restoration Effectiveness:** DWR and Reclamation will use the adaptive management program to evaluate and identify actions that may improve the effectiveness of its restoration projects.
- **Tributary Habitat Restoration Effectiveness:** The existing CVPIA Upper Sacramento River Habitat Restoration Technical Team includes Reclamation, USFWS, NMFS, CDFW, consultants (e.g., Chico State University, PSMFC), and recipients of competitive funding for habitat restoration will be utilized as the AMT for this action.
- **Winter-Run Early Life Stage Studies:**

  The Early Life Stage Survival Science Action aims to address two distinct knowledge gaps:

  1. Reducing uncertainty around the effects of water temperature and other factors (e.g. dissolved oxygen, spawning habitat and flow) on egg-fry-survival

  2. Improving understanding of juvenile survival during rearing and migration, including reducing uncertainties in the field monitoring data

- **Shasta Spring Pulse Studies:** Reclamation and DWR, through the SRG, will support hindcast evaluation of action effectiveness that includes technical review of the functional elements of the pulse flow (i.e., timing, magnitude, duration, and frequency) as well as an evaluation of criteria used to support beneficial use decisions.
- **Delta Route Selection and Survival:** These studies involve an acoustic receiver network and associated real-time and retrospective modeling of the data. The objectives are to provide real-time estimates of reach-specific survival and route entrainment for juvenile salmonids in the Sacramento River and Delta.
- **Delta Smelt Summer and Fall Habitat:** DWR and Reclamation will consider food subsidy measures to augment the SFHA.

- **Longfin Smelt Science Plan:** DWR and Reclamation will implement science activities as described in the 2020 Incidental Take Permit Longfin Smelt Science Plan; including the development of mathematical lifecycle model. The lifecycle model will be used as a quantitative tool to characterize the effects of abiotic and biotic factors on Longfin Smelt populations.

- **Longfin Smelt Science and Monitoring Initiatives:** DWR and Reclamation will support the implementation of the Longfin Smelt Science Plan (LFSSP). The purpose of the LFSSP is to provide a framework for Longfin Smelt science investments through 2030.

- **Management of Winter-run Spawning Location and Timing:** Reclamation will study how flow and temperatures can be used to manage SRWC spawning on the Sacramento River.. The goal of this management action is to ensure a resilient portfolio of life history strategies by supporting a diversity of spawn timings and locations in the population.

- **Alternative Loss Estimation Pilot Study:** DWR, has completed a draft updated Alternative Loss Equation (ALE-22) software tool for estimating losses at the SWP and CVP export facilities to quantify incidental take of winter-run and spring-run Chinook Salmon, and Central Valley steelhead. DWR, in coordination with Reclamation proposes to further refine the parameters of this tool by developing an Alternative Loss Pilot Study Implementation Plan (ALPS-IP) to implement this tool in parallel with current loss estimation methods. The goal of this pilot study is to provide a more accurate estimates of loss, and loss parameters, at the SWP and CVP export facilities while understanding the utility of the new alternative method relative to the existing method.

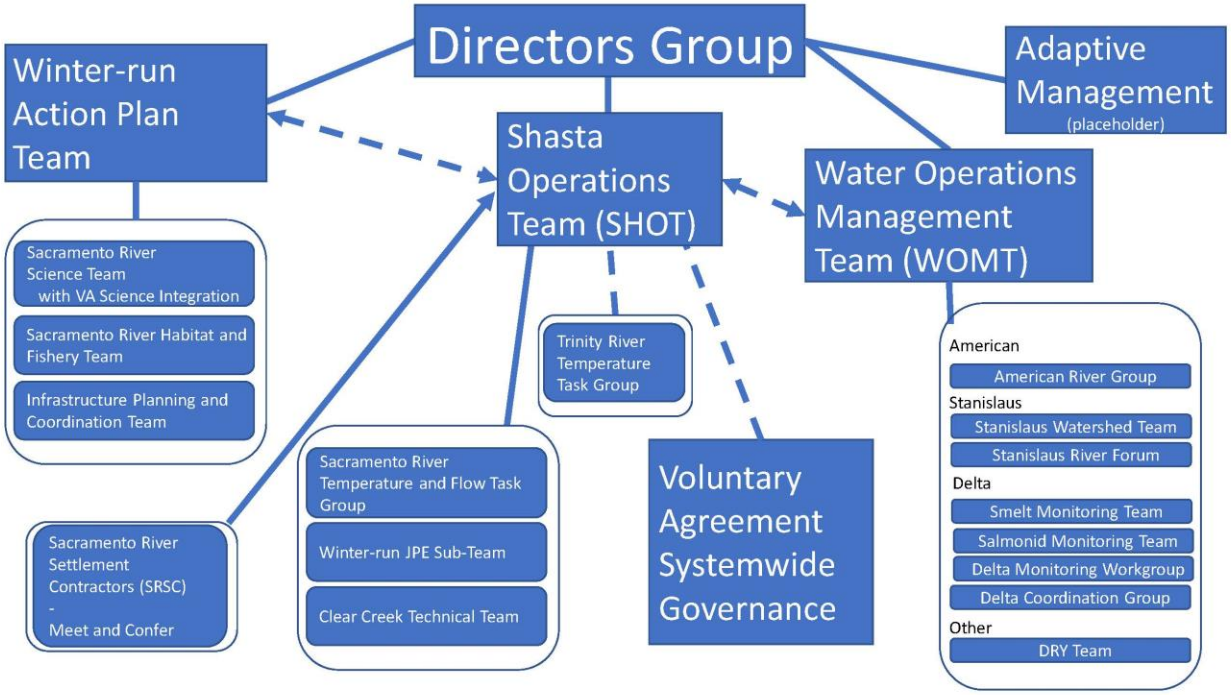
  Georgiana Slough Migratory Barrier Effectiveness: DWR will continue leading the GSSMB Coordination Group, with membership comprised of DWR, Reclamation, CDFW, USFWS, NMFS, and State/Federal Water Contractors representatives. DWR and Reclamation, working with the GSSMB Coordination Group, will provide at least a triennial report and review and update, as necessary, the GSSMB Operations and Monitoring Plans.

3.4.9 Drought

Starting each October, Reclamation and DWR, through the Drought Relief Year (DRY) Team, will meet at least monthly to determine whether it would be appropriate to pursue actions described in the drought toolkit to respond to current or anticipated drought and dry year conditions. Reclamation and DWR, through the DRY Team, may update the drought toolkit.

3.4.10 Governance

CVP/SWP Governance is structured such that a 5 Agency Directors Group oversees the ongoing authorities of each respective agency and serves as the final decision-making body for operational matters. The Directors Group directly interfaces with four management level groups (Winter-run Action Plan Team, SHOT, WOMT, and Adaptive Management), whose Federal and State agency representatives discuss the actions in Alternative 2 when implementation may have biological, system conditions or water supply impacts or tradeoffs. See Appendix E for the full description of governance and the adaptive management program. These policy groups work with numerous technical groups that coordinate on seasonal and real-time operations for specific divisions or watersheds. Figure 3-17 shows the identified groups and relationships.



Solid lines indicate a direct relationship for elevation and decision making, the dashed arrow between Winter-run Action Plan Team and SHOT indicates a direct line of communication and regular coordination, the dashed arrow between WOMT and SHOT indicates a direct line of communication and regular coordination, the dashed line between SHOT and the Trinity River Temperature Task Group indicates seasonal communication and coordination on an as-needed basis. The solid arrow between SHOT and the SRS Contractors indicates SRS Contractor integration into SHOT.

Figure 3-17. Governance Structure for CVP and SWP Water Operations.

3.4.11 Framework Programmatic Outline for Sites Reservoir Project and Delta Conveyance Project

Alternative 2 includes a framework for the development of future Federal actions related to Delta Conveyance Project (DCP) and Sites Reservoir Project (Sites) that will be authorized, funded, or carried out at a later time and will be subject to future project-specific consultations because of these subsequent Federal actions. A full description of activities addressed programmatically provided in Appendix E will be subject to a subsequent consultation.

Alternative 2 includes a framework programmatic outline for the operations of the Sites and the operations of the proposed DCP. The analysis for DCP (Appendix Z) and Sites (Appendix AA) provides information, to the extent possible given the information available today, to assess how these projects would operate along with broadly assessing the impacts of the operations of these projects in the context of the LTO of the CVP and SWP. The intended use of for the programmatic discussion of these two projects is to provide information, to the extent possible, on how these key projects would be implemented in conjunction with the LTO operations in the future and will support subsequent regulatory processes and coordinated operations planning.

3.4.12 Other Activities (Winter-run Action Plan)

This Winter-run Action Plan has been developed collaboratively among representatives from the U.S. Bureau of Reclamation (Reclamation), NMFS, U.S. Fish and Wildlife Service (USFWS), California Department of Water Resources (DWR), California Department of Fish and Wildlife (CDFW), and the Sacramento River Settlement Contractors to improve the survival and viability of winter-run that functions alongside planned operation of Shasta Reservoir. These components are not specifically proposed by Reclamation and may be implemented by other parties with separate NEPA efforts.

3.5 Alternative 3 – Modified Natural Hydrograph

Alternative 3 (Modified Natural Hydrograph) represents actions informed by discussions with some of the environmental NGOs involved in state-wide water projects. It combines additional Delta outflow with measures to improve drought protection and temperature management through increased reservoir carryover storage.

Alternative 3 applies the following priority order for meeting downstream demands:

1. Meet D-1641;
2. Meet minimum reservoir release and instream flow requirements;
3. Divert water for human health and safety as defined by California Code of Regulations, Title 24, Section 878;
4. Meet storage requirements further described in Appendix E for Shasta, Folsom, Oroville, and New Melones reservoirs;
5. Meet Delta outflow requirements as proposed in this alternative – limit water diversions by CVP and SWP water service contractors, settlement contractors, and exchange contractors under SWP and CVP water rights to human health and safety if outflow requirements are not achieved, and limit releases of stored water beyond releases necessary to meet D-1641 in most months to prioritize achieving reservoir storage requirements;
6. Meet Delta operational requirements as described below (e.g., OMR, 2:1 San Joaquin import/export flow ratio);
7. Divert and deliver water for wildlife refuges;
8. Divert and make water available for diversions for settlement, and exchange contractor demands. Diversions/deliveries may be reduced by more than contract terms currently allow to meet operational requirements to protect listed species.
9. Divert water for CVP and SWP water service contractors.

Reclamation would continue to operate each tributary with the same primary purposes as described in the Common Components seasonal operations. This alternative differs from No Action as summarized below and described in greater detail in Appendix E - *Draft Alternatives*.

3.5.1 Sacramento River

3.5.1.1 Ramping Rates

This component is the same as Alternative 2.

3.5.1.2 Winter and Spring Pulses and Delta Outflow

This component replaces the Spring Pulse flow component seen in the other alternatives.

Subject to modeling demonstrating that operations are reasonably likely to meet the Shasta Reservoir storage requirements for water temperature management described below, Alternative 3 bypasses 55% of unimpaired inflow to Shasta Reservoir from December through May to achieve the monthly Delta Outflow criteria in Table 3-15, as described below for the Delta. When the monthly Delta Outflow criteria in Table 3-15 is met, then releases from Shasta Reservoir that month may be reduced to 45% of unimpaired inflows from December to May.

3.5.1.3 Water Temperature Management

Reclamation would reduce deliveries from stored water releases from Shasta Reservoir to meet the storage requirements below. In addition, Reclamation would release unstored water to meet Delta outflow requirements described in Section 7.1.1 from December through May to the extent modeling indicates doing so was consistent with meeting these storage requirements.

Reclamation would release stored water to meet Delta outflow requirements from May through November. These storage requirements are designed to achieve water temperatures that protect winter-run Chinook salmon, and protect the salmon fishery, including fall-run Chinook salmon, pursuant to WRO 90-5:

- EOA Storage
    - Critical Year: 3.6 MAF
    - All other Years: 3.9 MAF
- EOS Storage
    - Critical Year: 1.9 MAF
    - All other Years: 2.2 MAF

Reclamation would not make water available for delivery until operational plans show the targets in 7.1.1 and 7.1.2 are likely to be met or exceeded. When those targets can be met, Reclamation would then make releases for deliveries in the priority identified above (first to CVPIA wildlife refuges, then to the SRS Contractors, then water service contractors).

Reclamation shall develop an annual TMP, consistent with WRO 90-5 and these criteria. The TMP will be reviewed and approved by NMFS on or before April 15, and will be approved before Reclamation releases water from Shasta Dam for delivery to or diversion by any contractor.

In water years classified as wet, above normal, below normal, or dry, the TMP shall achieve daily average water temperatures of 53.5°F at the Clear Creek gage from the earlier of the onset of spawning of winter-run Chinook salmon or May 15 until October 31. In water years classified as critical, the TMP shall achieve daily average water temperatures of 54.5°F or cooler at the Clear Creek gage from the earlier of the onset of spawning of winter-run Chinook salmon or May 15 until October 31, to the maximum extent possible. In addition, Reclamation's operations shall not result in seven-day average of daily maximum water temperatures at the Jelly's Ferry gage that exceed 61°F from March 1 to May 15. Shasta Dam operations described in the TMP should include modeling of water temperature dependent mortality using the Martin et al. model, and modeled estimates of water temperature dependent mortality of winter-run Chinook salmon should not exceed 30% in a critically dry year, 8% in a dry year, or 3% in other water year types. Reclamation would consider and implement warmwater and/or coldwater power bypasses at Shasta Dam when necessary to achieve these water temperature criteria.

If Reclamation, NMFS, and SWRCB jointly determine that reservoir storage is inadequate to achieve these water temperature criteria and comply with WRO 90-5, Reclamation, NMFS and SWRCB would jointly develop or revise the TMP that maximizes water temperature benefits for salmon spawning below Shasta Dam, provides a reasonable likelihood to achieve storage targets in the following year if that year is dry, documents water deliveries to contractors, and is disclosed to the public. This plan will be approved by NMFS before Reclamation releases water from Shasta Reservoir for its deliveries.

3.5.2 Clear Creek

All components for this watershed are the same as Alternative 2, except that Reclamation will manage Whiskeytown Dam releases to not exceed mean daily water temperatures of 60°F at the Igo gauge from June 1 through September 15 and 56°F from September 15 through November 15.

3.5.3 American River

3.5.3.1 Minimum Instream Flows (Minimum Release Requirements)

This component is the same as Alternative 2, except that Reclamation would incorporate the following Folsom Reservoir storage requirements:

- EOS: 300 TAF (230 TAF in a second consecutive dry or critical water year type)
- EOD: 300 TAF

Reclamation would prioritize minimum flows under the MRR, then storage, then additional Delta outflow in the winter and spring, then water deliveries.

3.5.3.2 Winter and Spring Pulses and Delta Outflow

This component replaces the Spring Pulse flow component seen in the other alternatives.

Subject to annual modeling demonstrating that operations are reasonably likely to meet the storage requirements described above, Alternative 3 bypasses 55% of unimpaired inflows to Folsom Reservoir from December through May to achieve the monthly Delta Outflow criteria in Table 3-15, as described in Winter and Spring Delta Outflow. Subject to achieving the storage requirements described above, Reclamation may release stored water from May to November to meet the Delta Outflow criteria described in Table 3-15. If the monthly Delta Outflow criteria in Table 3-15 is met, then releases from Folsom Reservoir that month may be reduced to 45% of unimpaired inflows from December through May.

3.5.4 Feather River

DWR would address Oroville Dam operations separately.

3.5.5 Delta

Alternative 3 assumes a single unit operation is feasible for exports to meet public health and safety and would be shared between the CVP and SWP.

3.5.5.1 3.5.5.1 Old and Middle River Reverse Flows

Reclamation and DWR would coordinate operations of the CVP and SWP to meet the following requirements that are different from the No Action Alternative.

From the earlier of January 1 or the onset of OMR management, until the earlier of June 30 or the offramp of OMR Management, flows shall not exceed -5,000 cfs on a 14-day running average. These requirements do not apply when San Joaquin River flows at Vernalis are greater than 20,000 cfs. In addition, when the SVI has been classified as a critically dry year for a second (or more) consecutive year, OMR flows shall not exceed -2,500 cfs on a 14-day running average.

From April 1 to May 31, Reclamation and DWR would operate to achieve a 2:1 ratio of San Joaquin River inflow at Vernalis to combined CVP/SWP exports in all water year types.

3.5.5.2 Winter and Spring Delta Outflow

This component replaces the Spring Pulse flow component seen in the No Action Alternative, and Alternatives 1, 2, and 4.

In addition to the requirements under D-1641, and consistent with modeling demonstrating that operations are reasonably likely to meet storage requirements described above, on a monthly basis, Reclamation and DWR would operate to meet the Delta Outflow criteria in Table 3-15 for the months of July to November. For the months of December through June, on a monthly basis, Reclamation and DWR would operate to meet Delta Outflow that is the lesser of 65 percent of unimpaired Delta inflow or the Delta Outflow criteria in Table 3-15.

Table 3-15. Maximum Required Delta Outflow Criteria by Month and Water Year Type.

Month	Water Year Type							
	Wet	Above Normal	Below Normal	Dry	Second Consecutive Dry	Critical	Second Consecutive Critical	Third or more Consecutive Critical
January	90,000 cfs	42,800 cfs	29,000 cfs	20,000 cfs	11,400 cfs	11,400 cfs	7,100 cfs + OMR -2,500 cfs	NC
February	90,000 cfs	42,800 cfs	29,000 cfs	20,000 cfs	11,400 cfs	11,400 cfs	7,100 cfs + OMR -2,500 cfs	NC
March	90,000 cfs	42,800 cfs	29,000 cfs	20,000 cfs	11,400 cfs	11,400 cfs	7,100 cfs + OMR -2,500 cfs	NC
April	90,000 cfs	42,800 cfs	29,000 cfs	20,000 cfs	11,400 cfs	11,400 cfs	7,100 cfs + OMR -2,500 cfs	NC
May	90,000 cfs	42,800 cfs	29,000 cfs	20,000 cfs	11,400 cfs	11,400 cfs	7,100 cfs + OMR -2,500 cfs	NC
June	D-1641	D-1641	D-1641	8,000 cfs	8,000 cfs	8,000 cfs	7,100 cfs to June 15 then July criteria	4,000 cfs
July	8,000 cfs	8,000 cfs	7,100 cfs	6,500 cfs	NC	5,000 cfs	NC	4,000 cfs
August	7,100 cfs	7,100 cfs	6,900 cfs	6,900 cfs	NC	5,000 cfs	4,000 cfs	4,000 cfs
September	8,100 cfs	7,100 cfs	5,000 cfs	4,000 cfs	NC	3,000 cfs	NC	NC
October	8,100 cfs	7,100 cfs	5,000 cfs	4,000 cfs	NC	3,000 cfs	NC	NC
November	≤7,100 cfs [a]	≤7,100 cfs [a]	5,000 cfs	4,500 cfs	NC	3,500 cfs	NC	NC
December	65% UIF	65% UIF	65% UIF	65% UIF	NC	65% UIF	NC	NC

Note: Lesser of 65% of unimpaired flow or maximum required Delta outflow for months of December through June.
cfs = cubic feet per second; OMR = old and middle river; UIF = unimpaired flow; NC = no change.
[a] Reservoir inflow

To meet the Delta outflow in Table 3-15, consistent with annual modeling demonstrating that storage requirements are reasonably likely to be achieved, for the months of December through May, Reclamation and DWR would bypass 55% of unimpaired inflow to Shasta, Folsom reservoirs and 40% of unimpaired inflow to New Melones Reservoir. If the storage requirements and monthly Delta Outflow criteria in Table 3-15 are met, then releases from Shasta, Folsom reservoirs that month may be reduced to 45% of unimpaired inflows from December through May. Reclamation and DWR may release stored water to meet Delta outflow criteria in May through November.

Reclamation and DWR would prioritize meeting the storage requirements described herein before making additional reservoir releases beyond what is required to meet D-1641 and human health and safety.

3.5.5.3 Delta Smelt Summer and Fall Habitat

Alternative 3 is the same as Alternative 2, except releases from upstream reservoirs are constrained to a Delta outflow of 7,100 cfs in November of wet and above normal years as described in Table 3-15. Fall salinity may vary based on the ability of export reductions to achieve Fall X2 subject to public health and safety.

3.5.5.4 Bernice Frederic Sisk Dam Raise and Reservoir Expansion

This is the same as under Alternative 1.

3.5.6 Stanislaus River

3.5.6.1 Minimum Instream Flows

Consistent with the 2018 Bay-Delta Water Quality Control Plan, this component is consistent with the No Action Alternative in the summer and fall. Alternative 3 requires reservoir releases to meet 40% of unimpaired inflow on a 7-day running average to the confluence with the San Joaquin in February through June.

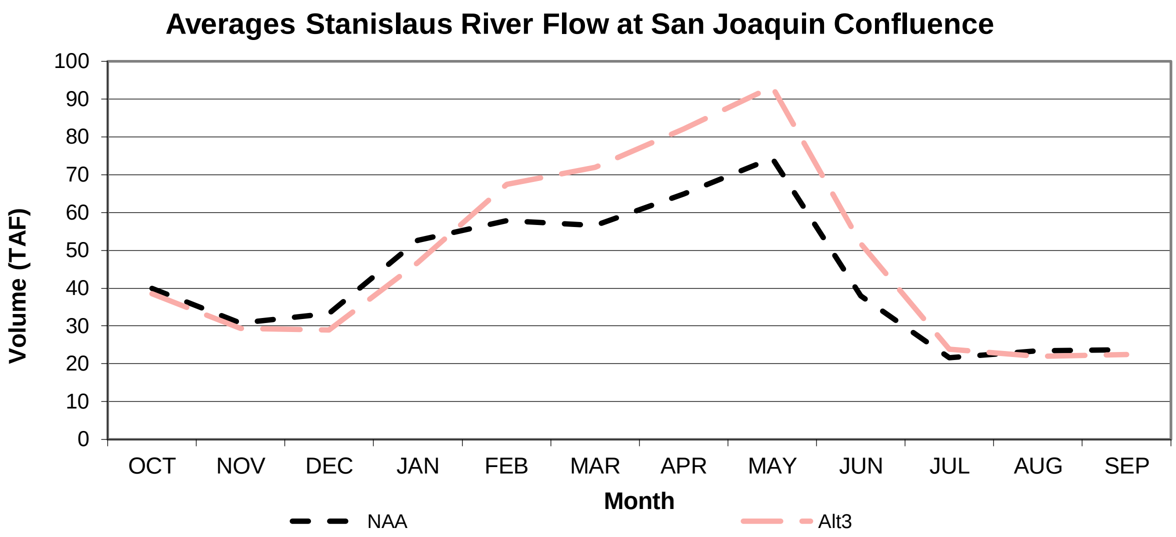


Figure 3-18. Stanislaus River Flow at Confluence with San Joaquin River.

In the months of February through June, Reclamation also would make releases from New Melones as necessary to contribute its share (29%) of meeting the 1,000 cfs minimum flow at Vernalis required in the Bay-Delta Water Quality Control Plan.

Reclamation would reduce deliveries to all CVP contractors to achieve a minimum EOS storage in New Melones Reservoir of 700 TAF.

3.5.6.2 Winter Instability Flows

This component is replaced by unimpaired inflow as minimum instream flows.

3.5.6.3 Spring Pulse Flows

This component is replaced by unimpaired inflow as minimum instream flows.

3.5.6.4 Fall Pulse Flows

This component is the same as Alternative 2.

3.5.7 San Joaquin River

This is the same as the No Action Alternative. Reclamation would continue implementation of the San Joaquin River Restoration Program as an independent related activity.

3.5.8 Monitoring

This component is the same as Alternative 1.

3.5.9 Special Studies

This component is the same as Alternative 1.

3.5.10 Drought

Similar to Alternative 2, however Alternative 3 prohibits the use of a TUCP. Alternative 3 does not include construction nor operation of the Drought Barrier in West False River.

Key drought measures analyzed from the drought toolkit include:

- Delta Cross Channel Gate Openings
- Winter-run Chinook salmon Hatchery Increased Adult Intake
- Curtailment Conditions
- SRS Contractors Meet and Confer Provisions
    - Delayed Rice Floodup
    - Delayed Water Transfers
- Spring Warmwater Power Bypass at Shasta Reservoir
- Summer/fall coldwater power bypass at Shasta Reservoir
- Fall Coldwater Power Bypass at Folsom Reservoir

3.5.11 Governance

This component is generally the same as Alternative 2, except that: (1) the management teams (e.g., Shasta Water Interagency Management Team, WOMT, Sacramento River Temperature and Flow Task Group) will be comprised solely of staff from federal and state agencies and Native American tribes; (2) fishery agencies (NMFS, USFWS, CDFW) will make final decisions regarding water project operations if the issue is not resolved in the management team process.

3.6 Alternative 4 – Risk Informed Operation

Alternative 4 provides alternative criteria for Shasta Reservoir and incorporates improved real-time information to support water deliveries in the Delta while limiting effects on listed species.

Reclamation would continue to operate each tributary with the same primary purposes as described in the Common Components seasonal operations. This alternative differs from No Action as summarized below and described in greater detail in *Appendix E - Draft Alternatives*.

Alternative 4b is derived from Alternative 4, but includes modifications developed by American River interested parties. These components are described below in Section 3.6.4.

Sensitivity studies show that changes resulting from Alternative 4b are within the range of effects modeled for Alternative 4. Moreover, Alternative 4B includes limitations such that the modifications to Folsom Reservoir operations do not result in impacts outside of those described for Alternative 4. *Appendix E – Draft Alternatives* include additional description of each of the components of Alternative 4B.

3.6.1 Sacramento River

On the Sacramento River, Reclamation would make releases from Shasta Reservoir for flood control, minimum instream flows, senior water rights, Delta requirements, and deliveries to CVP water service contractors.

3.6.1.1 Water Temperature Management

Reclamation would manage planned releases from Shasta Reservoir for water service contract deliveries to achieve an EOS storage of 2.0 MAF in Shasta Reservoir based on the 90% forecast unless a less conservative forecast requires more releases.

To address early season hydrologic uncertainty, Reclamation would limit the use of water under North of Delta Agricultural water service contractor allocations to no more than 30 TAF prior to the temperature management season and completion of a TMP.

If reductions to water service contracts would not achieve 2.0 MAF of storage in Shasta Reservoir by EOS, Reclamation would reduce releases for the Project Water component of the SRS Contractors' Contracts, resulting in diversions of ~60% of contract totals.

Alternative 4 includes drought toolkit actions such as Wilkins Slough Relief and relaxation of D-1641 water quality requirements that may improve the volume of coldwater pool and level of drought protection in Shasta Reservoir.

Reclamation would coordinate through governance to implement a water temperature management strategy that considers:

1. EOS Coldwater Pool
2. Minimization of modeled Temperature Dependent Mortality.

The water temperature management strategy would start with a 53.5°F temperature target at or downstream of CCR from May 15 through October 30 while preserving a projected EOS coldwater pool of 400 TAF. If projections show EOS coldwater pool cannot be achieved, the water temperature management strategy would relax water temperatures in the following order:

1. Target ≤56°F at CCR starting May 15 and delay the ≤53.5°F target to no later than June 15
2. Target June 16 temperatures ≤54°F at CCR through October 30
3. Relax end-of-October temperatures to ≤56°F daily to as early as October 1 and reduce the EOS coldwater pool target to 200 TAF
4. Increase June 16 through September 30 temperatures to ≤56°F
5. Reduce the EOS coldwater pool target and confer on additional drought toolkit actions.

Reclamation, through governance, would prepare a TMP consistent with requirements in WRO 90-5 and update the plan throughout the water temperature management season to improve water temperature conditions on or after June 16.

3.6.1.2 Fall and Winter Instream Flows

Fall and Winter Instream Flows under Alternative 4 are implemented as follows:

Table 3-16. Keswick Dam December through February Default Release Schedule determined by EOS Storage.

Keswick Release (cfs)	Shasta EOS Storage (MAF)
3,250	<2.4
4,000	≥2.4
4,500	≥2.8
5,000	≥3.2

EOS = end-of-September; cfs = cubic feet per second; MAF = million acre-feet.

3.6.2 Clear Creek

3.6.2.1 Minimum Instream Flows (Seasonally Variable Hydrograph)

Same as Alternative 2

3.6.2.2 Pulse Flows

Same as Alternative 2.

3.6.2.3 Water Temperature Management

Reclamation will target Whiskeytown Dam releases to not exceed the mean daily water temperatures at Igo gauge:

- 61°F from June 1 through August 15.
- 60°F from August 16 through September 15.
- 56°F from September 15 through November 15.

Water temperature management on Clear Creek is implemented through changes in guard gate configurations and flow manipulations. In dry, critical, or import curtailment years, Reclamation may not be able to meet these water temperatures and will operate Whiskeytown Dam as close to these temperatures as practicable.

3.6.3 American River

Reclamation will seek to develop and operate under a new ATSP, otherwise operations on the American River are the same as the No Action Alternative.

3.6.4 American River Alt4 B

Alternative 4b is derived from Alternative 4, but includes modifications developed by American River interested parties.

3.6.4.1 Minimum Instream Flows (Minimum Release Requirement)

Reclamation would adopt the minimum flow schedule outlined in the "2023 Updates and Refinements to the Lower American River 2017 Flow Management Standard Technical Memorandum" ("2023 MFMS"). The 2023 MFMS includes MRR ranges from 500 to 2000 cfs based on time of year and annual hydrology. The flow schedule is intended to improve coldwater pool and habitat conditions for steelhead and fall-run Chinook salmon.

Reclamation and the Water Forum would continue to review and update Folsom Reservoir's end-of-year Planning Minimum.

3.6.4.2 Water Temperature Management

By June 15, Reclamation, through Governance, will annually prepare a TMP as described under the No Action Alternative.

Reclamation will implement the ATSP described in the 2023 MFMS. Each ATSP schedule determines a monthly series of water temperature targets (for daily average water temperature) at the Watt Avenue Bridge. Schedule 1 has a water temperature upper limit of 63°F from May through September, and 56°F in October and November. Schedule 75 has a water temperature upper limit of 72°F from May through September, 65°F in October, and 58°F in November. Schedules 2 through 75 each represent a change in a single month's upper temperature limit by 1.0°F. The ATSP may be modified as described in Appendix E – Draft Alternatives.

3.6.5 Delta

3.6.5.1 Old and Middle River Flow Management

Reclamation and DWR will operate to the Hutton (2008) OMR index to allow for operational planning and real-time adjustments.

3.6.5.2 Start of OMR Management

Reclamation and DWR will reduce exports to achieve OMR no more negative than -5,000 cfs when one or more of the following conditions have occurred:

"First Flush"

In addition to the reduction in exports described in the No Action Alternative, Reclamation and DWR may initiate the "first flush" if, through Governance, monitoring indicates a high risk of migration and dispersal of smelt into areas at high risk of future entrainment. "First Flush" may be offramped to OMR no more negative than -5,000 cfs if the San Joaquin River at Vernalis is flowing at 10,000 cfs or more.

Delta Smelt Salvage

After December 1 if the Enhanced Delta Smelt Monitoring Program observes Delta smelt in the lower San Joaquin River and Southern Delta region or if any salvage of Delta smelt occurs. Reclamation and DWR, through Governance, may cease OMR restrictions related to this trigger or adjust the trigger requirements if hatchery release and monitoring data indicate that Delta smelt catch within the south Delta represent less than 5% of the overall catch.

Adult Longfin Salvage

After December 1 if monitoring data indicates that longfin smelt catch within the south Delta represent greater than or equal to 5% of the overall catch or if any salvage of longfin smelt occurs. Reclamation and DWR, through Governance, may cease OMR restrictions related to this trigger if monitoring data (e.g., Enhanced Delta Smelt Monitoring Program, Bay Study, Fall Midwater Trawl) indicate that longfin smelt catch within the south Delta represent <5% of the overall catch.

Juvenile Salmonid Salvage

After December 1, Reclamation and DWR, through Governance, may incorporate additional or different predictive models as necessary to improve the onset of OMR management season for salmonid species if any of the following occurs:

- Gaeta et al.'s (2023) machine learning model predicts one week in advance the presence of winter-run length-at-date juvenile Chinook salmon across all 30 submodels, or
- salvage of genetically confirmed juvenile winter-run or spring-run Chinook salmon, or
- annual cumulative loss total reaches 60 or above for wild Central Valley steelhead.

3.6.5.3 Real-time Adjustments

In addition to "First Flush", additional restrictions use real-time monitoring to identify an increased risk of entrainment. Reclamation and DWR will manage to a more positive OMR than -5,000 cfs under the following conditions:

Adult Delta Smelt Turbidity Protection

Reclamation and DWR would manage exports to OMR no more negative than -2,000 cfs when daily average turbidity at both Holland Cut, and Old River at Bacon Island are at or above 12 FNU. Reclamation and DWR will maintain OMR at no more negative than -2,000 cfs for one week, and then no more negative than -3,500 cfs until measured daily average turbidity at both sensors are less than 12 FNU, or as revised through Governance.

Adult Delta smelt protection will off-ramp when three-day average water temperature at Jersey Point reaches 59ºF. This off ramp will be based on data from the San Joaquin River at Jersey Point averaged over three days.

Delta Smelt Larvae and Juveniles Protection

Larval and juvenile Delta smelt management period will initiate when detected within the entrainment zone based on real-time sampling, or adult Delta smelt protection has off-ramped based on water temperature, whichever comes first. The presence of Delta smelt larvae and juveniles can also be identified through a detection of spent adult females in survey or salvage.

Reclamation and DWR will restrict exports to allow OMR no more negative than -3,500 cfs when Secchi depth average measurement is equal or less than one meter.

Longfin Smelt Larvae and Juveniles Protection

Recent studies indicated that regulations limiting Delta export for salmonids and Delta smelt since 2008-2009 have been protective for populations of longfin smelt.

Winter-Run Annual Cumulative Loss Thresholds

Reclamation and DWR will manage OMR to remain below the total annual loss thresholds for genetically-verified winter-run Chinook salmon at the Tracy and Skinner fish facilities:

- **Natural Winter-run Chinook salmon:** Salvage Loss <0.5% of JPE (same as the No Action Alternative)
- **Hatchery Winter-run Chinook salmon:** Salvage Loss <0.5% of JPE

JPE will be calculated using O'Farrell et al. (2018). Reclamation and DWR will use then-current monitoring of juvenile passage at Red Bluff Diversion Dam. Reclamation and DWR may update the JPE through Governance. Loss shall be calculated using the equation provided in CDFW (2018).

During the brood year, if at any time cumulative loss of natural or hatchery winter-run Chinook salmon exceed the total annual loss threshold, DWR and Reclamation shall restrict south Delta exports to maintain an OMR value of no more negative than -3,500 cfs for 14 days. Reclamation and DWR, through Governance, will also develop, implement, and update weekly an OMR schedule for the rest of the OMR management season to avoid further exceeding the annual loss thresholds using entrainment prediction tools and documented in an assessment.

Winter-Run Chinook Salmon High Salvage Avoidance

Reclamation and DWR will reduce exports to achieve OMR of no more negative than -3,500 cfs for at least seven days when Gaeta et al.'s (2023) machine learning model predicts one week in advance the high presence of winter-run length-at-date juvenile Chinook salmon across all 30 submodels. High presence is defined as seven-day moving average of more than 4.29 winter-run Chinook salmon expanded salvage at the salvage facilities. This action can only occur in the months of February, March, and April. OMR would continue to be managed to be no more negative than -3,500 cfs for longer than seven days until Gaeta et al.'s (2023) model no longer predicts high presence across all submodels.

Spring-Run Chinook Salmon Surrogate Thresholds

Reclamation and DWR will reduce exports to achieve OMR no more negative than -3,500 cfs for seven days the first instance cumulative salvage loss of a release group equals or exceeds 0.5% of the releases group at Delta entry.

Reclamation and DWR, through Governance, will develop the locations and times of in-river surrogate releases to best represent natural juvenile spring-run Chinook salmon migration into the Sacramento River and Delta. The percentage of the release group at Delta entry will be determined by survival from the release site to the Delta, similar to the development of the winter-run Chinook salmon JPE.

Steelhead Salvage Loss Thresholds

Same as Alternative 2.

3.6.5.4 Stormflex

Reclamation and DWR may operate to an OMR no more negative than -6,250 cfs to capture peak flows during storm-related events when no backstop conditions are triggered and following conditions are met:

- The Delta is in excess conditions as defined in 2018 amendment to the COA, and
- QWEST is greater than 0.

DWR and Reclamation, through Governance, will use estimates of the real-time distribution of winter-run Chinook salmon, Particle Track Model, and prediction tool output to assess potential winter-run Chinook salmon entrainment risk differences using OMR inputs of -5000, and -6250 cfs. If the assessment indicates that additional entrainment protections are unlikely to be triggered, Reclamation and DWR may operate to OMR no more negative than -6,250 cfs and will update the assessment no less than weekly.

If conditions indicate a backstop condition is likely to trigger, Reclamation and DWR will resume OMR no more negative than -5,000 cfs. If a backstop condition is triggered, Reclamation and DWR will cease storm-flex and implement the backstop.

3.6.5.5 End of OMR Management

Same as Alternative 2

3.6.5.6 Spring Delta Outflow

Same as Alternative 2.

3.6.5.7 Barker Slough

Same as Alternative 2.

3.6.5.8 Delta Smelt Summer and Fall Habitat

Same as Alternative 2.

3.6.5.9 Delta Smelt Supplementation

Same as Alternative 2.

3.6.5.10 Bernice Frederic Sisk Dam Raise and Reservoir Expansion

This component is the same as Alternative 1.

3.6.6 Stanislaus River

This alternative differs from the No Action Alternative as described below.

3.6.6.1 Minimum Instream Flows

This component is the same as Alternative 2.

3.6.6.2 Fall Pulse Flows

This component is the same as Alternative 2.

3.6.6.3 Fall Pulse Flows

This component is the same as Alternative 2.

3.6.7 San Joaquin River

This is the same as the No Action Alternative. Reclamation would continue implementation of the San Joaquin River Restoration Program.

3.6.8 Monitoring

This component is the same as Alternative 1.

3.6.9 Special Studies

This alternative does not include species studies; however, Reclamation's science enterprise will continue through separate environmental compliance and future plans as independent programs.

3.6.10 Governance

Reclamation and DWR would coordinate with CDFW, NMFS, USFWS, tribes, and interested parties specific to the operation of the CVP and SWP through two main processes, as shown in Figure 3-19.

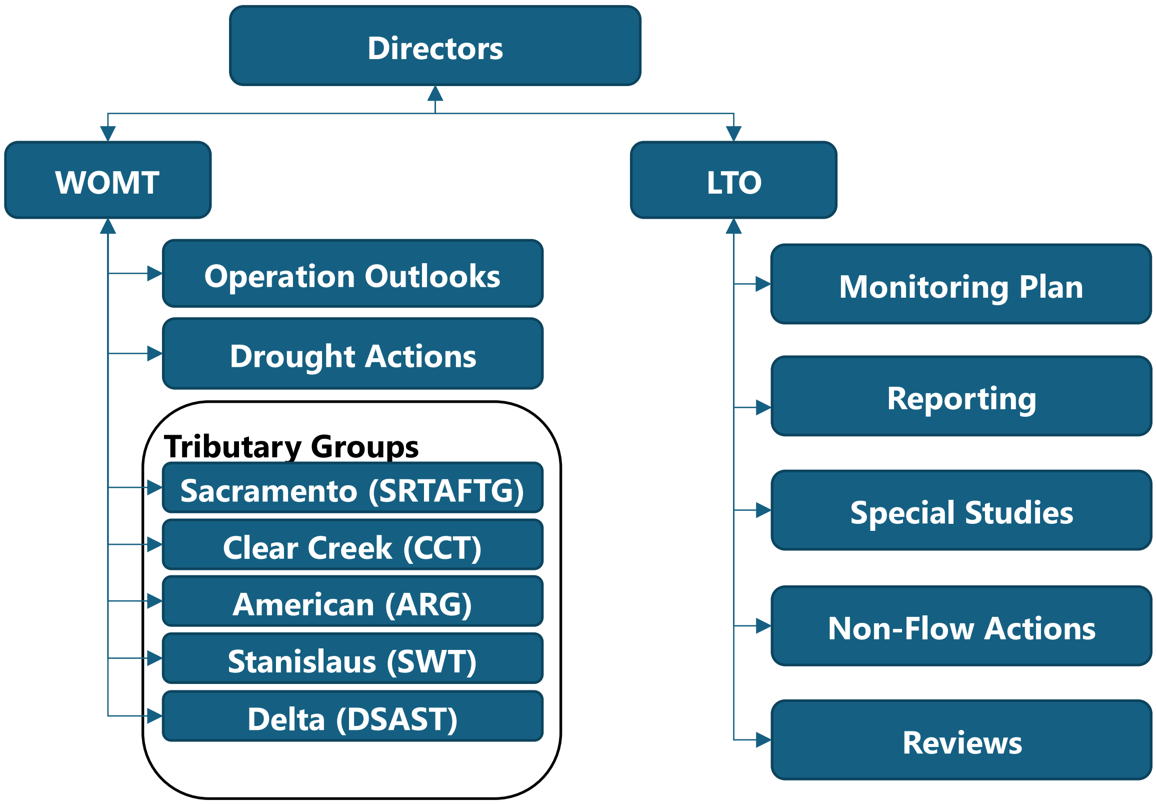


Figure 3-19. Governance Structure

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Chapter 4 Water Quality

This chapter is based on the background information and technical analysis documented in Appendix G, *Water Quality Technical Appendix*, which includes additional information on water quality conditions and technical analysis of the effects of each alternative.

4.1 Affected Environment

Changes in water quality due to changes in the Central Valley Project (CVP) and State Water Project (SWP) operation may occur in the Trinity River, Sacramento River, Clear Creek, American, Stanislaus, and San Joaquin rivers, San Francisco Bay/Sacramento–San Joaquin Delta (Bay-Delta), and the CVP/SWP service area (south to Diamond Valley).

The "Bay-Delta" region includes the legal Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay. Primary factors affecting water quality in the Delta, Suisun Marsh, and Suisun Bay include patterns of land use in the upstream watersheds; inter-annual hydrologic variations; operations of the SWP, CVP, and flow control gates within the Delta and marsh; and activities and sources of pollutants within and upstream of these water bodies. Point and nonpoint pollutant sources include drainage from inactive and abandoned mines and related debris/sediment from headwaters, industrial and municipal wastewater treatment plant discharges, agricultural return flows, urban storm water runoff, atmospheric deposition, recreational uses, and metabolic waste from wildlife and livestock. Natural erosion, in-stream sediments, and atmospheric deposition also affect water quality. The magnitude of each source's effect correlates with the relative contribution from each source at a given location and can differ by constituent or with hydrologic and climatic conditions during different times of year, and from year to year.

The San Francisco Bay water quality is similarly affected by upstream land uses; hydrologic variations; pollutant source input from municipal wastewater discharges, agricultural return flows, urban runoff, and mining activities; and recreational uses. The northern and central portions of San Francisco Bay are strongly influenced by freshwater Delta inputs, whereas the southern portion of the bay is often dominated by ocean water and is generally isolated from the northern portion.

4.2 Effects of the Alternatives

The impact analysis considers changes in water quality conditions related to changes in CVP and SWP operation under the alternatives as compared with the No Action Alternative.

The No Action Alternative is based on 2040 conditions. Changes that would occur over that time frame without implementation of the action alternatives are not analyzed in this chapter. However, the changes to water quality that are assumed to occur by 2040 under the No Action Alternative are summarized in this section.

Conditions in 2040 would be different than existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

In the long term, it is anticipated that climate change, and development throughout California, could affect water supply deliveries.

Under the No Action Alternative, Reclamation would continue with the current operation of the Central Valley Project (CVP), as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the State Water Project (SWP) represent current management direction or intensity pursuant to 43 CFR Section 46.30.

Although the No Action Alternative included habitat restoration projects at a programmatic level, the 2020 ROD did not provide environmental coverage for these projects, and all of the habitat projects considered under the No Action required or will require additional environmental documentation. Thus, ground disturbance for habitat restoration projects did not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

Under the No Action Alternative, land uses in 2040 would occur in accordance with adopted general plans, which could also result in impacts on water quality. In terms of CVP operations, under the No Action Alternative, by the end of September, the surface water elevations at CVP reservoirs generally decline. It is anticipated that climate change would result in more short-duration high-rainfall events and less snowpack in the winter and early spring months. As water is released in the spring, there would be less snowpack to refill the reservoirs. This condition would reduce flow within streams, potentially resulting in less dilution of constituents of concern. Since this water is delivered to reservoirs for storage in CVP and SWP reservoirs, concentrations of constituents of concerns in reservoirs may increase.

The No Action Alternative is expected to result in potential changes water quality at reservoirs that store CVP water, tributaries, and agricultural land. These changes were described and considered in the 2020 Long-Term Operation Record of Decision and associated documents.

4.2.1 Trinity, Sacramento, and American Rivers and Clear Creek

As documented in Appendix E, *Draft Alternatives*, Alternatives 1 through 4 would have limited changes in flows on the Trinity River compared with the No Action Alternative; therefore, changes in flows would have limited potential to affect water quality.

Under Alternative 1, long-term average flow changes on the Sacramento River are not expected to deviate substantially from the No Action Alternative. While Alternative 1 would create flow changes, including decreases of up to 20%, in the Sacramento River, the flow changes would largely occur during wet and above normal water years when base flow is adequate and decreases in flow are not expected to cause violations of water quality standards. Changes in flow in the Sacramento River under Alternatives 2, 3, and 4 generally increase in winter and early spring and decrease during the summer months. As flow increases are beneficial to water quality because it dilutes constituents of concern, flow decreases are not expected to be large enough to negatively impact water quality and increase the frequency of exceedances of water quality thresholds in the Sacramento River.

Flows in Clear Creek under Alternative 1 would decrease compared with the No Action Alternative because Alternative 1 does not include specific winter or spring pulse flows. It is expected that flows in Clear Creek would decrease in all months of all water year types, with a maximum average decrease of approximately 84% in June. Figure 4-1 illustrates changes in flow under all alternatives. Reductions in flow due to changes in the operations of CVP/SWP under Alternative 1 could result in less dilution causing increased concentrations of mercury within Clear Creek compared with the No Action Alternative. Changes in flow in Clear Creek under Alternatives 2, 3, and 4 would generally increase in the winter and spring months and decrease during the summer and fall months as compared with the No Action Alternative. Reductions in flow due to changes in the operations of CVP/SWP under Alternatives 2, 3, and 4 could result in less dilution causing increased concentrations of mercury within Clear Creek in certain months and year types compared with the No Action Alternative.

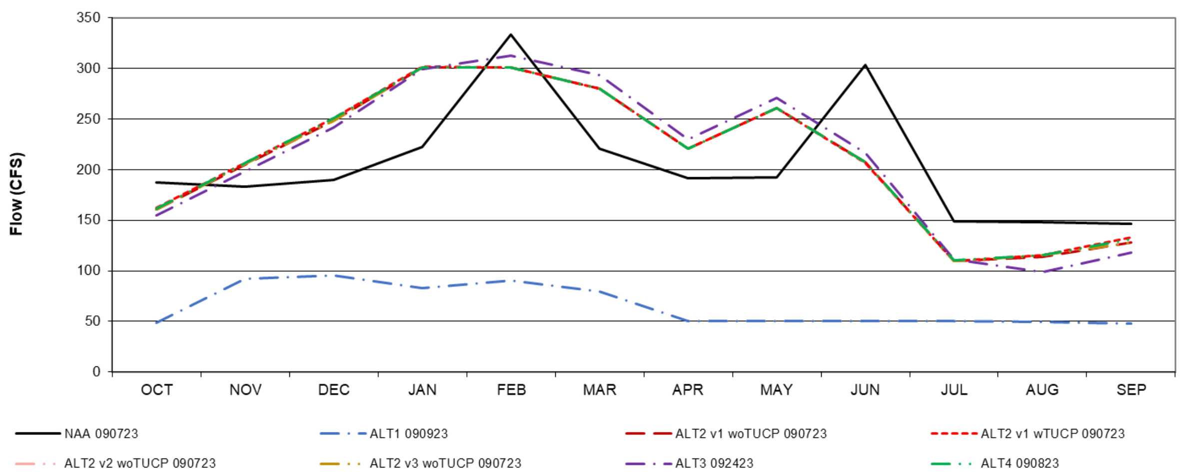

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Figure 4-1. Clear Creek Flow below Whiskeytown, Long-Term Average Flow

Flows on the American River would differ from those under the No Action Alternative, with the largest flow increases and decreases under Alternatives 1, 2, and 4 in dry and critical years. Based on modeling, the maximum average increase in flows on the American River at H Street would be during critical water years under Alternative 2, when flows would be expected to increase by up to 110% in some months. The maximum average decrease in flows would be during September of dry water years under Alternative 1, when flows are expected to decrease by 57%. Alternative 3 would bypass 55% of unimpaired inflows to Folsom Reservoir from December through May, which may shift the timing of releases from Folsom Reservoir. The largest flow decreases would be in June of above normal water years and the largest flow increases would be in December of critical water years. Figure 4-2 through Figure 4-3 illustrate flow changes on the American River at H Street under dry and critical years, respectively.

Alternative 4B is expected to be within the range of effects for water quality described for Alternatives 4.

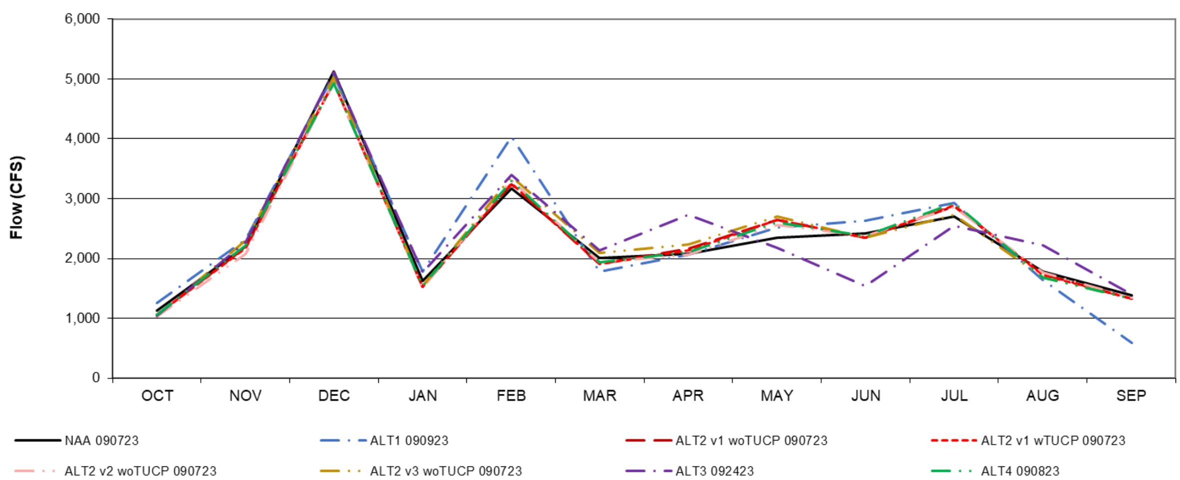

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Figure 4-2. American River at H Street, Dry Year Average Flow

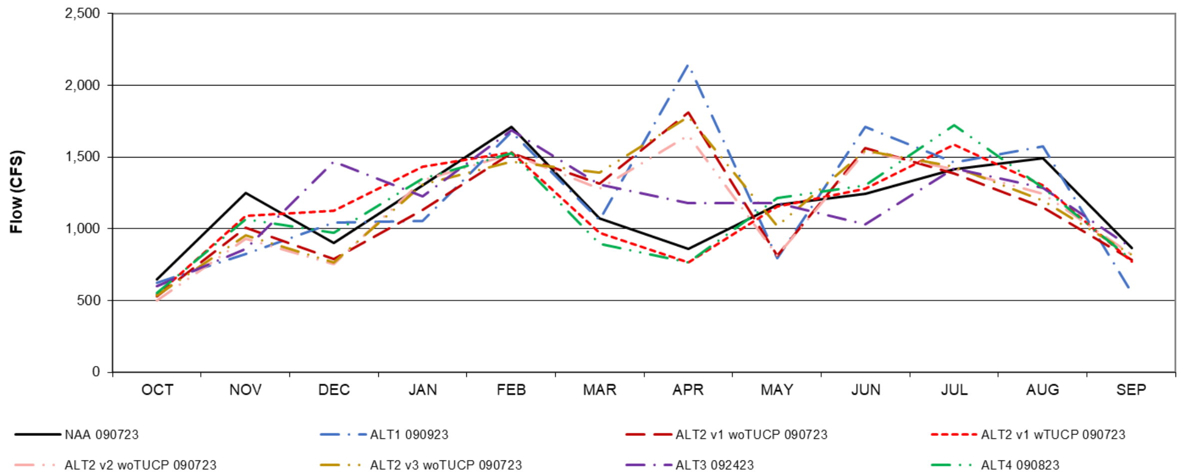

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Figure 4-3. American River at H Street, Critical Year Average Flow

4.2.2 Stanislaus and San Joaquin Rivers

Alternatives 1 through 4 would cause changes in flow in some water year types on the Stanislaus River relative to the No Action Alternative. Figure 4-4 through Figure 4-9 show changes in flow below Goodwin Dam across all water year types for all alternatives. Changes in flow at the mouth of Stanislaus River follow a similar trend but are generally smaller. Alternative 1 would change flows on the Stanislaus River, with the largest flow decrease (approximately 77%) in October of critical water years and the largest flow increase (approximately 74%) in November of below normal water years. Across all four phases of Alternative 2, changes in flow in the Stanislaus River below Goodwin Dam would generally decrease in October, January, and March through June, with flows increasing in all other months when compared with the No Action Alternative. Under Alternative 3, the largest flow decrease (approximately 77%) would be in December of below normal water years, and the largest flow increase (approximately 74%) would be in February of dry water years. Changes in flow under Alternative 4 would be similar to those under Alternative 2 because Alternative 4 includes the same minimum instream flow requirements, winter instability flows, and fall pulse flows.

As mentioned in Section G.1.7, *Stanislaus River*, there are several constituents of concern within the Stanislaus River, resulting in contamination in all reaches of the river. At times when flow increases, water quality could improve as more water is available to dilute pesticide runoff. Reductions in flow due to changes in the operations of CVP/SWP could result in less dilution causing increased concentrations of constituents of concern compared with the No Action Alternative.

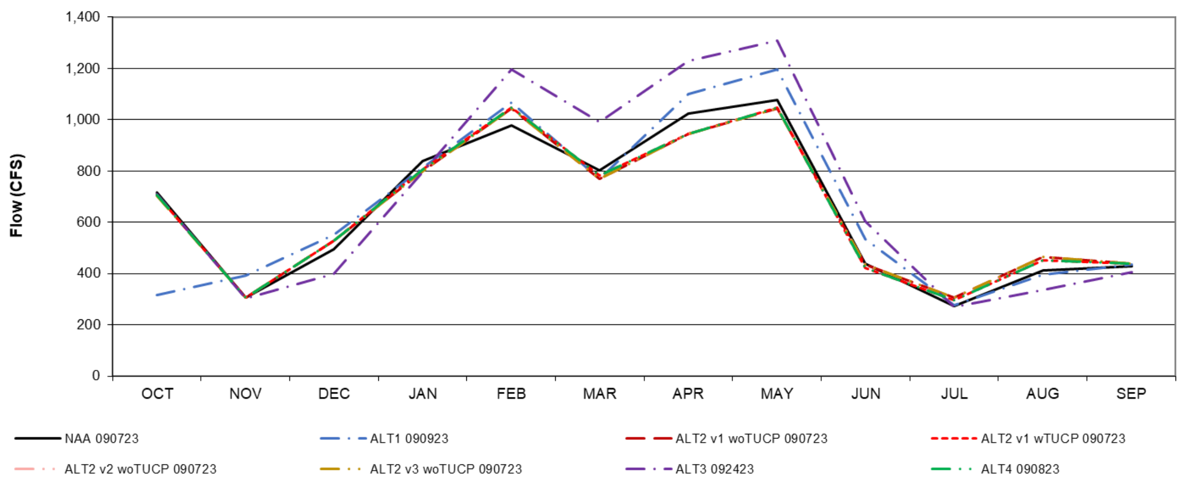

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Figure 4-4. Stanislaus River Flow below Goodwin, Long-Term Average Flow

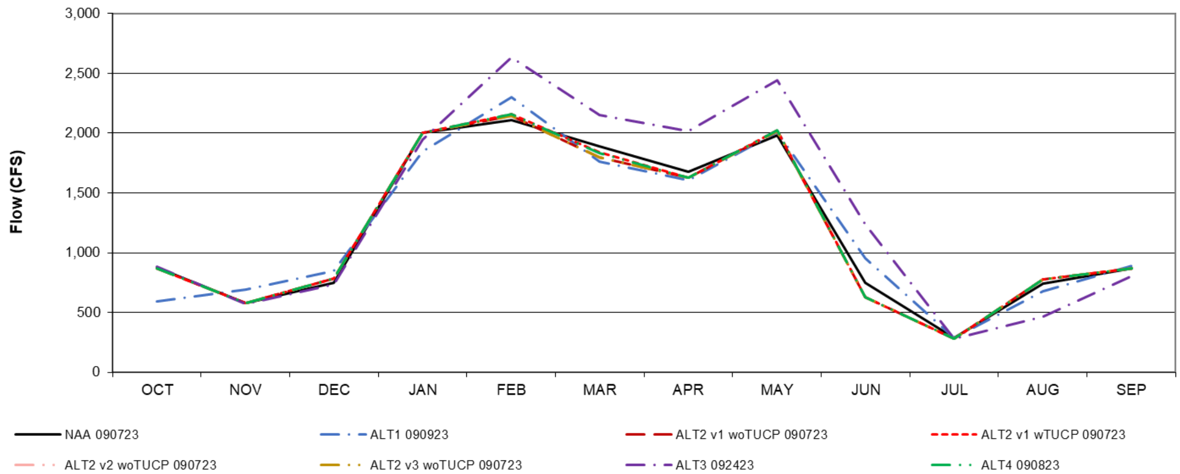

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Figure 4-5. Stanislaus River Flow below Goodwin, Wet Year Average Flow

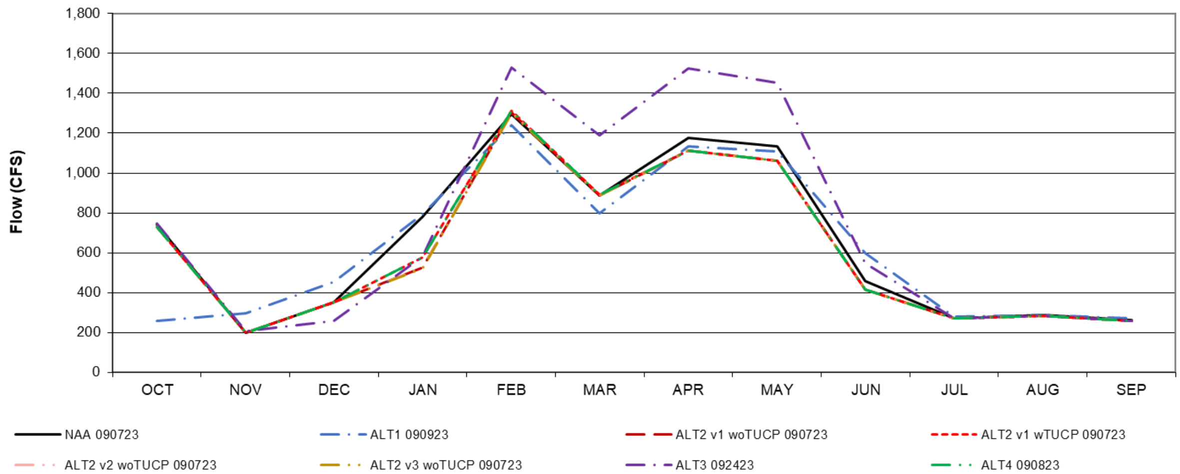

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Figure 4-6. Stanislaus River Flow below Goodwin, Above Normal Year Average Flow

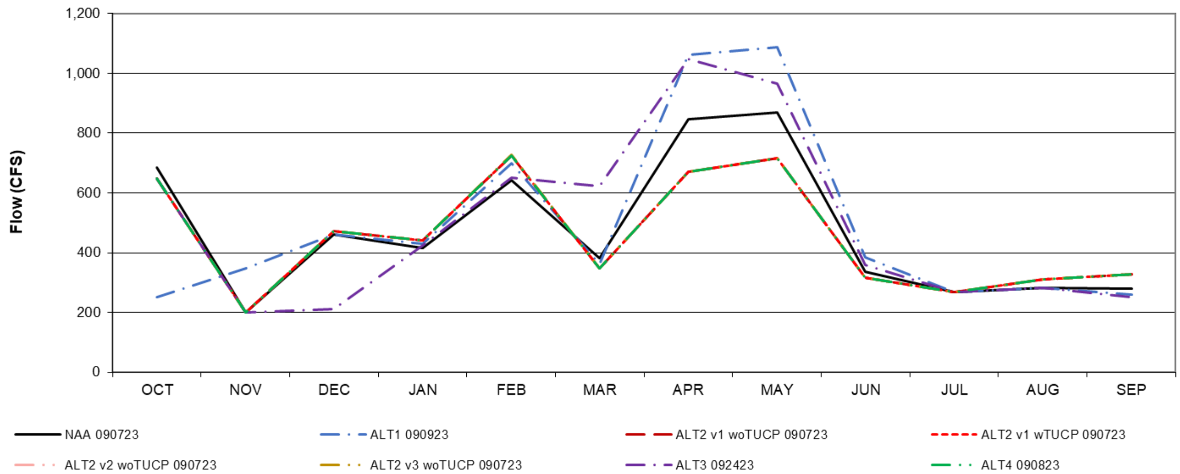

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Figure 4-7. Stanislaus River Flow below Goodwin, Below Normal Year Average Flow

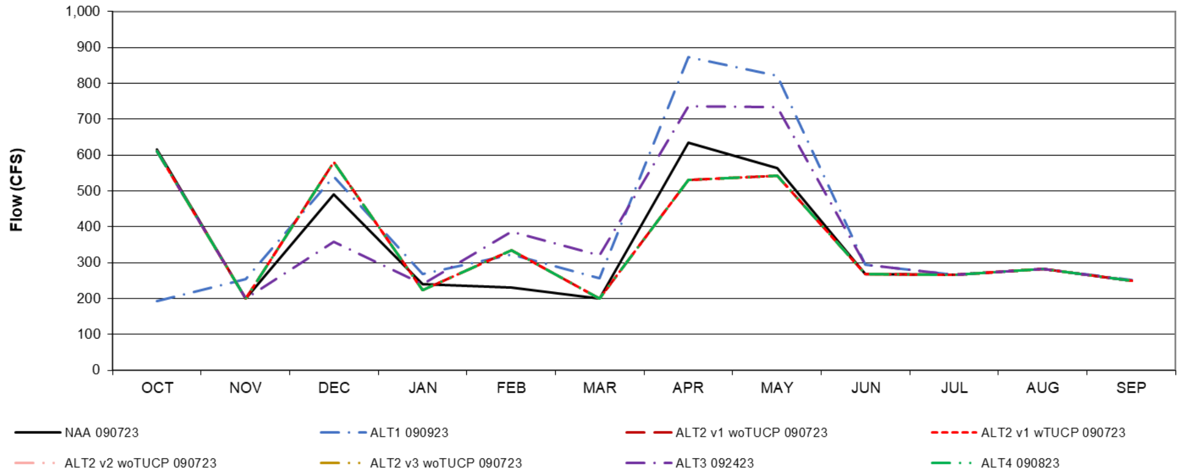

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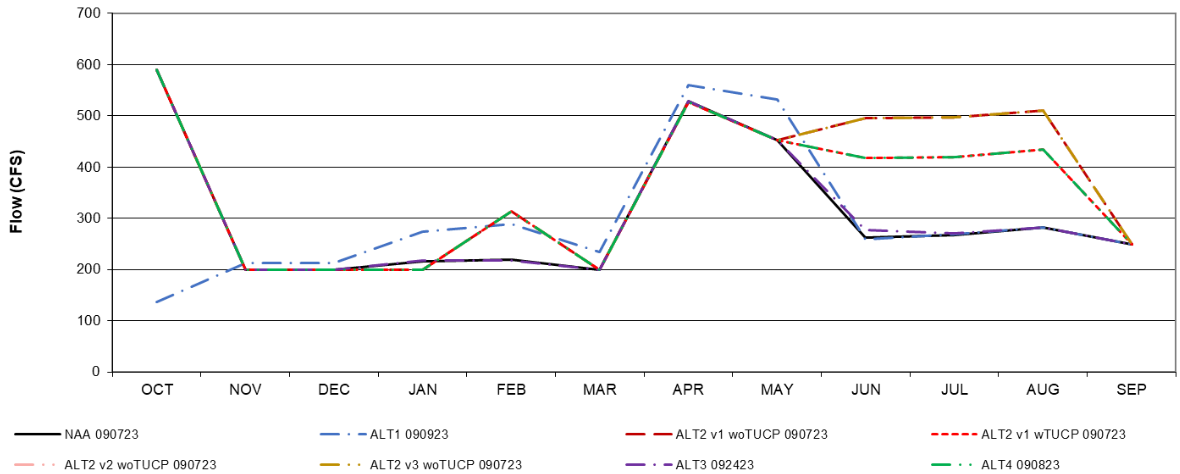
Figure 4-8. Stanislaus River Flow below Goodwin, Dry Year Average Flow



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*These results are displayed with water year – year type sorting.
*These are draft results and meant for qualitative analysis are subject to revision.
*cfs- cubic feet per second; NAA- No Action Alternative; ALT1 090923- Alternative 1 (Water Quality Control Plan); ALT2 v1 woTUCP 090723- Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition); ALT2 v1 wTUCP 090723- Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition); ALT2 v2 woTUCP 090723- Alternative 2 (Multi-Agency Consensus- Early Implementation Voluntary Agreements); ALT2 v3 woTUCP 090723- Alternative 2 (Multi-Agency Consensus- All Voluntary Agreements); ALT3 092423- Alternative 3 (Modified Natural Hydrograph); ALT4 090823- Alternative 4 (Risk Informed Operations)

Figure 4-9. Stanislaus River Flow below Goodwin, Critical Year Average Flow

Flows in the San Joaquin River at Vernalis would remain similar between the No Action Alternative and Alternatives 1, 2, and 4. The small changes in flows under these alternatives would have minimal effect on the concentrations of constituents of concern. The greatest flow change in the San Joaquin River would be at Vernalis under Alternative 3, where flows would decrease by a maximum of 22%. This change in flow under Alternative 3 would not likely result in adverse effects on water quality nor an increase in the frequency of exceedances of water quality thresholds in the San Joaquin River.

4.2.3 Bay-Delta

For most constituents and constituent groups of concern, water quality within the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay under the action alternatives would not differ substantially from the No Action Alternative or differ in a way that would contribute to adverse effects on beneficial uses compared with No Action Alternative conditions. The constituents for which there would be an appreciable difference in water quality under at least one of the action alternatives relative to the No Action Alternative are the salinity-related parameters electrical conductivity (EC), chloride, bromide, methylmercury, and cyanobacteria harmful algal blooms (CHABs).

Alternative 2B

Analysis of Alternative 2B, although qualitative, builds on the quantitative analysis provided for Alternative 2. Only components under Alternative 2B that are expected to result in water quality changes compared to Alternative 2 are discussed.

Alternative 2b is anticipated to be more restrictive than Alternative 2 and the No Action Alternative on Delta exports. Please see Chapter 5, *Water Supply,* for a description of the restrictions associated with the QWEST criteria under Alternative 2B. These restrictions on exports may result in increased outflow and a potential less adverse impact to water quality because of dilution capability of constituents of concern.

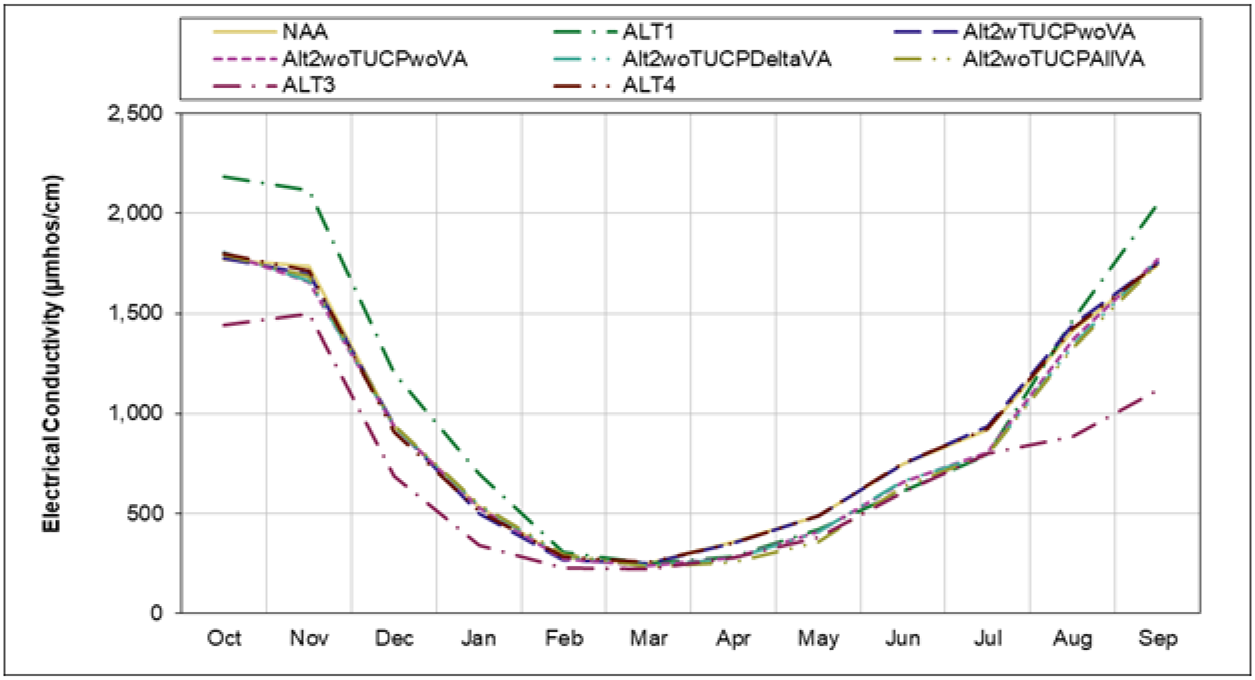
In addition to the more restrictive QWEST criteria, Alternative 2B includes an extension of the CCF operation period to December 1 through March 31 from mid-December through mid-March, effectively increasing the operation of the SWP by one month. This expansion may result in more frequently meeting seasonal thresholds, and also meeting weekly thresholds that may not have otherwise been met. Meeting these thresholds would result in additional export restriction under Alternative 2B that would result in increased outflow. Increased outflow could translate in less potential adverse impact to water quality because of dilution capability. On the other hand, an increase in water supply could materialize in the event that the thresholds are not met during the extended operation of CCF under Alternative 2B. Then, Alternative 2B would result in additional exports that may decrease outflow and reduce dilution capability of constituents of concern.

4.2.3.1 Electrical Conductivity

Under Alternative 1, modeled monthly average EC levels are substantially higher in the San Joaquin River at Jersey Point, Prisoners Point and San Andreas Landing, and the Sacramento River at Emmaton and Threemile Slough are substantially higher in September, October and November compared with the No Action Alternative. Modeled EC levels at other Delta assessment locations are similar to the No Action Alternative. Modeled EC for the Suisun Marsh assessment locations is also higher in these months under Alternative 1. Alternatives 2 and 4 modeled monthly average EC levels at Delta and Suisun Marsh assessment locations are similar to the No Action Alternative. Alternative 3 modeled EC is lower than No Action Alternative EC levels for western Delta locations and similar to the No Action Alternative for other Delta locations. No substantial differences in Suisun Bay or San Francisco Bay are expected with any of the alternatives.

An example of EC levels under the alternatives is shown in Figure 4-10. As shown in Figure 4-10, the modeled average EC levels under Alternative 1 for the full simulation period are approximately 100–400 µmhos/cm higher than the No Action Alternative in September through January. Conversely, under Alternative 3, modeled EC levels at Emmaton are approximately 300–600 µmhos/cm lower in September through November, on average, and lower in most months compared with the No Action Alternative. Modeled EC levels for Alternatives 2 and 4 are similar to the No Action Alternative.

For all alternatives, the CVP/SWP would operate in real-time to meet the Bay-Delta Plan EC objectives, which aim to protect beneficial uses. Thus, these alternatives are not expected to contribute to salinity-related impairments.



*NAA- No Action Alternative; ALT1 090923- Alternative 1 (Water Quality Control Plan); ALT2 v1 woTUCP 090723- Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition); ALT2 v1 wTUCP 090723- Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition); ALT2 v2 woTUCP 090723- Alternative 2 (Multi-Agency Consensus- Early Implementation Voluntary Agreements); ALT2 v3 woTUCP 090723- Alternative 2 (Multi-Agency Consensus- All Voluntary Agreements); ALT3 092423- Alternative 3 (Modified Natural Hydrograph); ALT4 090823- Alternative 4 (Risk Informed Operations); µmhos/cm- micromhos per centimeter

Figure 4-10. Long-Term Monthly Average EC for the Sacramento River at Emmaton for Water Years 1922–2021

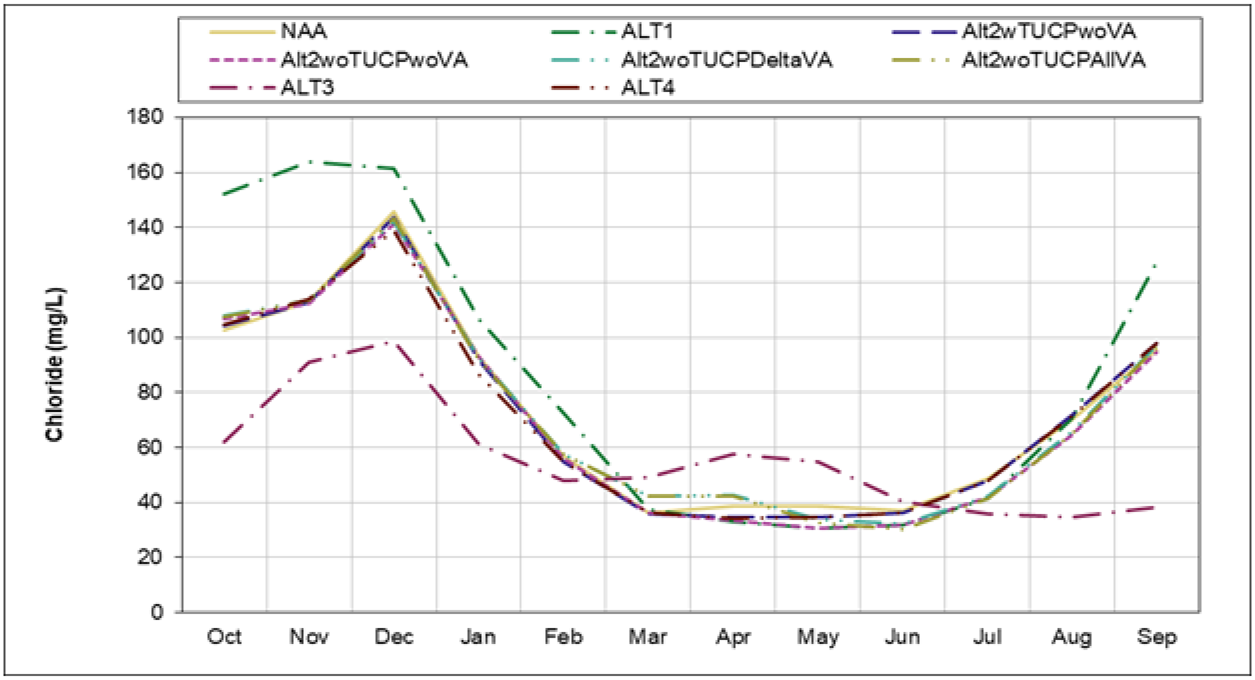
4.2.3.2 Chloride

Under Alternative 1, modeled monthly average chloride concentrations at Contra Costa Pumping Plant #1 and San Joaquin River at Antioch are substantially higher in September, October and November compared with the No Action Alternative. Modeled chloride concentrations at other Delta assessment locations—Barker Slough, and Banks and Jones pumping plants—are more similar to the No Action Alternative under Alternative 1. For Alternatives 2 and 4, modeled monthly average concentrations at the Delta assessment locations are similar to the No Action Alternative. For Alternative 3, modeled monthly average chloride concentrations are substantially lower than the No Action Alternative in the fall months and more similar to the No Action Alternative in other months.

An example of chloride concentrations under the alternatives is shown in Figure 4-11. As shown in Figure 4-11, the modeled long-term average concentrations under Alternative 1 are approximately 30–50 mg/L higher than the No Action Alternative in September through

November. Conversely, Alternative 3 modeled long-term average chloride concentrations are approximately 20–60 mg/L lower in September through November, and lower in most months compared with the No Action Alternative. Modeled chloride concentrations for Alternatives 2 and 4 are similar to the No Action Alternative.

For all alternatives, the CVP/SWP would operate in real-time to meet the Bay-Delta Plan chloride objectives, which aim to protect beneficial uses. Thus, these alternatives are not expected to contribute to beneficial use impairments related to chloride.



*NAA- No Action Alternative; ALT1 090923- Alternative 1 (Water Quality Control Plan); ALT2 v1 woTUCP 090723- Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition); ALT2 v1 wTUCP 090723- Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition); ALT2 v2 woTUCP 090723- Alternative 2 (Multi-Agency Consensus- Early Implementation Voluntary Agreements); ALT2 v3 woTUCP 090723- Alternative 2 (Multi-Agency Consensus- All Voluntary Agreements); ALT3 092423- Alternative 3 (Modified Natural Hydrograph); ALT4 090823- Alternative 4 (Risk Informed Operations); mg/L- milligrams per liter

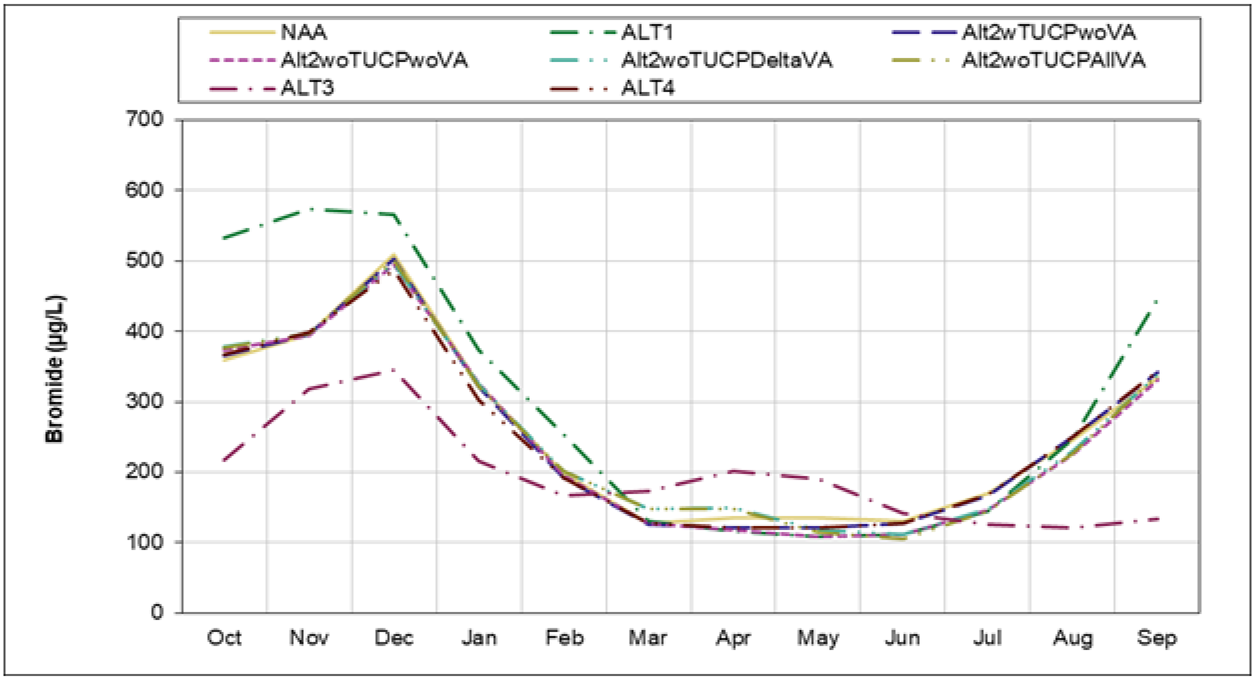
Figure 4-11. Long-Term Monthly Average Chloride for Contra Costa Pumping Plant #1 for Water Years 1922–2021

4.2.3.3 Bromide

Under Alternative 1, modeled monthly average bromide concentrations at Contra Costa Pumping Plant #1 and San Joaquin River at Antioch are substantially higher in September through February compared with the No Action Alternative. Modeled bromide concentrations at other Delta assessment locations—Barker Slough, and Banks and Jones pumping plants—are more similar to the No Action Alternative under Alternative 1. For Alternatives 2 and 4, modeled monthly average concentrations at the Delta assessment locations are similar to the No Action Alternative. For Alternative 3, modeled monthly average bromide concentrations are substantially lower than the No Action Alternative in the fall months and more similar to the No Action Alternative in other months.

An example of bromide concentrations under the alternatives is shown in Figure 4-12. As shown in Figure 4-12, the modeled long-term average concentrations under Alternative 1 are approximately 100–200 µg/L higher than the No Action Alternative in September through November, and 50 µg/L higher in December through February. Conversely, Alternative 3 modeled long-term average bromide concentrations are approximately 100–200 µg/L lower in September through January, and lower in most months compared with the No Action Alternative. Modeled chloride concentrations for Alternatives 2 and 4 are similar to the No Action Alternative.

To meet current drinking water regulations for disinfection byproducts, bromide from 100 to 300 µg/l (and total organic carbon from 4 to 7 mg/l) is acceptable to provide users adequate flexibility in their choice of treatment method (Appendix G, Attachment 3, Section G3.3, *Applicable Water Quality Objectives*). The potentially higher bromide concentrations under Alternative 1, relative to the No Action Alternative, could result in greater potential for disinfection byproduct formation in drinking water supplies that use Delta source waters, but the degree to which this would occur is uncertain. Treatment plants that use the Delta as a source for drinking water already experience highly variable bromide concentrations and, thus, must implement appropriate treatment technologies to ensure compliance with drinking water regulations for disinfection byproducts. However, the higher bromide concentrations under the Alternative 1, relative to the No Action Alternative, at specific times and locations, are of a magnitude of concern such that they could contribute to drinking water impairments relative to those that would occur under the No Action Alternative.



*NAA- No Action Alternative; ALT1 090923- Alternative 1 (Water Quality Control Plan); ALT2 v1 woTUCP 090723- Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition); ALT2 v1 wTUCP 090723- Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition); ALT2 v2 woTUCP 090723- Alternative 2 (Multi-Agency Consensus- Early Implementation Voluntary Agreements); ALT2 v3 woTUCP 090723- Alternative 2 (Multi-Agency Consensus- All Voluntary Agreements); ALT3 092423- Alternative 3 (Modified Natural Hydrograph); ALT4 090823- Alternative 4 (Risk Informed Operations); µg/L- microgram per liter

Figure 4-12. Long-Term Monthly Average Bromide for Contra Costa Pumping Plant #1 for Water Years 1922–2021

4.2.3.4 Methylmercury

Water column methylmercury concentrations and methylmercury bioaccumulation in biota the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be substantially affected and existing impairments would not be made worse relative to the No Action Alternative for Alternatives 1, 2, and 4. Modeled total methylmercury concentrations in largemouth bass fillets, presented in Table 4-1, show little difference for these alternatives compared with the No Action Alternative. For Alternative 3, modeled changes in total methylmercury concentrations at all Delta assessment locations indicate this alternative may result in increased Delta, Suisun Bay, and San Francisco Bay water column methylmercury concentrations that could substantially degrade water quality such that methylmercury bioaccumulation in biota the Delta, Suisun Bay, and San Francisco Bay may be affected, and existing impairments could be made worse relative to the No Action Alternative.

Table 4-1. Modeled Total Methylmercury Concentrations in Largemouth Bass Fillets (in milligrams per kilogram wet weight) at Delta Assessment Locations for the Full Simulation Period

Assessment Location	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4
San Joaquin River at Empire Tract	0.78	0.76	0.78	0.82	0.78
Turner Cut	0.96	0.94	0.96	1.00	0.96
San Joaquin River at San Andreas Landing	0.61	0.60	0.61	0.63	0.61
San Joaquin River at Jersey Point	0.64	0.63	0.63 to 0.64	0.66	0.63
Victoria Canal	0.84	0.82	0.84 to 0.85	0.92	0.84
Sacramento River at Emmaton	0.60	0.60	0.60	0.61	0.60
San Joaquin River at Antioch	0.65	0.65	0.64 to 0.65	0.66	0.65
Montezuma Slough near Beldon Landing	0.73	0.79	0.73	0.74	0.73
Barker Slough at North Bay Aqueduct	0.74	0.75	0.75	0.75	0.75
Contra Costa Water District Pumping Plant #1	0.68	0.67	0.68 to 0.69	0.75	0.68
Banks Pumping Plant	0.83	0.80	0.83	0.90	0.83
Jones Pumping Plant	0.87	0.85	0.87	0.92	0.87

Values for Alternative 2 are a range for the four phases of Alternative 2: Alt2 With TUCP Without VA, Alt2 Without TUCP Without VA, Alt2 Without TUCP Delta VA, Alt2 Without TUCP Systemwide VA.

4.2.3.5 Cyanobacteria Harmful Algal Blooms

Alternatives 1, 2, and 4 would not have substantial increased risk of increased CHABs in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay relative to the No Action Alternative. For Alternative 3, there could be increased risk of CHABs in the Delta and Suisun Marsh. This increased risk is associated with lower summer Delta inflows, which may result in lower residence times, making conditions more conducive to CHABs. There is no increased risk of CHABs in Suisun Bay and San Francisco Bay relative to the No Action Alternative for Alternative 3.

4.3 Mitigation Measures

Appendix D includes a detailed description of mitigation measures identified for water quality resources per alternative. These mitigation measures include avoidance and minimization measures that are part of each alternative and, where appropriate, additional mitigation to lessen impacts of the alternatives. An additional mitigation measure for water quality resources is identified: Mitigation Measure WQ-1: Develop a water quality mitigation and monitoring program.

4.3.1 Avoidance and Minimization Measures

4.3.1.1 Alternatives 1-4

For water quality, avoidance and minimization measures generally include measures identified for aquatic resources. These measures include water temperature and storage management, minimum instream flows, pulse flows, turbidity management, increase delta outflow, salinity management.

4.3.2 Additional Mitigation

4.3.2.1 Alternative 1

Alternative 1 could increase concentrations of constituents of concern compared with the No Action Alternative.

- *Mitigation Measure WQ-1: Develop a water quality mitigation and monitoring program* - could be implemented to reduce impacts.

4.3.2.2 Alternative 2

Same as Alternative 1.

4.3.2.3 Alternative 3

Same as Alternative 1.

4.3.2.4 Alternative 4

Same as Alternative 1.

4.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and may result in potential changes in water quality at reservoirs that store CVP water, tributaries, and agricultural land. The action alternatives will result in changes to water quality at reservoirs that store CVP water, tributaries, and agricultural land. The magnitude of the changes is dependent on alternative and water year type. Therefore, the No Action Alternative and action alternatives may contribute to cumulative changes to water quality as described in Appendix G, *Water Quality* and Appendix Y, *Cumulative Impacts Technical Appendix*.

Chapter 5 Water Supply

Variability and uncertainty are dominant characteristics of California's water resources. Precipitation is the primary source of California's water supply (California Department of Water Resources 2018a). It varies greatly from year to year, as well as by season and location within the state. Unpredictability and geographic variation in precipitation that California receives make it challenging to manage available runoff to meet urban, agricultural, and environmental water needs.

During an average year, approximately two thirds of the precipitation that California receives is lost through evapotranspiration by trees and other vegetation, evaporation into the atmosphere, runoff, storage as effective precipitation, or through other outflows (California Department of Water Resources 2018b). Therefore, approximately one third of the precipitation remains available for use by urban, agricultural, and other environmental uses. However, the variability of annual precipitation in California and the differences in volumes of precipitation and runoff between different regions of the state makes it difficult to standardize water management between years (California Department of Water Resources 2018b).

Due to hydrologic variability that ranges from dry summers and fall months to floods in winter and spring, water from precipitation in winter and spring must be stored for use in summer and fall. The amount of water stored as snowpack is highly variable from year to year. During dry periods, snowpack may comprise less than 5 MAF of water; however, snowpack during wet periods may comprise approximately 30 MAF (University of California, San Diego 2023). However, not all snowpack becomes available in a timely manner for uses throughout the state. Therefore, federal, state, and local agencies and private entities have constructed reservoirs, aqueducts, pipelines, and water diversion facilities to capture and use rainfall and subsequent snowmelt.

With passage of Rivers and Harbors Act of 1935, Congress appropriated funds and authorized construction of CVP by USACE (Bureau of Reclamation 1999). When the Rivers and Harbors Act was reauthorized in 1937, construction and operation of CVP was assigned to Reclamation, and CVP became subject to Reclamation Law (as defined in the Reclamation Act of 1902 and subsequent legislation).

As CVP facilities were being constructed after World War II, the state began investigations to meet additional water needs through development of the California Water Plan. In 1957, DWR published Bulletin Number 3 that identified new facilities to provide flood control in northern California and water supplies to San Francisco Bay Area, San Joaquin Valley, San Luis Obispo and Santa Barbara counties in the Central Coast Region, and southern California (California Department of Water Resources 1957). The study identified a seasonal deficiency of 2.675 MAF/year in 1950 that resulted in groundwater overdraft throughout many portions of California. The report described facilities to meet water demands and reduce groundwater overdraft, including facilities that would become part of SWP. In 1960, California voters authorized the Burns-Porter Act to construct initial SWP facilities.

During the past 100 years, numerous water supply, flood management, and hydroelectric generation reservoirs were constructed throughout California. Many of these projects were constructed on tributaries to Sacramento and San Joaquin rivers and tributaries to Tulare Lake Basin. Operations of these non-CVP and non-SWP reservoirs affect flow patterns into Sacramento and San Joaquin rivers and Delta. Pacific Gas and Electric owns and operates the McCloud-Pit Hydroelectric Project, which includes five dams, two tunnels, and associated equipment and transmission facilities that limit the flow and temperature of water into Shasta Reservoir (State Water Resources Control Board 2019). However, implementation of alternatives evaluated in this EIS would not result in changes in operations in most of these reservoirs, except on lower Stanislaus River.

5.1 Effects of the Alternatives

The impact analysis considers changes in water supply related to changes in CVP and SWP operation under the alternatives as compared with the No Action Alternative.

The No Action Alternative is based on 2040 conditions. Changes that would occur over that time frame without implementation of the action alternatives are not analyzed in this chapter. However, the changes to water supply that are assumed to occur by 2040 under the No Action Alternative are summarized in this section.

Conditions in 2040 would be different than existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

In the long term, it is anticipated that climate change, and development throughout California, could affect water supply deliveries.

Under the No Action Alternative, Reclamation would continue with the current operation of the Central Valley Project (CVP), as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the State Water Project (SWP) represent current management direction or intensity pursuant to 43 CFR Section 46.30.

Although the No Action Alternative included habitat restoration projects at a programmatic level, the 2020 ROD did not provide environmental coverage for these projects, and all of the habitat projects considered under the No Action required or will require additional environmental documentation. Thus, ground disturbance for habitat restoration projects did not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

The No Action Alternative is expected to result in potential changes in water supply deliveries, with improved water supply deliveries to some CVP and SWP contractors and for other water users, deliveries would remain similar to existing conditions. These changes were described and considered in the 2020 Record of Decision and associated documents.

5.1.1 Potential changes in water supply deliveries

5.1.1.1 Trinity River, Sacramento River, Clear Creek, and American River

CVP and SWP contract deliveries on the Trinity, Sacramento, Clear Creek, and American rivers and their tributaries under the No Action Alternative and action alternatives are shown in Figure 5-1. Tables presenting changes to water supply deliveries are included in Appendix H. The CalSim 3 model was used to estimate operations. The CalSim 3 model depicts operation of the CVP and SWP on a monthly time step and relies on assumptions and approaches that contribute to minor fluctuations of up to 5% in its simulation of real-time operations. In addition, minor deviations in CVP Refuge Level 2 deliveries are the result of modeling but do not reflect an intention by Reclamation to deviate from the CVPIA.

Alternative 1 may reduce (by less than 5%) average annual deliveries to CVP Refuge Level 2 water users. Compared to the No Action Alternative, all contract delivery types, except for deliveries to CVP Refuge Level 2 would remain the same or increase slightly under Alternative 1.

Under Alternative 2, there would be no measurable change in minimum average annual deliveries for CVP M&I and SWP M&I water users. The maximum reductions in average annual deliveries under Alternative 2 to CVP Refuge Level 2 and CVP agricultural water users would average less than 5%. Alternative 2 would result in a maximum reduction of approximately 6% in average annual water made available for diversion to CVP Settlement Contractors water users.

Alternative 3 may reduce (by less than 5%) average annual deliveries to CVP Settlement Contractors, CVP Refuge Level 2, and CVP M&I water users and would generate no measurable change to average annual SWP M&I deliveries. Alternative 3 would reduce (by approximately 11%) average annual deliveries to CVP agricultural water users.

Alternative 4 may reduce (by less than 5%) average annual deliveries to CVP Settlement Contractors and CVP agricultural water users and would generate no measurable change to average annual to CVP Refuge Level 2, CVP M&I, and SWP M&I deliveries.

Alternative 4B is expected to be within the range of effects for water supply described for Alternative 4.

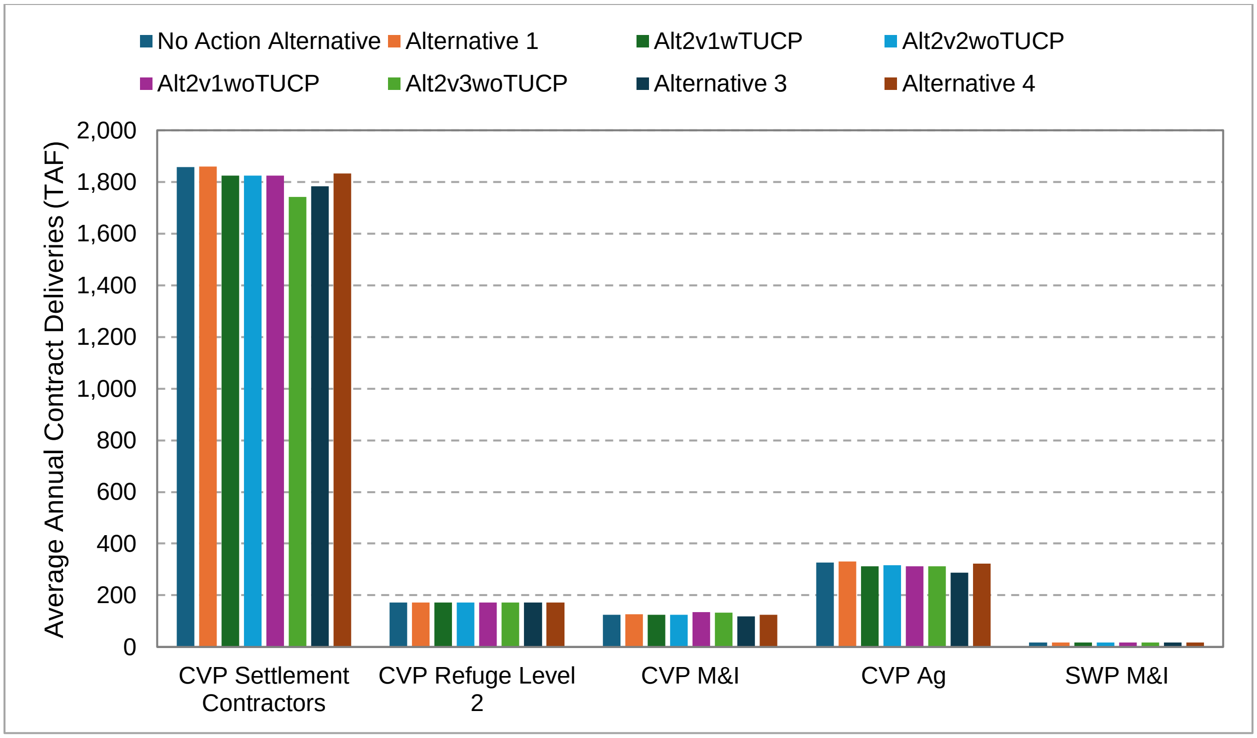


Figure 5-1. Sacramento River Hydrologic Region Average Annual Contract Deliveries under All Water Year Types

5.1.1.2 Stanislaus River and San Joaquin River

CVP and SWP deliveries to contractors in Stanislaus River and San Joaquin River watersheds under the No Action Alternative and action alternatives are shown in Figure 5-2. Tables presenting changes to water supply deliveries are included in Appendix H. Compared to the No Action Alternative, Alternative 1 would improve average annual deliveries for all contractor types. Under Alternative 2, there would be no measurable change in minimum average annual deliveries for CVP M&I and SWP agricultural water users and there would be improvements in minimum average annual deliveries for CVP Exchange Contractors and CVP Refuge Level 2. Alternative 2 would result in a maximum reduction of approximately 9% in average annual deliveries to CVP agricultural water users. Alternative 3 would reduce (by less than 5%) average annual deliveries to CVP Exchange Contractors and CVP Refuge Level 2. Alternative 3 would reduce (by approximately 38%) average annual deliveries to CVP M&I water users, would reduce (by approximately 63%) average annual deliveries to CVP agricultural water users, and would reduce (by approximately 33%) average annual deliveries to SWP agricultural water users. Under Alternative 4, there would be no measurable change in average annual deliveries for all contractor types.

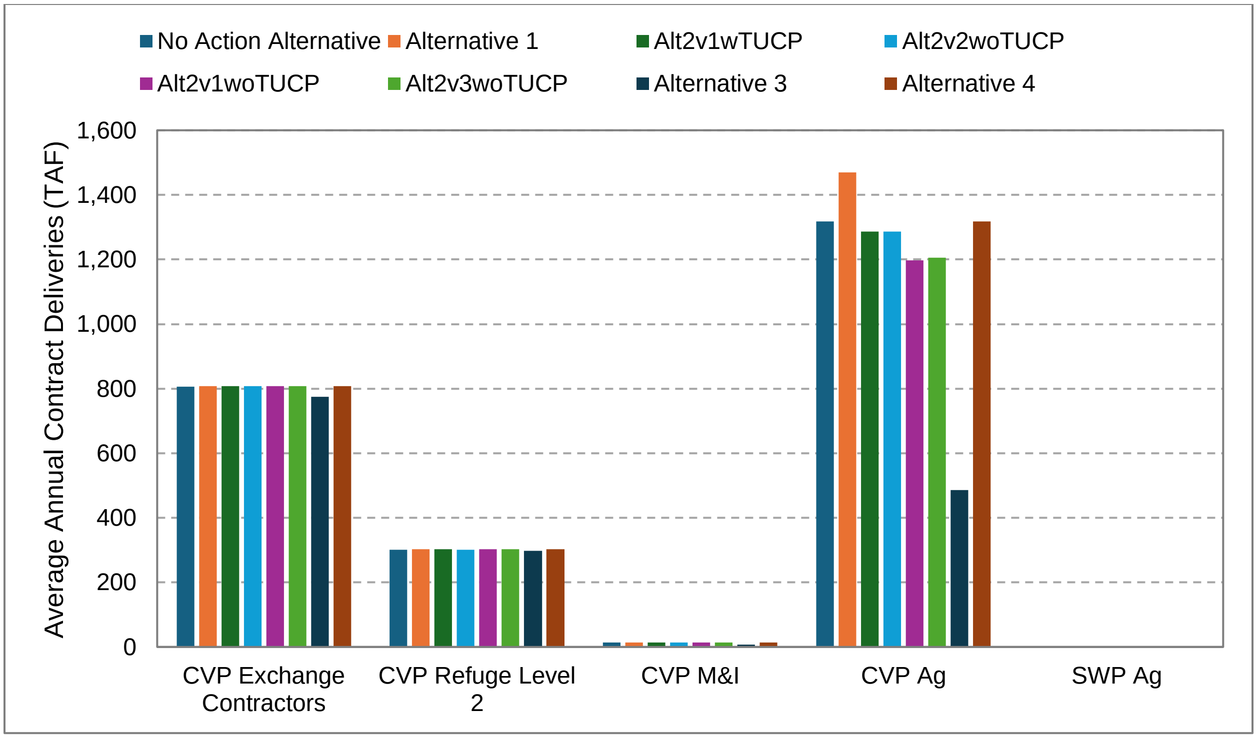


Figure 5-2. San Joaquin River Hydrologic Region Average Annual Contract Deliveries under All Water Year Types

5.1.1.3 Bay-Delta

CVP and SWP contract deliveries in Bay-Delta under the No Action Alternative and action alternatives are shown in Figure 5-3. Tables presenting changes to water supply deliveries are included in Appendix H. Compared to the No Action Alternative, Alternative 1 would improve average annual deliveries for all contractor types. Under Alternative 2, the maximum reductions in average annual deliveries to CVP M&I and CVP agricultural water users would average less than 5%. Alternative 2 would result in improvements in minimum average annual deliveries for SWP M&I water users. Alternative 3 would reduce (by approximately 17%) average annual deliveries to CVP M&I water users, would reduce (by approximately 70%) average annual deliveries to CVP agricultural water users, and would reduce (by approximately 38%) average annual deliveries to SWP M&I water users. Alternative 4 would reduce average annual deliveries to CVP M&I water users by less than 5%. Under Alternative 4, there would be no measurable change in average CVP agricultural annual deliveries and there would be improvements in average annual SWP M&I deliveries.

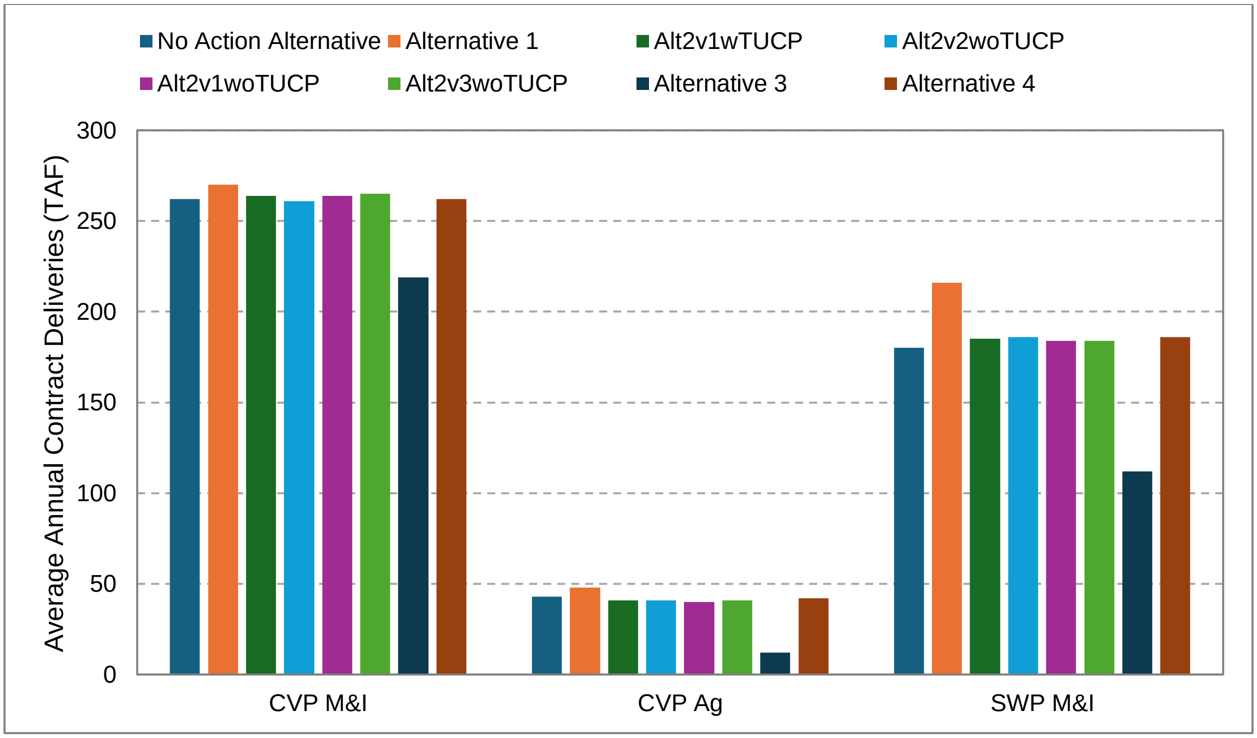


Figure 5-3. San Francisco Hydrologic Region Average Annual Contract Deliveries under All Water Year Types

Alternative 2B

Analysis of Alternative 2B, although qualitative, builds on the quantitative analysis provided for Alternative 2. Only components under 2B that are expected to result in water supply changes compared to Alternative 2 are discussed.

Alternative 2b is anticipated to be more restrictive than Alternative 2 and the No Action Alternative on Delta exports. CalSim results (Alternative 2v2) shows that the change in QWEST criteria would increase the number of times during January through June when the trigger could apply by up to 68 months (out of 1200 months), over the 100-year record. This increased occurrence would result in a decrease of water supply. However, the real-time impacts to water supply are anticipated to be less because the longfin may not be present when the threshold is considered.

In addition to the more restrictive QWEST criteria, Alternative 2B includes an extension of the CCF operation period to December 1 through March 31 from mid-December through mid-March, effectively increasing the operation of the SWP by one month. This expansion may result in more frequently meeting seasonal thresholds, and also meeting weekly thresholds that may not have otherwise been met. Meeting these thresholds would result in additional export restriction under Alternative 2B that would result in a decrease in water supply. On the other hand, an increase in surface water supply could materialize in the event that the thresholds are not met during the extended operation of CCF under Alternative 2B.

5.1.1.4 CVP and SWP Service Areas

This section details changes in contract deliveries under the No Action Alternative and action alternatives to CVP and SWP Service Areas in central coast, Tulare Lake, South Lahontan, and south coast regions.

5.1.1.5 Central Coast Region

SWP contract deliveries in the central coast region under the No Action Alternative and action alternatives are shown in Figure 5-4. Tables presenting changes to water supply deliveries are included in Appendix H. Compared to the No Action Alternative, Alternatives 1, 2, and 4 would improve average annual deliveries to SWP M&I water users. Alternative 3 would reduce (by approximately 53%) average annual deliveries to SWP M&I water users.

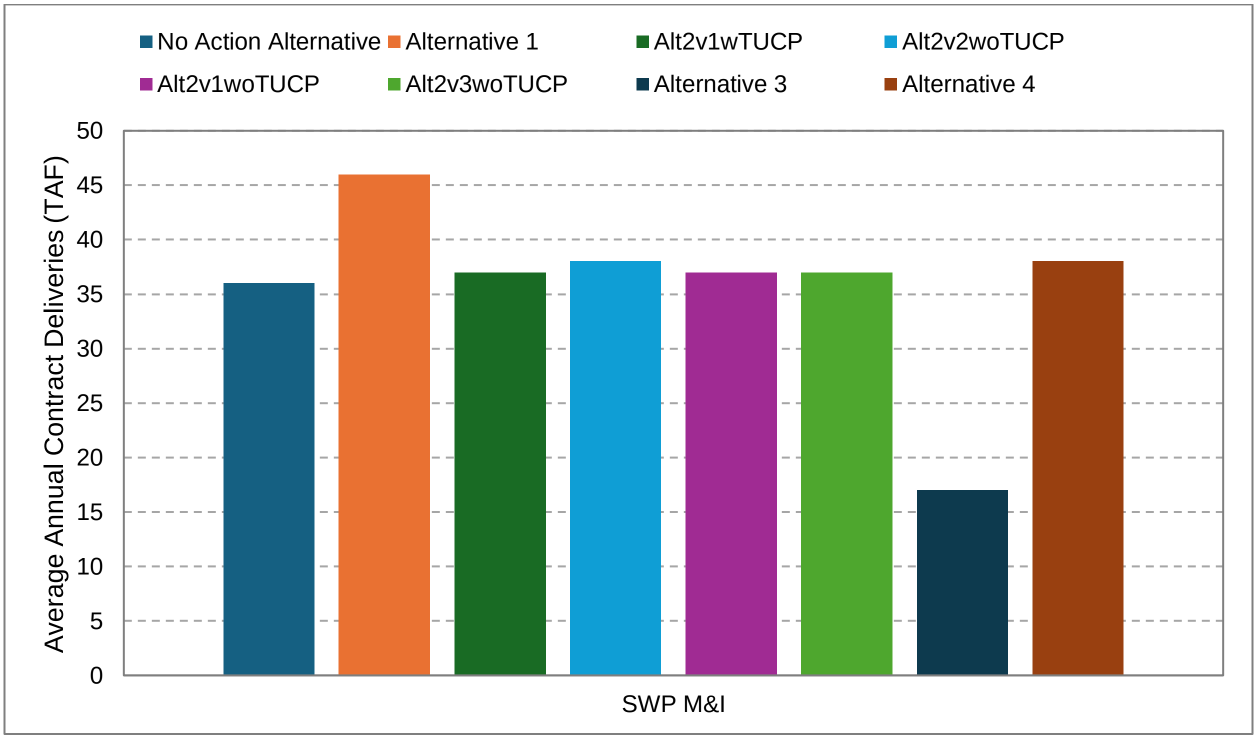


Figure 5-4. Central Coast Hydrologic Region Average Annual Contract Deliveries under All Water Year Types

5.1.1.6 Tulare Lake Region

CVP and SWP contract deliveries in Tulare Lake region under the No Action Alternative and action alternatives are shown in Figure 5-5. Tables presenting changes to water supply deliveries are included in Appendix H. Compared to the No Action Alternative, Alternative 1 would generate no measurable change to average annual CVP Refuge Level 2 deliveries and would improve average annual deliveries for all other contractor types. Alternative 2 would generate no measurable change to minimum average annual CVP Refuge Level 2 deliveries and would improve minimum average annual deliveries for all other contractor types. Alternative 2 would result in a maximum reduction of approximately 11% in average annual deliveries to CVP agricultural water users. Alternative 3 would reduce (by approximately 7%) average annual deliveries to CVP Refuge Level 2, would reduce (by approximately 72%) average annual deliveries to CVP agricultural water users, would reduce (by approximately 52%) average annual deliveries to SWP M&I water users, and would reduce (by approximately 55%) average annual deliveries to SWP agricultural water users. Alternative 4 would reduce (by less than 5%) average annual deliveries to CVP agricultural water users. Alternative 4 would generate no measurable change to average annual CVP Refuge Level 2 deliveries and would improve average annual deliveries for SWP M&I SWP agricultural and water users.

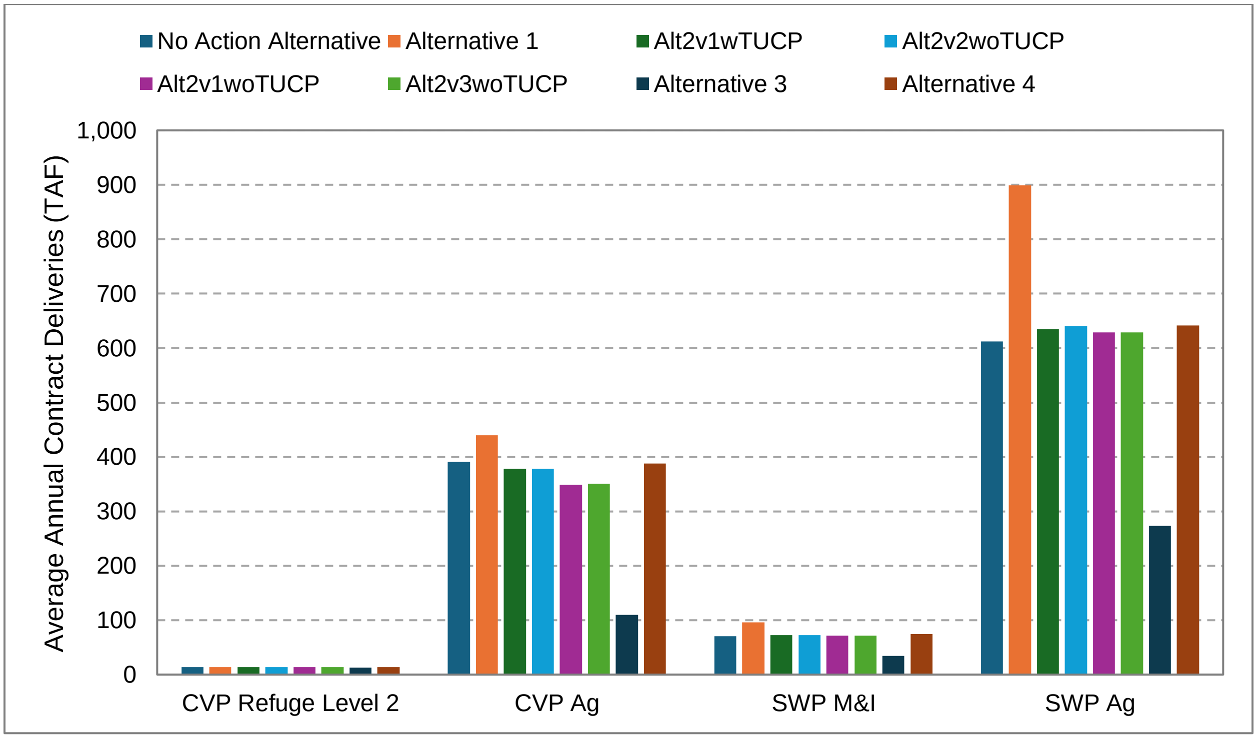


Figure 5-5. Tulare Lake Hydrologic Region Average Annual Contract Deliveries under All Water Year Types

5.1.1.7 South Lahontan Region

SWP contract deliveries in south Lahontan region under the No Action Alternative and action alternatives are shown in Figure 5-6. Tables presenting changes to water supply deliveries are included in Appendix H. Compared to the No Action Alternative, Alternative 1, Alternative 2, and Alternative 4 would improve average annual deliveries to SWP M&I water users. Alternative 3 would reduce (by approximately 51%) average annual deliveries to SWP M&I water users.

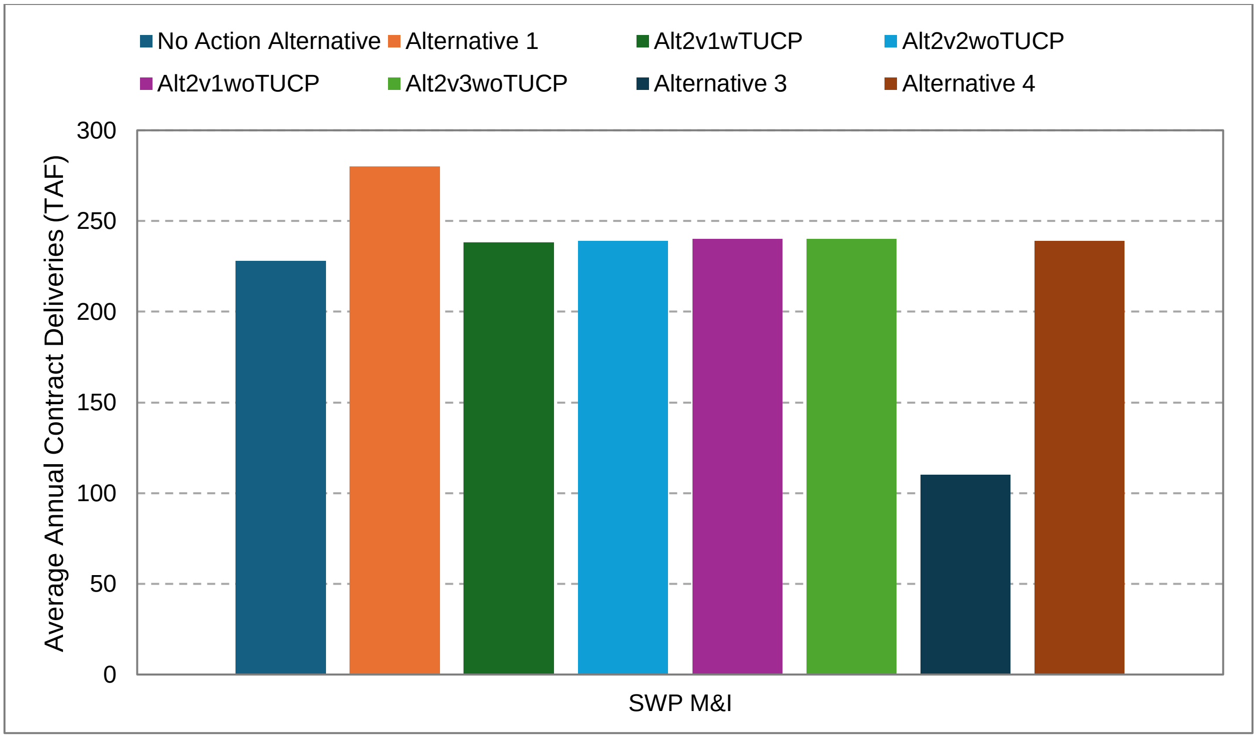


Figure 5-6. South Lahontan Hydrologic Region Average Annual Contract Deliveries under All Water Year Types

5.1.1.8 South Coast Region

SWP contract deliveries in south coast region under the No Action Alternative and action alternatives are shown in Figure 5-7. Tables presenting changes to water supply deliveries are included in Appendix H. Compared to the No Action Alternative, Alternative 1, Alternative 2, and Alternative 4 would improve or generate no measurable change to average annual deliveries to SWP M&I and SWP agricultural water users. Alternative 3 would reduce (by approximately 54%) average annual deliveries to SWP M&I water users and would reduce (by approximately 54%) average annual deliveries to SWP agricultural water users.

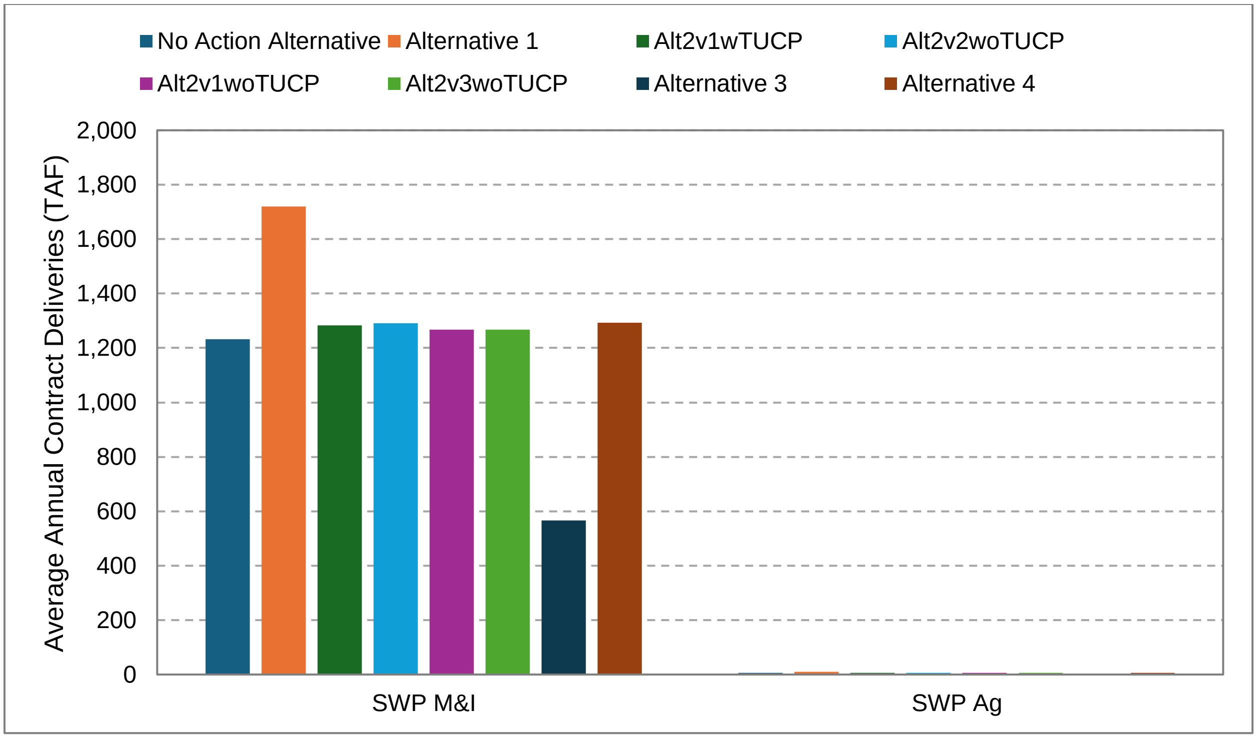


Figure 5-7. South Coast Hydrologic Region Average Annual Contract Deliveries under All Water Year Types

5.2 Mitigation Measures

Appendix D includes a detailed description of mitigation measures identified for water supply resources per alternative. These mitigation measures include avoidance and minimization measures that are part of each alternative and, where appropriate, additional mitigation to lessen impacts of the alternatives. For water supply, avoidance and minimization measures generally include measures identified for aquatic resources. These measures include water temperature and storage management, minimum instream flows, and capture of high flows during storms. No additional mitigation measures have been identified for water supply resources.

5.3 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and may result in changes to water supply deliveries. The action alternatives will result in changes to water supply deliveries. The magnitude of the changes is dependent on alternative and water year type. Therefore, the No Action Alternative and action alternatives may contribute to cumulative changes to water supply as described in Appendix H, *Water Supply* and Appendix Y, *Cumulative Impacts Technical Appendix*.

Chapter 6 Groundwater

This impact assessment is based on the background information and technical analysis documented in Appendix I, *Groundwater Technical Appendix*, which includes additional information on groundwater conditions and technical analysis of the effects of each alternative.

6.1 Affected Environment

Groundwater occurs throughout the study area. The groundwater resources that could be directly or indirectly affected through implementation of the alternatives analyzed in the EIS are related to groundwater basins where users of Central Valley Project (CVP) and State Water Project (SWP) water supplies also use groundwater, and areas along the rivers downstream of CVP or SWP reservoirs that use groundwater supplies. Changes in CVP and SWP operations may change groundwater resources in the Trinity River, Sacramento Valley (Sacramento River, American River), Clear Creek, San Joaquin Valley (Stanislaus River, San Joaquin River), and Sacramento–San Joaquin Delta (Delta) areas. The additional areas where CVP and SWP deliveries are exported (Central Coast and Southern California regions) are also included.

6.1.1 Overview

Groundwater supplied about 37% of the state's average agricultural, municipal, and industrial water needs between 1998 and 2010, and 40% or more during dry and critical water years in that period (California Department of Water Resources 2013a). About 20% of the nation's groundwater demand is supplied from the Central Valley aquifers, making it the second-most-pumped aquifer system in the United States (U.S. Geological Survey 2009). The three Central Valley hydrologic regions (Tulare Lake, San Joaquin River, and Sacramento River) account for about 75% of the state's average annual groundwater use (California Department of Water Resources 2013a).

California Department of Water Resources (DWR) has delineated distinct groundwater systems throughout the state, as described in Bulletin 118 (California Department of Water Resources 2019, 2021a), that are the most important groundwater basins. These basins and subbasins have various degrees of supply reliability considering yield, storage capacity, and water quality and are typically alluvial, or nonconsolidated (nonfractured rock) aquifers. Through the Sustainable Groundwater Management Act (SGMA), DWR accepted applications to modify the delineation of groundwater basins if enough newer information was available. DWR finalized the basin boundaries and prioritization in 2019 (California Department of Water Resources 2020). The groundwater basin descriptions are provided Appendix I, *Groundwater Technical Appendix*.

DWR developed a priority ranking for the groundwater basins and subbasins as part of the 2009 Comprehensive Water package. The priority rankings were released in 2014 as part of the California Statewide Groundwater Elevation Monitoring Program. The SGMA legislation that went into effect in 2015 required DWR to reassess the basin prioritization. Basins were prioritized based on eight factors: population, population growth, public supply wells in the basin, total wells in the basin, acres of irrigated agriculture, reliance on groundwater as a primarily supply source, documented impacts to groundwater (overdraft, subsidence, saline intrusion, water quality issues) and “other” factors (such as habitat and streamflow). DWR developed four prioritization categories by weighing these factors: high, medium, low, and very low priority. Some groundwater basins have been designated with a “with overdraft” indication to designate that they are on a faster track towards developing Groundwater Sustainability Plans (GSP) under SGMA. Of the 517 groundwater basins evaluated statewide, DWR identified 109 as high- and medium-priority basins. These high- and medium-priority basins account for approximately 98% of the groundwater use in California.

The importance of groundwater as a resource varies regionally. The Central Coast has the most reliance on groundwater to meet its local uses, with nearly 90% of the agricultural, municipal, and industrial water supplies by groundwater in an average year. The Sacramento Valley and northern portion of the San Joaquin Valley Groundwater Basin use groundwater to meet approximately 34% and 48% of the agricultural, municipal, and industrial water demand, respectively (California Department of Water Resources 2021b). On an annual average basis in the coastal areas of Southern California, groundwater use varies from less than 10% in western San Diego County to between 35% and 50% of the agricultural, municipal, and industrial water supplies in counties along the coast in western Ventura, Los Angeles, and Riverside counties and in Orange County. In the inland areas of Southern California, groundwater use varies from approximately 45% to over 90% of the agricultural, municipal, and industrial water supplies (California Department of Water Resources 2013b).

6.1.2 Trinity River

The Trinity River Region includes the area along the Trinity River from Trinity Reservoir to the confluence with the Klamath River and along the Klamath River from the confluence with the Trinity River to the Pacific Ocean.

Most usable groundwater in the Trinity River Region occurs in widely scattered alluvium-filled valleys, such as those immediately adjacent to the Trinity River. These valleys contain only small quantities of recoverable groundwater and therefore are not considered a major source. A number of shallow wells adjacent to the river provide water for domestic purposes (Bureau of Reclamation et al. 2006; North Coast Regional Water Quality Control Board and Bureau of Reclamation 2009). Groundwater present in these alluvial valleys is in close hydraulic connection with the Trinity River and its tributaries. Both groundwater discharge to surface streams and leakage of steam flow to underlying aquifers are expected to occur at various locations.

6.1.3 Sacramento River Valley

The Sacramento Valley includes the Redding Area Groundwater Basin and the Sacramento Valley Groundwater Basin. The Sacramento Valley Groundwater Basin is one of the largest groundwater basins in the state and extends from Redding in the north to the Delta in the south (U.S. Geological Survey 2009).

Approximately one-third of the Sacramento Valley’s urban and agricultural water needs are met by groundwater (California Department of Water Resources 2003a). The portion of the water diverted for irrigation but not actually consumed by crops or other vegetation, or evaporation directly, becomes recharge to the groundwater aquifer or flows back to surface waterways.

Overall, the Sacramento Valley Groundwater Basin is approximately balanced with respect to annual recharge and pumping demand. However, there are several locations showing early signs of persistent drawdown, suggesting limitations because of increased groundwater use in dry years. Locations of persistent drawdown include Glenn County, areas near Chico in Butte County, northern Sacramento County, and portions of Yolo County.

6.1.4 Clear Creek

Clear Creek is a major tributary to the Sacramento River that lies just below Shasta Dam. Clear Creek originates in the mountains east of Clair Engle Reservoir and flows approximately 35 miles to its confluence with the Sacramento River, just south of the town of Redding in Shasta County. Clear Creek drains approximately 249 square miles and receives the majority of its inflow from rainfall and snowmelt.

Given that Clear Creek flows primarily through the mountain valleys, there is little in the way of substantial groundwater basins underlying this area. Groundwater present in these valleys is likely in close hydraulic connection with Clear Creek. Both groundwater discharge to surface streams and leakage of stream flow to underlying aquifers are expected to occur at various locations.

6.1.5 San Joaquin Valley

Extending south into the Central Valley from the Delta to the southern extent marked by the San Joaquin River, DWR has delineated nine subbasins within the northern portion of the San Joaquin Valley Groundwater Basin based on groundwater divides, barriers, surface water features, and political boundaries (California Department of Water Resources 2003a). The Cosumnes, Eastern San Joaquin, and Tracy subbasins partially underlie the Delta. The Delta-Mendota, Modesto, Turlock, Merced, Chowchilla, and Madera subbasins are located between the Delta and the San Joaquin River.

The northern portion of the San Joaquin Valley Groundwater Basin is marked by laterally extensive deposits of thick, fine-grained materials deposited in lacustrine and marsh depositional systems. These units, which can be tens to hundreds of feet thick, create vertically differentiated aquifer systems within the subbasins. The Corcoran Clay (or E-Clay) occurs in the Tulare formation and separates the alluvial water-bearing formations into confined and unconfined aquifers. The direction of groundwater flow generally coincides with the primary direction of surface water flows in the area, which is to the northwest toward the Delta. Groundwater levels fluctuate seasonally, and a strong correlation exists between depressed groundwater levels and periods of drought when more groundwater is pumped in the area to support agricultural operations.

Water users in the northern portion of the San Joaquin Valley Groundwater Basin rely on groundwater, which is used conjunctively with surface water for agricultural, industrial, and municipal supplies (California Department of Water Resources 2003a). Groundwater is estimated to account for about 38% of the overall water supply in the northern portion of the San Joaquin

Valley Groundwater Basin (California Department of Water Resources 2013a). Annual groundwater pumping in the northern portion of the San Joaquin Valley Groundwater Basin accounts for about 19% of all groundwater pumped in the state of California. Groundwater use in the northern portion of the San Joaquin Valley Groundwater Basin is estimated to average 3.2 million acre-feet per year (AFY) between 2005 and 2010.

6.1.6 Bay-Delta

The Delta overlies the western portion of the area where the Sacramento River and San Joaquin River Groundwater Basins converge. The Delta includes the Solano subbasin and the South American subbasin in the Sacramento Valley Groundwater Basin; the Tracy subbasin, the Eastern San Joaquin subbasin, and the Cosumnes subbasin in the San Joaquin Valley Groundwater Basin (as described previously); and the Suisun-Fairfield Valley.

6.1.7 Central Coast Region

The Central Coast Region includes portions of San Luis Obispo and Santa Barbara counties served by the SWP. The Central Coast Region encompasses the southern planning area of the Central Coast Hydrologic Region (California Department of Water Resources 2013a).

SWP water is provided to the Central Coast Region by the Central Coast Water Authority (Central Coast Water Authority 2013). The facilities divert water from the SWP California Aqueduct at Devil's Den and convey the water to the 43 million gallon per day water treatment plant at Polonto Pass. The treated water is conveyed to municipal water users in San Luis Obispo and Santa Barbara counties to reduce groundwater overdraft in these areas.

Portions of the Central Coast Region that use CVP and SWP water are included in the Central Coast Hydrologic Region, which includes 50 delineated groundwater basins as defined by DWR (California Department of Water Resources 2003a). The basins vary from large extensive alluvial aquifers to small inland valleys and coastal terraces. Groundwater in the large alluvial aquifers exists in thick unconfined and confined basins. Groundwater is generally used for urban and agricultural use in the Central Coast Region.

6.1.8 Southern California Region

The Southern California Region includes portions of Ventura, Los Angeles, Orange, San Diego, Riverside, and San Bernardino counties served by the SWP. The Southern California Region groundwater basins are as varied as the geology that occurs in different geographic portions of the region.

- Ventura County and northwestern Los Angeles County
- Central and southern Los Angeles County and Orange County
- Western San Diego County
- Western and central Riverside County and southern San Bernardino County
- Antelope Valley and Mojave Valley

6.2 Methods and Tools

The impact assessment considers changes to groundwater related to changes in CVP and SWP operations under the alternatives compared to the No Action Alternative.

While the changes in CVP and SWP operations under the alternatives compared with the No Action Alternative do not directly result in pumping more or less groundwater, changes to CVP and SWP operations may change the amount of surface water delivered to users. A change in surface water deliveries may result in users changing the amount of groundwater pumping to offset this change in surface water supply. For example, if less surface water is supplied to an agricultural area, additional groundwater would need to be pumped and supplied to maintain cropping. The surface water supply analysis was conducted using CalSim 3, as described in Appendix F, *Model Documentation*, to simulate the operational assumptions of each alternative. The CalSim 3 results were then applied to the California Central Valley Groundwater-Surface Water Simulation Model Fine-Grid (C2VSimFG) groundwater flow model (see Appendix F) to simulate changes in groundwater conditions, including the changes to pumping, groundwater-surface water interaction, and groundwater elevation. The C2VSimFG modeling was conducted for the basins and subbasins in the Sacramento and San Joaquin valleys. A qualitative assessment was conducted in the other project areas.

DWR has designated each ground water basin (GWB) and groundwater subbasin (GWSB) in the state with a low, medium, or high priority designation. Some GWBs have been designated with an additional "with overdraft" indication to designate that they are on a faster track towards management through a GSP. The development of a GSP may result in limitation of on groundwater pumping to limit decreases in groundwater levels. The C2VSimFG model does not directly simulate limitations to groundwater levels and pumping that may be imposed as part of SGMA. The model assumes that groundwater will be used to supplement water supply if surface water supplies are decreased in order to meet demands. Conversely, if surface water supplies are increased, the C2VSimFG model will decrease groundwater pumping. The model, therefore, may over predict increases in groundwater pumping, decreases in groundwater levels, increases in loss of surface water to groundwater, and subsidence. If groundwater supply is unable to be increased beyond a certain level (based on the GSP for the area) then the current demand level may not be able to be supported.

6.3 Effects of the Alternatives

The impact analysis considers changes in groundwater conditions related to changes in CVP and SWP operation under the alternatives as compared with the No Action Alternative.

The No Action Alternative is based on 2040 conditions. The changes to groundwater resources such as changes in groundwater pumping and potential changes in ground and surface water interaction flow that are assumed to occur by 2040 under the No Action Alternative conditions would be different than existing conditions because of the following factors:

- Climate change and sea-level rise

- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

In the long term, it is anticipated that climate change, and development throughout California, could affect water supply deliveries.

Under the No Action Alternative, Reclamation would continue with the current operation of the Central Valley Project (CVP), as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the State Water Project (SWP) represent current management direction or intensity pursuant to 43 CFR Section 46.30.

Although the No Action Alternative included habitat restoration projects at a programmatic level, the 2020 ROD did not provide environmental coverage for these projects, and all of the habitat projects considered under the No Action required or will require additional environmental documentation. Thus, ground disturbance for habitat restoration projects did not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

The No Action Alternative is expected to result in potential changes to groundwater resources, such as groundwater pumping, elevation, and groundwater-surface water interaction flow. These changes were described and considered in the 2020 LTO Record of Decision and associated documents.

6.3.1 Potential Changes in Groundwater Pumping

6.3.1.1 Trinity River

Operations in the Trinity River would remain similar to those under the No Action Alternative. The Trinity River Restoration Program Record of Decision controls Trinity River operations, and Reclamation would continue to release flows into the Trinity River as it does under the No Action Alternative.

6.3.1.2 Central Valley

Alternatives 1 through 4 would cause flow changes in the Sacramento River in Delta outflow requirements. Flow changes could affect surface water available for use by SWP and CVP contractors. *Chapter 5, Water Supply,* provides additional information on the extent and magnitude of changes to water supply. Changes in surface water supply deliveries may result in changes to groundwater pumping to offset the change in deliveries.

Groundwater pumping locations and amounts are typically not publicly available for inclusion in groundwater models; therefore groundwater models of the region calculate the amount of pumping. The calculated groundwater pumping is a function of the available water from the surface (e.g., rainfall, surface water deliveries) and the demand of the surface land use (e.g., crop type). Table 6-1, shows annual groundwater pumping simulated by the C2VSimFG groundwater model across the entire Central Valley, from Red Bluff through the Tule region, including the Sacramento and San Joaquin valleys. The C2VSimFG model does not simulate limitations to groundwater pumping that may be imposed as part of a local GSP. Therefore, the simulated groundwater pumping values may overestimate the amount of groundwater pumping in certain areas. Groundwater basins denoted to be in overdraft conditions will likely have more limitations on groundwater pumping per SGMA.

Table 6-1. Simulated Groundwater Pumping in the Central Valley

Year	WY Type (Sacramento Valley, San Joaquin Valley)	NAA (TAF)	Alt1 (TAF)	Alt 2v1 (TAF)	Alt2v1 wTUCP (TAF)	Alt 2v2 (TAF)	Alt 2v3 (TAF)	Alt 3 (TAF)	Alt 4 (TAF)
1	W, W	11,480	11,398	11,472	11,472	11,482	11,488	12,089	11,472
2	W, W	11,974	11,742	11,964	11,965	12,033	12,047	12,742	11,961
3	C, C	15,993	15,914	16,059	16,059	16,048	16,072	16,392	15,995
4	C, C	18,361	18,242	18,366	18,454	18,370	18,381	19,281	18,332
5	AN, W	12,115	12,128	12,114	12,116	12,194	12,210	12,832	12,111
6	BN, AN	11,948	11,707	11,971	11,947	12,010	12,055	12,478	11,908
7	AN, W	11,024	10,972	11,016	11,006	11,105	11,121	11,588	11,005
8	D, D	13,572	13,266	13,620	13,621	13,690	13,728	14,395	13,598
9	W, W	10,224	10,141	10,245	10,246	10,249	10,255	10,931	10,241
10	W, W	9,317	9,316	9,315	9,317	9,313	9,315	9,810	9,316
11	W, AN	12,217	12,185	12,202	12,203	12,208	12,201	12,838	12,199
12	D, D	13,560	13,446	13,618	13,618	13,665	13,686	14,231	13,634
13	W, W	11,172	11,146	11,199	11,200	11,195	11,200	11,864	11,204
14	D, D	14,141	13,979	14,248	14,243	14,281	14,302	14,684	14,150
15	C, C	15,521	15,323	15,732	15,730	15,725	15,742	16,186	15,706
16	D, C	15,738	15,582	15,779	15,795	15,837	15,854	16,252	15,747
17	C, C	16,066	15,846	15,929	16,008	15,919	15,935	16,278	16,030
18	C, C	16,285	16,182	16,337	16,371	16,344	16,352	16,516	16,338
19	C, C	16,907	16,791	16,882	16,924	16,844	16,867	16,981	16,821
20	AN, W	11,852	11,612	11,722	11,708	11,790	11,797	12,553	11,715
21	C, C	14,650	14,403	14,875	14,829	14,904	14,901	15,351	14,630
22	W, W	10,618	10,574	10,669	10,656	10,678	10,678	11,450	10,610
23	W, W	11,582	11,550	11,580	11,581	11,584	11,585	12,407	11,575
24	W, W	11,688	11,594	11,641	11,641	11,643	11,641	12,384	11,639
25	W, W	9,077	9,085	9,080	9,080	9,085	9,086	9,737	9,081
26	W, AN	11,117	11,077	11,109	11,109	11,113	11,118	11,821	11,104
27	AN, AN	12,334	12,036	12,338	12,338	12,463	12,475	13,116	12,329
28	D, D	14,164	13,856	14,233	14,233	14,298	14,311	14,702	14,178
29	D, D	14,818	14,658	14,858	14,859	14,924	14,939	15,603	14,857
30	AN, BN	13,112	12,950	13,107	13,109	13,194	13,192	13,936	13,102
31	BN, D	14,433	14,090	14,446	14,445	14,556	14,585	15,142	14,456

Year	WY Type (Sacramento Valley, San Joaquin Valley)	NAA (TAF)	Alt1 (TAF)	Alt 2v1 (TAF)	Alt2v1 wTUCP (TAF)	Alt 2v2 (TAF)	Alt 2v3 (TAF)	Alt 3 (TAF)	Alt 4 (TAF)
32	AN, W	10,589	10,447	10,576	10,575	10,645	10,667	11,352	10,575
33	W, W	10,369	10,353	10,358	10,360	10,366	10,375	11,029	10,357
34	D, C	15,096	14,912	15,123	15,124	15,183	15,198	15,643	15,126
35	C, C	15,291	15,148	15,417	15,415	15,448	15,457	16,044	15,361
36	D, BN	15,777	15,638	15,865	15,861	15,872	15,883	16,169	15,825
37	BN, AN	12,847	12,748	12,884	12,883	12,937	12,945	13,366	12,856
38	W, W	10,067	10,036	10,065	10,066	10,057	10,059	10,714	10,061
39	BN, D	13,779	13,666	13,720	13,720	13,771	13,783	14,445	13,721
40	D, C	16,652	16,552	16,760	16,766	16,804	16,820	17,269	16,741
41	C, C	19,152	19,052	19,239	19,269	19,230	19,245	19,881	19,196
42	C, C	18,860	18,811	18,817	18,857	18,796	18,798	19,340	18,925
N/A	Average	13,465	13,337	13,489	13,495	13,520	13,532	14,091	13,471
N/A	Maximum	19,152	19,052	19,239	19,269	19,230	19,245	19,881	19,196
N/A	Minimum	9,077	9,085	9,080	9,080	9,085	9,086	9,737	9,081

TAF=thousand acre-feet; WY=water year
Water Year types: W=wet, AN=above normal, BN=below normal, D=dry, C=critical

Table 6-2, shows the change in annual average groundwater pumping as well as the range of changes to single year pumping.

Table 6-2. Simulated Change in Groundwater Pumping in the Central Valley for Each Alternative Compared to the No Action Alternative

Alternative	Average Annual Change in Groundwater Pumping	Maximum Single Year Change in Groundwater Pumping	Minimum Single Year Change in Groundwater Pumping
ALTERNATIVE 1			
TAF	-128	13	-343
% Difference	-0.9%	0.1%	-2.4%
ALTERNATIVE 2 WITH TUCP WITHOUT VA			
TAF	30	209	-144
% Difference	0.2%	1.3%	-1.2%

Alternative	Average Annual Change in Groundwater Pumping	Maximum Single Year Change in Groundwater Pumping	Minimum Single Year Change in Groundwater Pumping
ALTERNATIVE 2 WITHOUT TUCP WITHOUT VA			
TAF	24	225	-137
% Difference	0.2%	1.5%	-1.1%
ALTERNATIVE 2 WITHOUT TUCP DELTA VA			
TAF	55	253	-146
% Difference	0.4%	1.7%	-0.9%
ALTERNATIVE 2 WITHOUT TUCP SYSTEMWIDE VA			
TAF	67	250	-131
% Difference	0.5%	1.7%	-0.8%
ALTERNATIVE 3			
TAF	626	920	74
% Difference	4.9%	7.8%	0.4%
ALTERNATIVE 4			
TAF	6	185	-137
% Difference	0.0%	1.2%	-1.2%

TAF = thousand acre-feet
Positive numbers are an increase in pumping, negative numbers decreases in pumping

6.3.1.3 Central Coast

The C2VSimFG groundwater model does not include a simulation of groundwater conditions in the Central Coast Region. Changes in surface water supply delivered to this region could result in changes in the amount of groundwater pumped. *Chapter 6, Water Supply*, provides an analysis of potential changes in surface water supply delivered by each of the alternatives. A conservative estimate would be that any decrease in surface water supply delivered to the Southern California Region would results in an equal increase in groundwater pumping and assuming that existing GWB hydrogeology can support the increase. All groundwater pumping would need to be conducted in accordance with existing regulatory setting such as an adjudication or GSP.

The groundwater pumping amounts stipulated in adjudications and GSPs may be supported by recharge from surface water supplies as well as recharge from recycled water originally sourced by surface deliveries. Surface deliveries from the SWP are also in some Central Coast basins, an important support for satisfying salinity standards. In these basins, existing salinity levels in the underlying groundwater would limit its use to replace reduced surface water deliveries needed to support both sources of recharge. Without the ongoing support of groundwater recharge in this region, groundwater levels may decrease, eventually resulting in reduced groundwater production.

6.3.1.4 Southern California

Similar to the Central Coast Region, the C2VSimFG groundwater model does not include simulation of groundwater conditions in the Southern California Region. Changes in surface water supply delivered to this region could result in changes in the amount of groundwater pumped. Chapter 6 provides an analysis of potential changes in surface water supply delivered. A conservative estimate would be that any decrease in surface water supply delivered to the Southern California Region would results in an equal increase in groundwater pumping and assuming that existing GWB hydrogeology can support the increase. Decreases in surface water supply delivered to this region may result in a decrease in groundwater pumping. All groundwater pumping would need to be conducted in accordance with existing regulatory setting such as an adjudication or GSP.

The groundwater pumping amounts stipulated in adjudications and GSPs may be supported by recharge from surface water supplies as well as recharge from recycled water originally sourced by surface deliveries. Surface deliveries from the SWP are also in some Southern California basins, an important support for satisfying salinity standards. In these basins, existing salinity levels in the underlying groundwater would limit its use to replace reduced surface water deliveries needed to support both sources of recharge. Without the ongoing support of groundwater recharge in this region, groundwater levels may decrease, eventually resulting in reduced groundwater production.

6.3.2 Potential Changes in Groundwater-Surface Water Interaction Flow

6.3.2.1 Trinity River

Most usable groundwater in the Trinity River Region occurs in widely scattered alluvium-filled valleys, such as those immediately adjacent to the Trinity River. These valleys contain only small quantities of recoverable groundwater and therefore are not considered a major source. Given this hydrogeologic nature of this region, changes in surface water flow will likely result in little change to the groundwater-surface water interaction flow.

6.3.2.2 Central Valley

Table 6-3 shows annual groundwater-surface water interaction flow simulated by the C2VSimFG groundwater model across the entire Central Valley, from Red Bluff through the Tule region, including the Sacramento and San Joaquin valleys.

Table 6-3. Simulated Groundwater-Surface Water Interaction Flow in the Central Valley

Year	WY Type (Sacramento Valley, San Joaquin Valley)	NAA (TAF)	Alt 1 (TAF)	Alt 2v1 (TAF)	Alt2v1 wTUCP (TAF)	Alt 2v2 (TAF)	Alt 2v3 (TAF)	Alt 3 (TAF)	Alt 4 (TAF)
1	W, W	2,604	2,536	2,570	2,570	2,575	2,573	2,323	2,570
2	W, W	1,822	1,891	1,807	1,806	2,009	1,784	1,543	1,807

Year	WY Type (Sacramento Valley, San Joaquin Valley)	NAA (TAF)	Alt 1 (TAF)	Alt 2v1 (TAF)	Alt2v1 wTUCP (TAF)	Alt 2v2 (TAF)	Alt 2v3 (TAF)	Alt 3 (TAF)	Alt 4 (TAF)
3	C, C	1,555	1,241	1,561	1,560	1,570	1,569	1,552	1,557
4	C, C	1,673	1,566	1,864	1,738	1,746	1,751	2,245	1,684
5	AN, W	3,033	2,937	3,051	3,103	3,075	3,098	3,570	3,033
6	BN, AN	1,189	929	995	994	992	1,044	1,200	1,006
7	AN, W	2,047	2,032	2,045	2,041	2,074	2,074	2,153	2,016
8	D, D	1,129	1,140	1,127	1,127	1,108	1,127	1,177	1,113
9	W, W	1,842	1,812	1,840	1,840	1,859	1,670	2,002	1,832
10	W, W	2,866	2,861	2,872	2,872	2,880	2,881	2,899	2,871
11	W, AN	2,976	3,167	2,959	2,959	2,957	2,945	2,822	2,960
12	D, D	1,898	1,905	1,897	1,897	1,905	1,916	1,772	1,896
13	W, W	1,548	1,708	1,550	1,547	1,554	1,539	1,493	1,549
14	D, D	1,491	1,475	1,648	1,647	1,670	1,675	1,652	1,476
15	C, C	1,524	1,317	1,520	1,519	1,518	1,523	1,617	1,509
16	D, C	668	558	710	709	741	769	1,226	686
17	C, C	1,187	1,507	1,201	1,196	1,175	1,214	1,553	1,167
18	C, C	1,661	1,801	2,110	1,674	1,891	1,897	2,075	1,647
19	C, C	1,770	1,748	1,701	1,695	1,745	1,760	2,083	1,823
20	AN, W	2,162	2,058	1,942	1,940	1,932	1,959	2,176	1,922
21	C, C	1,459	1,405	1,468	1,477	1,507	1,534	1,602	1,480
22	W, W	1,936	1,795	2,002	1,989	2,008	1,032	1,355	1,945
23	W, W	1,442	1,600	1,456	1,454	1,468	1,479	1,764	1,434
24	W, W	2,276	2,475	2,064	2,063	2,071	2,074	2,247	2,052
25	W, W	2,374	2,728	2,390	2,390	2,387	2,385	2,009	2,389
26	W, AN	1,603	1,800	1,785	1,785	1,788	1,782	1,458	1,787
27	AN, AN	2,650	2,449	2,648	2,648	2,635	2,594	2,234	2,641
28	D, D	1,272	1,375	1,266	1,265	1,261	1,265	1,458	1,252
29	D, D	1,506	1,663	1,515	1,515	1,357	1,400	1,557	1,504
30	AN, BN	1,893	1,620	1,885	1,885	1,908	1,524	1,688	1,881
31	BN, D	1,748	1,735	1,735	1,734	1,742	1,775	1,738	1,728
32	AN, W	1,562	1,232	1,320	1,319	1,338	1,358	1,442	1,310
33	W, W	2,435	2,430	2,442	2,441	2,439	2,426	2,111	2,444
34	D, C	1,867	1,877	1,845	1,845	1,847	1,864	1,698	1,843
35	C, C	1,680	2,063	1,674	1,674	1,674	1,679	1,901	1,662

Year	WY Type (Sacramento Valley, San Joaquin Valley)	NAA (TAF)	Alt 1 (TAF)	Alt 2v1 (TAF)	Alt2v1 wTUCP (TAF)	Alt 2v2 (TAF)	Alt 2v3 (TAF)	Alt 3 (TAF)	Alt 4 (TAF)
36	D, BN	1,304	1,445	1,328	1,327	1,353	1,394	1,472	1,316
37	BN, AN	1,632	1,788	1,865	1,865	1,884	1,924	1,706	1,848
38	W, W	2,276	2,143	2,287	2,287	2,278	2,294	2,499	2,273
39	BN, D	1,934	1,934	1,946	1,947	1,940	1,957	1,575	1,946
40	D, C	2,131	2,110	1,772	1,771	1,800	1,834	2,059	1,959
41	C, C	2,083	1,994	2,137	2,124	2,119	2,169	2,408	2,084
42	C, C	2,463	2,404	2,330	2,335	2,333	2,349	2,988	2,312
N/A	Average	1,861	1,863	1,860	1,847	1,860	1,830	1,907	1,838
N/A	Maximum	3,033	3,167	3,051	3,103	3,075	3,098	3,570	3,033
N/A	Minimum	668	558	710	709	741	769	1,177	686

TAF=thousand acre-feet; WY=water year
Water Year types: W=wet, AN=above normal, BN=below normal, D=dry, C=critical

Table 6-4 shows the change in annual average groundwater-surface water interaction flow as well as the range of changes to single year flow.

Table 6-4. Simulated Change in Groundwater-Surface Water Interaction Flow in the Central Valley for Each Alternative Compared to the No Action Alternative

Alternative	Average Annual Change in Groundwater-Surface Water Interaction Flow	Maximum Single Year Change in Groundwater-Surface Water Interaction Flow	Minimum Single Year Change in Groundwater-Surface Water Interaction Flow
ALTERNATIVE 1			
TAF	2	383	-330
% Difference	0.1%	26.9%	-21.8%
ALTERNATIVE 2 WITH TUCP WITHOUT VA			
TAF	-14	233	-360
% Difference	-0.6%	14.3%	-16.9%
ALTERNATIVE 2 WITHOUT TUCP WITHOUT VA			
TAF	-1	449	-359
% Difference	0.3%	27.0%	-16.9%

Alternative	Average Annual Change in Groundwater-Surface Water Interaction Flow	Maximum Single Year Change in Groundwater-Surface Water Interaction Flow	Minimum Single Year Change in Groundwater-Surface Water Interaction Flow
ALTERNATIVE 2 WITHOUT TUCP DELTA VA			
TAF	-1	251	-331
% Difference	0.2%	15.4%	-16.6%
ALTERNATIVE 2 WITHOUT TUCP SYSTEMWIDE VA			
TAF	-31	292	-904
% Difference	-1.1%	17.9%	-46.7%
ALTERNATIVE 3			
TAF	46	572	-581
% Difference	4.7%	83.5%	-30.0%
ALTERNATIVE 4			
TAF	-23	216	-252
% Difference	-1.2%	13.2%	-16.2%

TAF = thousand acre-feet
Positive numbers are an increase in flow from surface water to groundwater, negative numbers are a decrease in the flow from surface water to groundwater.

6.3.2.3 Central Coast

The C2VSimFG groundwater model does not include a simulation of groundwater conditions in the Central Coast Region. Increases in groundwater pumping have the potential to increase the amount of water that discharges from streams to groundwater.

6.3.2.4 Southern California

The C2VSimFG groundwater model does not include simulation of groundwater conditions in the Southern California Region. Increases in groundwater pumping have the potential to increase the amount of water that discharges from streams to groundwater.

6.3.3 Potential Changes in Groundwater Elevation

6.3.3.1 Trinity River

Given that there is likely to be little change to the volume of groundwater either through pumping or groundwater-surface water interaction flow, there will be little change to groundwater levels in the area are also not expected to change.

6.3.3.2 Central Valley

Increases in groundwater pumping are likely to result in a decrease in the elevation of groundwater. The distribution of changes in groundwater level will vary across the Central Valley as well as in time. Table 6-5 shows the average, maximum, and minimum changes in simulated groundwater levels for each of the alternatives compared to the No Action Alternative for the five water year types.

Table 6-5. Simulated Change in Groundwater Table Elevation (feet) in the Central Valley for Each Alternative Compared to the No Action Alternative for Each Water Year Type

Alternative	Wet	Above Normal	Below Normal	Dry	Critical
ALTERNATIVE 1					
Average	1.2	1.2	1.0	1.1	1.3
Maximum	32.6	31.0	29.9	30.7	32.5
Minimum	-0.6	-0.6	-1.4	-0.9	-1.2
ALTERNATIVE 2 WITH TUCP WITHOUT VA					
Average	-0.2	-0.2	-0.2	-0.2	-0.3
Maximum	3.0	3.6	2.2	2.1	1.8
Minimum	-8.0	-7.8	-8.4	-8.8	-11.5
ALTERNATIVE 2 WITHOUT TUCP WITHOUT VA					
Average	-0.3	-0.2	-0.3	-0.3	-0.3
Maximum	2.3	1.7	1.2	1.8	2.0
Minimum	-11.0	-10.1	-12.0	-11.5	-12.5
ALTERNATIVE 2 WITHOUT TUCP DELTA VA					
Average	-0.7	-0.7	-0.7	-0.7	-0.8
Maximum	2.4	3.5	1.1	0.9	2.4
Minimum	-21.9	-20.0	-18.1	-19.9	-21.5
ALTERNATIVE 2 WITHOUT TUCP SYSTEMWIDE VA					
Average	-0.8	-0.8	-0.7	-0.8	-0.8
Maximum	2.8	3.0	1.2	0.9	2.3
Minimum	-20.1	-18.5	-17.6	-18.6	-20.0
ALTERNATIVE 3					
Average	-5.5	-5.1	-4.5	-5.0	-5.6
Maximum	0.5	0.7	0.5	0.7	2.4
Minimum	-158.6	-145.9	-125.0	-143.7	-155.2
ALTERNATIVE 4					
Average	0.0	0.0	0.0	0.0	-0.1

Alternative	Wet	Above Normal	Below Normal	Dry	Critical
Maximum	2.8	2.3	3.0	2.9	2.2
Minimum	-4.6	-4.6	-6.2	-5.3	-7.1

6.3.3.3 Central Coast

Increases in groundwater pumping in this region have the potential to reduce groundwater levels in the GWB and GWSB in the area. The decreases in surface water supply delivered are not expected to result in large increases in groundwater pumping, therefore, large decreases in groundwater levels are not expected. Increase in surface water supply delivery to the region may result in a reduction in groundwater pumping and, therefore, an increase in groundwater levels.

Groundwater pumping amounts stipulated in adjudications and GSPs may be supported by recharge from surface water supplies as well as recharge from recycled water. Surface deliveries from the SWP are important support both sources of recharge, because for some basins only SWP supplies satisfy salinity standards. Without the ongoing support of groundwater recharge, groundwater levels may decrease.

6.3.3.4 Southern California

Increases in groundwater pumping in this region have the potential to reduce groundwater levels in the GWB and GWSB in the area. The decreases in surface water supply delivered are not expected to result in large increases in groundwater pumping, therefore, large decreases in groundwater levels are not expected. Increase in surface water supply delivery to the region may result in a reduction in groundwater pumping and, therefore, an increase in groundwater levels.

Groundwater pumping amounts stipulated in adjudications and GSPs may be supported by recharge from surface water supplies as well as recharge from recycled water. Surface deliveries from the SWP are important support both sources of recharge, because for some basins only SWP supplies satisfy salinity standards. Without the ongoing support of groundwater recharge, groundwater levels may decrease.

6.3.4 Potential Changes in Land Subsidence

Additional information related to subsidence is available in Chapter 20, *Geology and Soils*, and Appendix W, *Geology and Soils Technical Appendix*.

6.3.4.1 Trinity River

The area along the Trinity River is not known to be susceptible to subsidence and groundwater pumping is not expected to increase in this region, suggesting that subsidence will not be a concern in this area.

6.3.4.2 Central Valley

On average, groundwater pumping is expected to increase (0.02% to 4.9%) for all alternatives compared to the No Action Alternative except for Alternative 1. Annual groundwater pumping is expected to vary from year-to-year and include both increases and decreases. Periods of sustained increases in groundwater pumping are more likely to result in land subsidence in areas that are susceptible to subsidence.

Average groundwater levels are simulated to decrease up to approximately 12 feet for Alternative 2 With TUCP Without VA and Alternative 2 Without TUCP Without VA in some water year types compared to the No Action Alternative. Groundwater levels may decrease closer to 20 feet for Alternative 2 Without TUCP Delta VA and Alternative 2 Without TUCP Systemwide VA compared to the No Action Alternative. Average groundwater levels are simulated to decrease up to approximately 160 feet for Alternative 3 in some water year types compared to the No Action Alternative. Average groundwater levels are generally expected to decrease up to 7 feet in certain water year types under Alternative 4 compared to the No Action Alterative. The largest decreases in groundwater levels are simulated to occur along the western portion of the Central Valley in the Sacramento Valley and in the San Joaquin Valley. Portions of these areas are known to have historic subsidence and further reductions in groundwater level may cause additional subsidence. Alternatives with larger decreases in groundwater levels have a higher likelihood of generating additional subsidence. The location and amount of subsidence is highly dependent on the local soil conditions and historical groundwater levels in the area.

6.3.4.3 Central Coast

The Central Coast region is not known to be susceptible to subsidence. Groundwater pumping is not expected to increase in this region suggesting that subsidence will not be a concern in this area.

6.3.4.4 Southern California

The Southern California region is not known to be susceptible to subsidence. Groundwater pumping is not expected to increase in this region suggesting that subsidence will not be a concern in this area.

6.3.5 Potential Changes in Groundwater Quality

6.3.5.1 Trinity River

Given that there is likely to be little change to groundwater conditions in this region either through pumping or groundwater-surface water interaction flow, there will similarly be little change generated by the alternatives on groundwater quality in the region.

6.3.5.2 Central Valley

Groundwater quality in the Central Valley has the potential to be affected if groundwater flow patterns and elevations change due to changes with implementation of the alternatives on groundwater pumping. Changes in groundwater pumping quantities and locations, and subsequent changes in groundwater elevation may result in groundwater moving faster or slower, in an altered flow direction, or to a different well. Increases or decreases in groundwater levels may also saturate or strand constituents in the soil matrix as the water table moves, thus changing the concentration of constituents in the groundwater. These changes in groundwater quality may result in a change in constituent concentrations depending on the local conditions and the water quality constituents present. The uncertainty in the distribution of water quality constituents does not allow for an assessment of the level of change, but groundwater quality may decrease due to changes from implementation of the alternatives.

6.3.5.3 Central Coast

Similar to the Central Valley, groundwater quality in the Central Coast Region has the potential to be affected if groundwater flow patterns and elevations change due to changes with implementation of the alternatives on groundwater pumping. The uncertainty in the distribution of water quality constituents does not allow for an assessment of the level of change, but groundwater quality may decrease due to changes from implementation of the alternatives.

6.3.5.4 Southern California

Groundwater quality in the Southern California Region has the potential to be affected if groundwater flow patterns and elevations change due to changes with implementation of the alternatives on groundwater pumping. The uncertainty in the distribution of water quality constituents does not allow for an assessment of the level of change, but groundwater quality may decrease due to changes from implementation of the alternatives.

6.3.5.5 Alternative 2B

Analysis of Alternative 2B, although qualitative, builds on the quantitative analysis provided for Alternative 2. Only components under Alternative 2B that are expected to result in changes to groundwater pumping compared with Alternative 2 are discussed.

Alternative 2B is anticipated to be more restrictive on Delta exports than Alternative 2 and the No Action Alternative. Please see Chapter 5, Water Supply, for a description of the restrictions associated with the QWEST criteria under Alternative 2B. These restriction on exports may result in a decrease of surface water supply. There may be an increase in groundwater pumping to meet water supply demands. An increase in groundwater pumping may result in exacerbation of groundwater overdraft and increase in the potential for ground subsidence. Additionally, increased groundwater pumping to make up the reduced water supply may result in a change in groundwater quality.

In addition to the more restrictive QWEST criteria, Alternative 2B includes an extension of the Clifton Court Forebay (CCF) operation period to December 1 through March 31 from mid-December through mid-March, effectively increasing the operation of the SWP by one month. This extended operation would result in an increase in available surface water supply that may result in a decrease in groundwater pumping. Decreases in groundwater pumping result in less potential for exacerbating groundwater overdraft and decreased potential for ground subsidence. Groundwater quality may improve when less groundwater is pumped.

On the other hand, this extension in the operation of the CCF may result in more frequently exceeding seasonal and weekly salvage thresholds that may not have otherwise been exceeded. Exceeding these thresholds would result in additional export restrictions and potential decreased availability of surface water supply. There may be an increase in groundwater pumping to meet water supply demands. Potential adverse impacts of increased groundwater pumping are described above in relation to the export restrictions associated with more restrictive QWEST criteria.

6.3.5.6 Alternative 4B

Alternatives 4B is expected to be within the range of effects for groundwater described above for Alternative 4.

6.4 Mitigation Measures

No avoidance and minimization measures or additional mitigation measures have been identified for groundwater.

6.5 Cumulative Impact

The No Action Alternative would continue with the current operation of the CVP and is not expected to result in potential changes to groundwater pumping, groundwater-surface water interaction, groundwater elevation, land subsidence, and groundwater quality. The action alternatives will result in changes to groundwater pumping, groundwater-surface water interaction, groundwater elevation, land subsidence, and groundwater quality. The magnitude of the changes is dependent on alternative and water year type. Therefore, the No Action Alternative is not expected to contribute to cumulative changes to groundwater while the action alternatives may minimally contribute to cumulative changes to groundwater as described in Appendix I, *Groundwater* and Appendix Y, *Cumulative Impacts Technical Appendix*.

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Chapter 7 Indian Trust Assets

This chapter is based on the background information and technical analysis documented in Appendix J, *Indian Trust Resources Technical Appendix*, which includes additional information on Indian Trust Assets and technical analysis of the effects of each alternative.

7.1 Affected Environment

Federal Indian Trust Asset policies have been used to identify potential areas of change to Indian Trust Assets (ITAs) that could occur due to changes in long-term operation of the Central Valley Project (CVP) and/or State Water Project (SWP) facilities.

The ITAs are legal interests in property held in trust by the United States for federally recognized Indian Tribes or individual Indians. An Indian trust has three components: (1) the trustee, (2) the beneficiary, and (3) the trust asset. ITAs can include land, minerals, federally reserved hunting and fishing rights, federally reserved water rights, and in-stream flows associated with trust land. Beneficiaries of the Indian trust relationship are federally recognized Indian Tribes with trust land; the United States is the trustee. By definition, ITAs cannot be sold, leased, or otherwise encumbered without approval of the U.S. government. The characterization and application of the U.S. trust relationship have been defined by case law that interprets congressional acts, executive orders, and historic treaty provisions.

The federal government, through treaty, statute, or regulation, may take on specific, enforceable fiduciary obligations that give rise to a trust responsibility to federally recognized Tribes and individual Indians possessing trust assets. Courts have recognized an enforceable federal fiduciary duty with respect to federal supervision of Indian money or natural resources, held in trust by the federal government, where specific treaties, statutes or regulations create such a fiduciary duty.

The U.S. Government’s trust responsibility for Indian resources requires Reclamation and other agencies to take measures to protect and maintain trust resources. These responsibilities include taking reasonable actions to preserve and restore tribal resources. Table J.1-1 in Appendix J lists federally recognized Tribes in the vicinity of the study area. The analysis focuses on changes in reservoir and channel erosion and water quality conditions in all project rivers, and salmon fisheries in the Trinity River. There are no ITAs in the rivers in the Central Valley that would be affected by the project.

7.2 Effects of the Alternatives

The impact analysis considers changes in ITAs related to changes in CVP and SWP operation under the alternatives as compared with the No Action Alternative.

The No Action Alternative is based on 2040 conditions. Changes that would occur over that time frame without implementation of the action alternatives are not analyzed in this chapter. However, the changes to ITAs that are assumed to occur by 2040 under the No Action Alternative are summarized in this section.

The changes to Indian Trust Assets that are assumed to occur by 2040 under the No Action Alternative conditions would be different than existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

In the long term, it is anticipated that climate change, and development throughout California, could affect water supply deliveries.

Under the No Action Alternative, Reclamation would continue with the current operation of the Central Valley Project (CVP), as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the State Water Project represent current management direction or intensity pursuant to 43 Code of Federal Regulations Section 46.30.

Although the No Action Alternative included habitat restoration projects at a programmatic level, the 2020 ROD did not provide environmental coverage for these projects, and all of the habitat projects considered under the No Action required or will require additional environmental documentation. Thus, ground disturbance for habitat restoration projects did not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

The No Action Alternative, thus, is expected to result in potential changes to erosion or degradation of sites of religious or cultural importance to federally recognized Tribes, quality of water used by a federally recognized Tribe, and salmonid populations. These changes were described and considered in the 2020 Record of Decision.

Alternatives 2B and 4B are expected to be within the range of effects for ITAs described below for Alternatives 2 and 4, respectively.

7.2.1 Potential Changes in Erosion or Degradation of Land or Sites of Religious or Cultural Importance to Federally Recognized Tribes

Appendix W, *Geology and Soils Technical Appendix,* describes in detail channel (bed and bank) erosion in rivers in the project area due to changes in the operation of the CVP/SWP under

Alternatives 1 through 4 relative to the No Action Alternative. Under the No Action Alternative, peak flows in the rivers analyzed would remain as under current conditions and the nature and extent of erosion of the bed and banks of these rivers would not change. Alternative 1 would result in a potential decrease (-1.8% average annually in wet periods to -3.1% average annually in dry periods) in erosion in the Trinity River. Under Alternatives 2 through 4, while there could be negligible increased potential of erosion in some of the rivers, including the Trinity River which has ITAs, there would likely be negligible to no resulting change in degradation of land or sites of religious or cultural importance caused by changes in erosion.

7.2.2 Potential Changes in Quality of Water Used by a Federally Recognized Tribe

Appendix G, *Water Quality Technical Appendix,* describes changes in flow in the study area rivers and resulting changes in water quality due to changes in the operation of the CVP/SWP under Alternatives 1 through 4 relative to the No Action Alternative. Under the No Action Alternative, there would be no anticipated change in water quality. Under Alternatives 1 through 4, the water quality in the Trinity River would be similarly affected by changes in flow caused by changes in operations compared with the No Action Alternative.

7.2.3 Potential Changes to Salmonid Populations

A detailed analysis is provided in Appendix O, *Aquatic Resources Technical Appendix*. Under Alternatives 1 and 3, relative to the No Action Alternative, the seasonal operations would have similar effects on salmonid populations in the Trinity River compared with the No Action Alternative. Under Alternative 2 with TUCP without VA, relative to the No Action Alternative, the seasonal operations would have similar effects on most species and life stages but would result in minor adverse effects on spawning and incubating Southern Oregon/Northern California Coast Coho salmon. Under Alternative 4 relative to the No Action Alternative, the seasonal operations would result in similar effects on most species and life stages except for migrating and holding adult Southern Oregon/Northern California Coast Coho salmon. Therefore, Alternative 2 with TUCP without VA and Alternative 4 would have e minor adverse effects on the federally recognized Tribes which have fishing rights for Coho salmon.

7.3 Mitigation Measures

No avoidance and minimization measures or additional mitigation has been identified for Indian Trust Assets.

7.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and may result in potential changes to erosion or degradation of land or sites of religious or cultural importance to federally recognized Tribes, quality of water used by a federally recognized Tribe, and salmonid populations. Under the action alternatives, flow changes and water fluctuations would not be of a magnitude that would be expected to result in changes to erosion or degradation of land or sites of religious or cultural importance to federally recognized Tribes, quality of water used by a federally recognized Tribes, and salmonid populations in the Trinity River. As such, the

No Action Alternative may contribute to cumulative impacts to Indian Trust Assets while the action alternatives would not result in cumulative impacts to Indian Trust Assets as described in Appendix J, *Indian Trust Assets* and Appendix Y, *Cumulative Impacts Technical Appendix***.** Any cumulative impacts resulting from the No Action Alternative and the action alternatives on salmonids are discussed in detail in Appendix O.

Chapter 8 Cultural Resources

This chapter is based on the background information and technical analysis documented in Appendix K, *Cultural Resources Technical Appendix*, which includes additional information and detail on cultural resource conditions and technical analysis of the effects of each alternative.

8.1 Affected Environment

The study area has a long and complex cultural history with distinct regional patterns that began more than 11,000 years ago. The first generally agreed upon evidence for the presence of prehistoric peoples in the study area is represented by the distinctive fluted spear points called Clovis points. The subsequent period from about 10,000 to 8,000 years before present is characterized in the archaeological record by a small number of sites with stemmed spear points instead of fluted spear points. Approximately 8,000 years ago, many California cultures shifted the main focus of their subsistence strategies from hunting to seed gathering.

Initial contact between Europeans and Native Americans occurred when Spanish missionaries and soldiers entered California from the south in 1769, eventually founding 21 missions along the California coast. This period was also characterized by the establishment military presidios, development of large tracts of land owned by the missions, and subjugation of the local Indian population for labor. This way of life began to change in 1822 when Mexico became independent of Spain. The mission lands were divided by government grants into large ranchos.

Extensive transportation systems were created to support the growing population of settlers. Many of the supply centers and shipment points along these transportation corridors developed into cities, towns, and settlements. During the latter part of the nineteenth century, American ranchers amassed large tracts of former rancho land and formed several great cattle empires. As settlements grew, farming increased. Irrigation was virtually unknown in California until the 1880s, when large-scale irrigation systems were developed to improve agriculture yields. Irrigation capabilities further expanded in the 1950s and 1960s with the implementation of multiple water projects.

The study area encompasses lands occupied by more than 40 distinct Native American cultural groups. Although most California tribes shared similar elements of social organization and material culture, linguistic affiliation and territorial boundaries primarily distinguish them from each other. Before European settlement of California, an estimated 310,000 native Californians spoke dialects of as many as 80 languages representing six major North American language stocks.

8.2 Effects of the Alternatives

The impact assessment considers changes to existing or potential cultural resources related to changes in Central Valley Project (CVP) and State Water Project (SWP) operations under the alternatives as compared with the No Action Alternative.

Because there is no ground disturbance involved in the action alternatives, the key mechanism for impacts on cultural resources is the potential for inundation and/or exposure of buried archaeological historic properties in a way that can cause damage or destruction to those properties. Because the coordinated long-term operation of the CVP and SWP is subject to Section 106 of the National Historic Preservation Act, Reclamation is responsible for compliance with Section 106. Compliance with Section 106 follows a series of steps, identified in its implementing regulations found at 36 Code of Federal Regulations Part 800, that include identifying consulting and interested parties, delineating an area of potential effects, identifying historic properties within the area of potential effects, and assessing effects on any identified historic properties, and resolving adverse effects through consultations with the State Historic Preservation Officer, Indian tribes, and other consulting parties.

The No Action Alternative is based on 2040 conditions. Changes that would occur over that time frame without implementation of the action alternatives are not analyzed in this chapter. However, the changes to cultural resources that are assumed to occur by 2040 under the No Action Alternative are summarized in this section.

Conditions in 2040 would be different than existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

Under the No Action Alternative, Reclamation would continue with the current operation of the Central Valley Project (CVP), as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the State Water Project (SWP) represent current management direction or intensity pursuant to 43 CFR Section 46.30.

The No Action Alternative includes habitat restoration projects at a programmatic level, but these habitat projects require additional site specific environmental documentation. Thus, ground disturbance for habitat restoration projects would not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis of the No Action Alternative, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

Under the No Action Alternative, land uses in 2040 would occur in accordance with adopted general plans, which could result in impacts to cultural resources. In terms of CVP operations, under the No Action Alternative, by the end of September, the surface water elevations at CVP reservoirs generally decline. It is anticipated that climate change would result in more short-duration high-rainfall events and less snowpack in the winter and early spring months. The reservoirs would be full more frequently by the end of April or May by 2040 than in recent historical conditions, potentially resulting in less exposure of previously inundated areas around reservoirs and therefore less exposure of potential cultural resources. However, as the water is released in the spring, there would be less snowpack to refill the reservoirs. This condition would reduce reservoir storage, thereby increasing the vertical height of the exposed but previously inundated area around reservoirs and potentially exposing cultural resources.

The No Action Alternative is not expected to result in potential effects to historic properties at reservoirs that store CVP water and in tributaries.

Alternatives 2B and 4B are expected to be within the range of effects for cultural resources described below for Alternatives 2 and 4, respectively.

8.2.1 Project Activities with Potential to Affect Historic Properties

Alternatives 1 through 4 would make changes to the year-to-year magnitude of releases, pattern of releases within a year, rate of change in release rates (ramping), minimum instream flows, and other operational parameters at a variety of CVP facilities. If peak river flows or reservoir levels have substantial increases beyond the No Action Alternative, the action alternatives could result in erosion in areas with historic properties and has the potential to adversely affect the historic properties if they are present. However, storage changes are relatively small during each year type and follow existing patterns in reservoir storage. River flows would generally be within the range of fluctuations occurring under the No Action Alternative. Therefore, Alternatives 1 through 4 do not have the potential to adversely affect historic properties, if they are present, because no actions would result in alteration, damage, or demolition of historic properties. No mitigation is identified.

8.3 Mitigation Measures

No avoidance and minimization measures or mitigation measures have been identified for cultural resources.

8.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and is not expected to affect historic properties. The action alternatives would make changes to the year-to-year magnitude of releases, pattern of releases within a year, rate of change in release rates (ramping), minimum instream flows, and other operational parameters at a variety of CVP facilities. The magnitude of the changes is dependent on alternative and water year type. Under the action alternatives, there are no activities which include ground disturbing activities and/or alteration to a historic property and the range of flow fluctuations are within the range of flow fluctuations associated with the No Action Alternative. As such, the No Action Alternative and the action alternatives are not expected to result in cumulative impacts to cultural resources. as described in Appendix K *Cultural Resources* and Appendix Y, *Cumulative Impacts Technical Appendix*.

Chapter 9 Air Quality

This chapter is based on the background information and technical analysis documented in Appendix L, *Air Quality Technical Appendix*, which includes additional information on air quality conditions and technical analysis of the effects of each alternative.

9.1 Affected Environment

The U.S. Environmental Protection Agency (USEPA) has set National Ambient Air Quality Standards (NAAQS) for seven common pollutants, known as criteria pollutants, according to health-based criteria. The criteria pollutants are carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ozone, particulate matter of 10 microns diameter and smaller (PM_{10},), particulate matter of 2.5 microns diameter and smaller ($PM_{2.5}$), and sulfur dioxide (SO_2). The California Air Resources Board (CARB) has set state ambient air quality standards that are similar or stricter than the NAAQS. Lead is not a component of the fuels used in power plants and consequently is not assessed. Reactive organic gases (ROG), though not a criteria pollutant, are evaluated because they contribute to ozone formation. Ozone is not emitted directly from sources but is formed in the atmosphere from chemical reactions of the ozone precursor chemicals nitrogen oxides (NO_x) and ROG. Therefore, potential ozone impacts are assessed based on emissions of NO_x and ROG.

USEPA and CARB have designated many of the counties in the action area as nonattainment (not meeting the NAAQS) for one or more pollutants, based on ambient concentrations measured by a network of monitors. Appendix L provides information on the attainment status of each county in the action area.

9.2 Effects of the Alternatives

The impact analysis considers changes in air quality related to changes in CVP and SWP operation under the alternatives as compared with the No Action Alternative.

The No Action Alternative is based on 2040 conditions. The changes to emissions that are assumed to occur by 2040 under the No Action Alternative conditions would be different from existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

Under the No Action Alternative, Reclamation would continue with the current operation of the CVP, as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions.

The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the SWP represent current management direction or intensity pursuant to 43 CFR Section 46.30.

Although the No Action Alternative included habitat restoration projects at a programmatic level, the 2020 ROD did not provide environmental coverage for these projects, and all of the habitat projects considered under the No Action required or will require additional environmental documentation. Thus, ground disturbance for habitat restoration projects did not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

For the purposes of this analysis, the changes in operations and flows are linked to changes in air pollutant emissions because changes in operations and flows affect the amount of power the hydroelectric facilities in the system can generate. Where flows increase on rivers that have hydroelectric facilities then hydropower generation could increase. The additional hydroelectric power is expected to displace power that must be purchased from suppliers connected to the regional electric system (grid). To the extent that the displaced power would have been generated by fossil-fueled power plants, emissions of criteria pollutants from these plants would decrease. Conversely, if hydropower generation decreases, the decrease must be offset by purchased power from the grid to meet demand for power. To the extent that the additional purchased power would have been generated by fossil-fueled power plants, emissions from these plants would increase.

Changes in river flows and reservoir levels also can affect the amount of water available for agricultural irrigation. If surface water availability decreases, farmers could make up the difference in water supply by increasing groundwater pumping, which could lead to an increase in emissions. Conversely, if surface water availability increases, farmers could decrease the amount of groundwater they pump, which could lead to a decrease in emissions.

- The No Action Alternative, thus, is expected to result in potential changes to air quality from potential changes in emissions from fossil-fueled power plants, hydropower generation, and groundwater pumping. These changes were described and considered in the 2020 Long-term Operation of the CVP and SWP record of decision and associated documents.

Alternative 4B is expected to be within the range of effects for air quality described below for Alternative 4.

9.2.1 Air quality impacts from potential changes in emissions from fossil-fueled power plants (hydropower generation)

The action alternatives would change operations of the CVP and SWP, which change river flows and reservoir levels. These changes could affect the amount of hydroelectric energy generated, as well as the amount of energy used for operations and pumping, at CVP and SWP facilities. Net energy is the difference between energy generated and energy used. When net energy is positive the CVP and SWP sell the excess to the grid, and GHG emissions from power plants decrease. When net energy is negative the CVP and SWP purchase power from the grid, and GHG emissions from power plants (to the extent fossil-fueled) supplying that power increase.

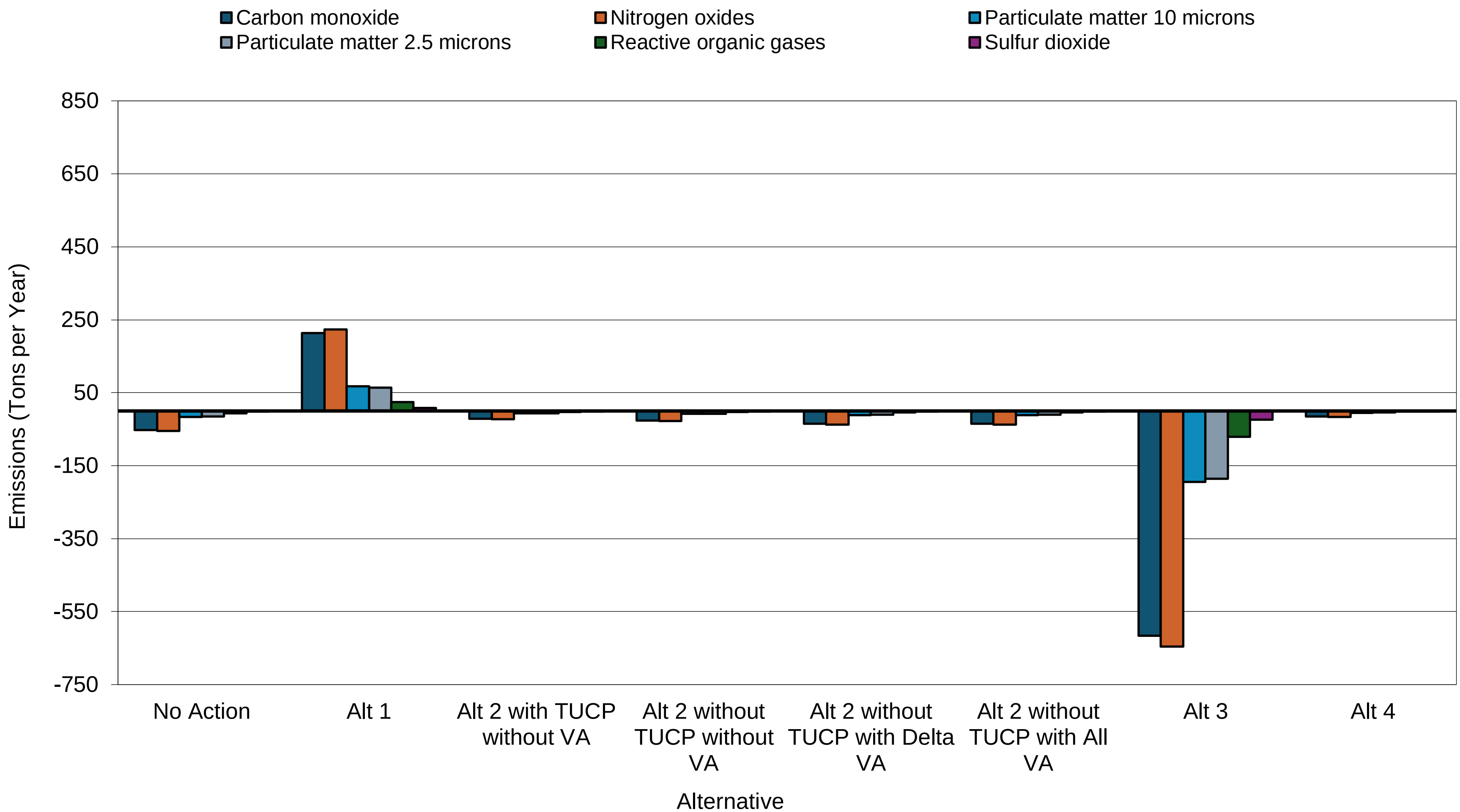
With alternatives 1, 2 (all four phases), and 4, net energy would decrease compared to the No Action Alternative (decreases of long-term averages from 4% to 42% for SWP and no change to 4% for CVP), and as a result emissions would increase. The increases would be largest with Alternative 1, less with Alternative 2 (all four phases), and least with Alternative 4. With Alternative 3 net energy would increase compared to the No Action Alternative (increases of long-term averages of 77% for SWP and 21% for CVP), and as a result emissions would decrease.

Table 9-1 shows the estimated emissions from fossil-fueled grid power plants associated with net generation. Figure 9-1 and Figure 9-2 show the emissions of each pollutant for grid power generation and the changes compared to the No Action Alternative, respectively.

Table 9-1. Emissions from Net Generation.

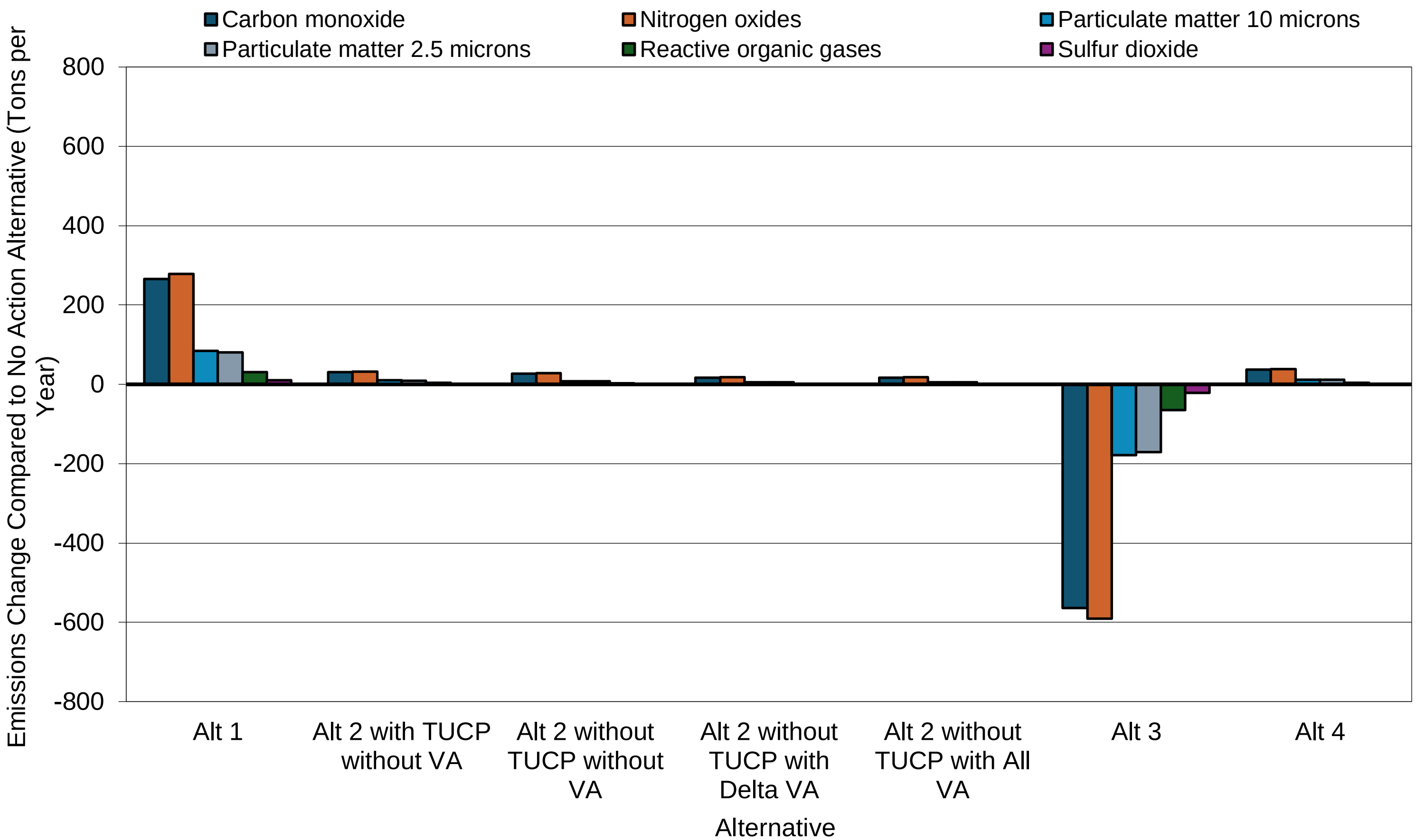
Pollutant	Emissions (U.S. tons per average year)							
	No Action	**Alt 1**	**Alt 2 with TUCP without VA**	**Alt 2 without TUCP without VA**	**Alt 2 without TUCP with Delta VA**	**Alt 2 without TUCP with All VA**	**Alt 3**	**Alt 4**
CO	-52	214	-21	-26	-35	-35	-617	-15
NO_x	-55	223	-22	-27	-37	-37	-645	-16
PM_{10}	-17	68	-7	-8	-11	-11	-195	-5
$PM_{2.5}$	-16	64	-6	-8	-11	-11	-186	-5
ROG	-6	25	-2	-3	-4	-4	-71	-2
SO_2	-2	8	-1	-1	-1	-1	-24	-1

Notes:
Values represent the emissions effects of net generation, i.e., CVP/SWP hydropower generation minus CVP/SVP energy use. Emissions of zero would indicate that CVP/SWP hydropower generation exactly equals CVP/SWP energy use. Negative emission values indicate decreases in emissions because net generation is positive and displaces grid power; positive emission values indicate increases in emissions because net generation is negative and CVP/SWP purchases the needed power from the grid.
CO = carbon monoxide; NOx = nitrogen oxides; PM_{10} = particulate matter of 10 microns diameter and smaller; $PM_{2.5}$ = particulate matter of 2.5 microns diameter and smaller; ROG = reactive organic gases; SO_2 = sulfur dioxide; Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements



Notes: Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements

Figure 9-1. Emissions from Grid Power Generation.



Notes: Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements

Emissions for the No Action Alternative are not shown because they are the baseline to which changes under the action alternatives are compared. These baseline emissions are indicated by the No Action bar in Figure 9-1.

Figure 9-2. Changes in Emissions from Grid Power Generation Compared to the No Action Alternative.

9.2.2 Air quality impacts from potential changes in emissions from fossil-fueled power plants (groundwater pumping)

The action alternatives would change operation of the CVP and SWP, which could change river flows and reservoir levels. These changes could affect the amount of water available for agricultural irrigation. If surface water availability decreases, farmers could make up the difference in water supply by increasing groundwater pumping. To the extent that the additional purchased power would be generated by fossil-fueled power plants, emissions from these plants could increase. Conversely, if surface water availability increases, farmers could decrease the amount of groundwater they pump, which could lead to a decrease in emissions.

Air quality effects resulting from changes in groundwater pumping were evaluated on a project-wide basis in terms of air pollutant emissions from the fossil-fueled power plants (for electrically-powered pumps) and from engines (for engine-powered pumps). For the details of the groundwater modeling on which the air quality analysis was based and the project-wide quantities of water pumped, see Appendix I, *Groundwater Technical Appendix*. Table 9-2 shows the estimated emissions from fossil-fueled grid power plants associated with net generation. Figure 9-3 and Figure 9-4 show the emissions of each pollutant for grid power generation and the changes compared to the No Action Alternative, respectively.

Table 9-2. Emissions from Groundwater Pumping.

Pollutant	Emissions (U.S. tons per average year)							
	No Action	Alt 1	Alt 2 with TUCP without VA	Alt 2 without TUCP without VA	Alt 2 without TUCP with Delta VA	Alt 2 without TUCP with All VA	Alt 3	Alt 4
ELECTRIC PUMPS								
CO	1,853	1,835	1,857	1,856	1,862	1,861	1,939	1,854
NO_x	1,939	1,921	1,943	1,943	1,949	1,947	2,029	1,940
PM_{10}	586	581	587	587	589	589	613	586
$PM_{2.5}$	559	554	560	560	562	561	585	559
ROG	214	212	214	214	215	215	224	214
SO_2	72	71	72	72	73	72	76	72
DIESEL PUMPS								
CO	9,492	9,402	9,513	9,509	9,539	9,531	9,933	9,496
NO_x	8,670	8,588	8,690	8,686	8,713	8,706	9,073	8,674
PM_{10}	275	272	275	275	276	276	287	275
$PM_{2.5}$	251	248	251	251	252	252	262	251
ROG	1,034	1,024	1,037	1,036	1,039	1,038	1,082	1,035
SO_2	17	17	17	17	17	17	17	17

Pollutant	Emissions (U.S. tons per average year)							
	No Action	Alt 1	Alt 2 with TUCP without VA	Alt 2 without TUCP without VA	Alt 2 without TUCP with Delta VA	Alt 2 without TUCP with All VA	Alt 3	Alt 4
TOTAL PUMPING EMISSIONS [1]								
CO	11,345	11,237	11,370	11,365	11,401	11,391	11,872	11,350
NO_x	10,609	10,508	10,633	10,628	10,662	10,653	11,103	10,614
PM_{10}	861	853	863	862	865	864	901	861
$PM_{2.5}$	810	802	812	811	814	813	848	810
ROG	1,248	1,236	1,251	1,250	1,254	1,253	1,306	1,249
SO_2	89	88	89	89	89	89	93	89

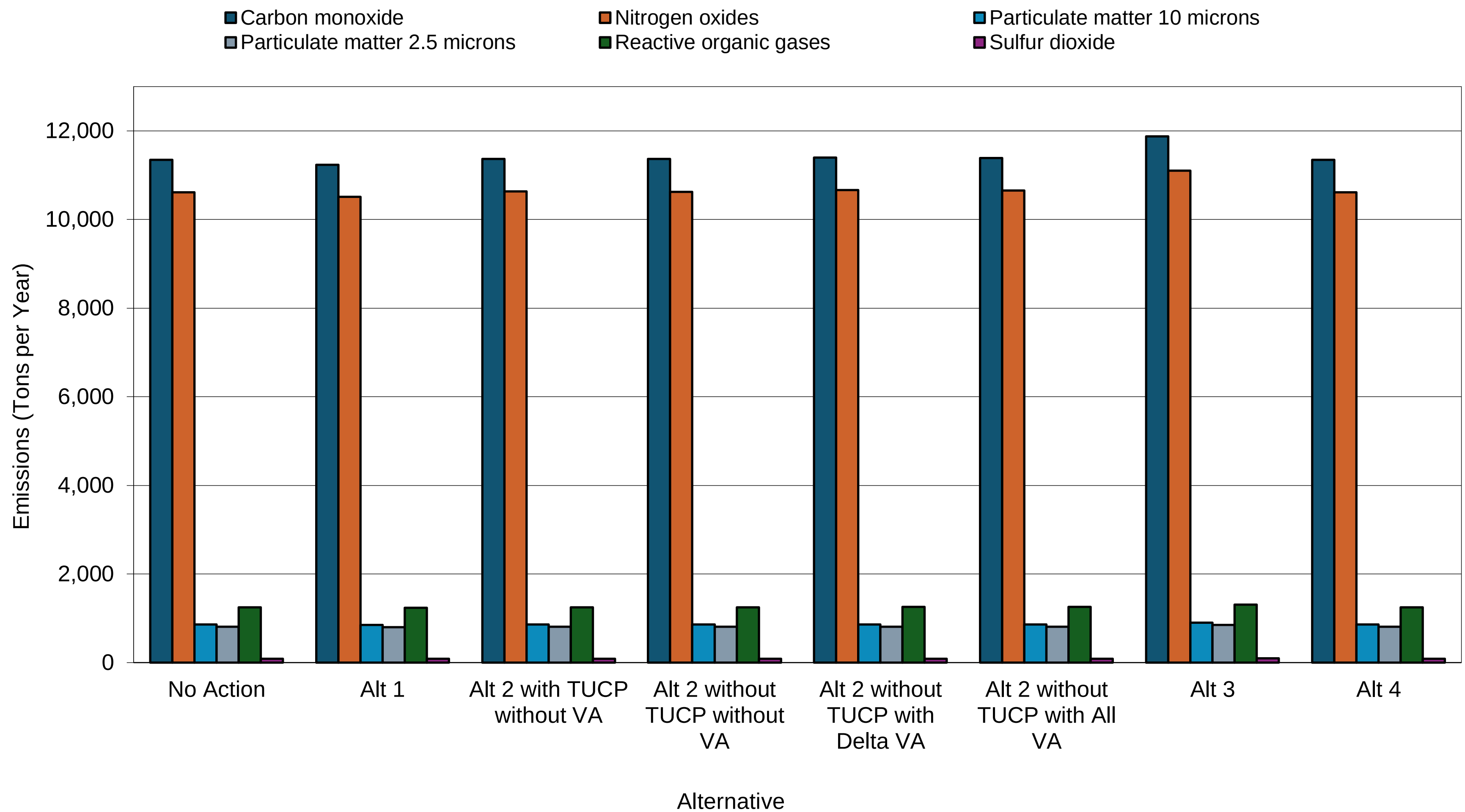
Notes: Alt = Alternative; CO = carbon monoxide; NO_x = nitrogen oxides; PM_{10} = particulate matter of 10 microns diameter and smaller; $PM_{2.5}$ = particulate matter of 2.5 microns diameter and smaller; ROG = reactive organic gases; SO_2 = sulfur dioxide; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements

[1] Sum of individual values may not equal total due to rounding.

9.2.3 Air quality impacts from combined potential changes in emissions

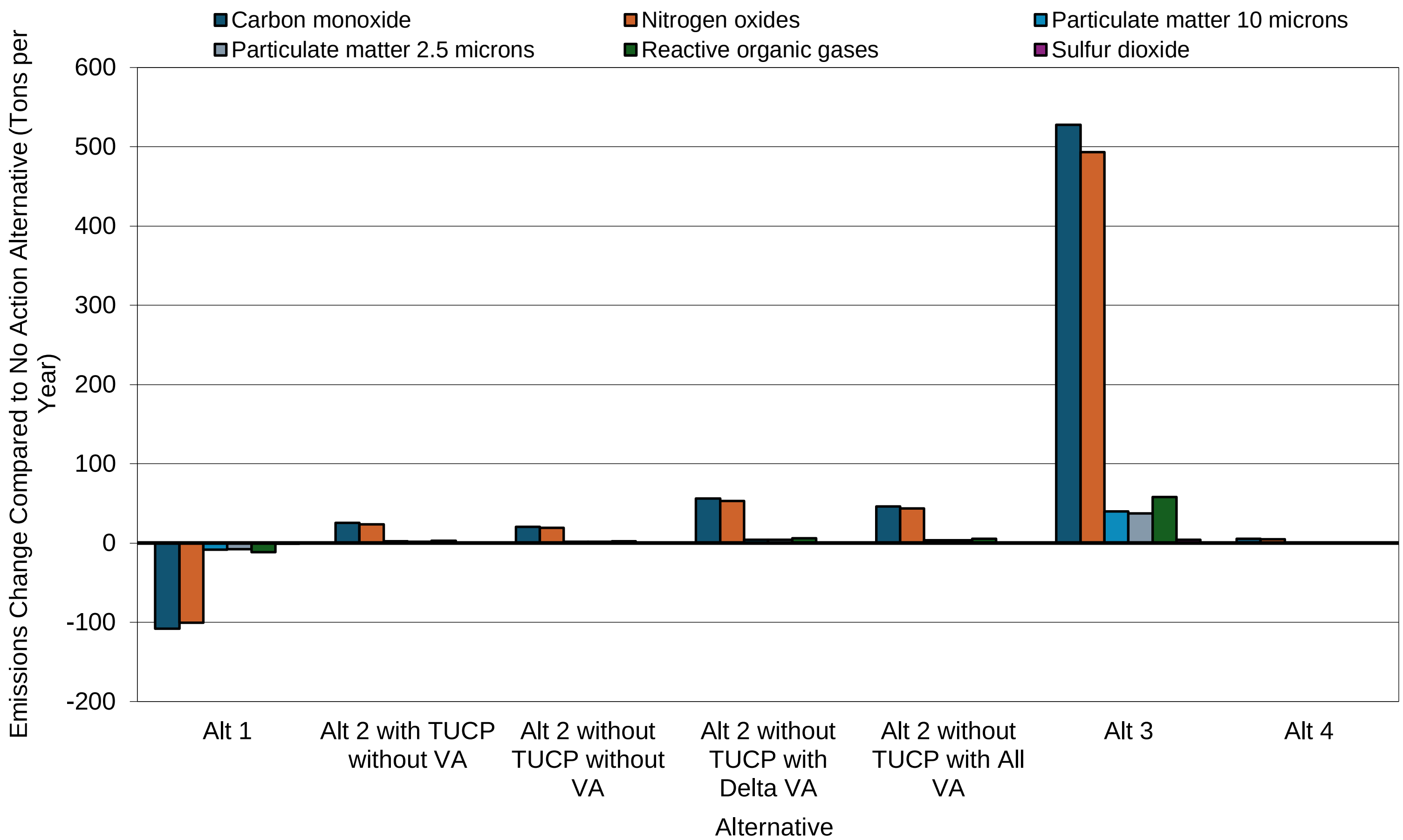
The total emissions associated with the alternatives are the sum of the emissions from net generation (Table 9-1) and groundwater pumping (Table 9-2). Table 9-3 shows the estimated total project emissions for a long-term average year. Figure 9-5 and Figure 9-6 show the overall emissions of each pollutant for all emission sources, and the changes in emissions compared to the No Action Alternative, respectively.

Alternative 1 would lead to increases in regional emissions of CO, NO_X, PM_{10}, $PM_{2.5}$, ROG, and SO_2 compared to the No Action Alternative by 1.4% to 11% depending on the pollutant. Alternative 2, including all four phases, would lead to increases in regional emissions of CO, NO_X, PM_{10}, $PM_{2.5}$, ROG, and SO_2 compared to the No Action Alternative by 0.4% to 1.6% depending on the pollutant. Alternative 3 would lead to decreases in regional emissions of CO, NO_X, PM_{10}, $PM_{2.5}$, ROG, and SO_2 compared to the No Action Alternative by 0.3% to 20.6% depending on the pollutant. Alternative 4 would lead to increases in regional emissions of CO, NO_X, PM_{10}, $PM_{2.5}$, ROG, and SO_2 compared to the No Action Alternative by 0.4% to 1.7% depending on the pollutant.



Notes: Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements

Figure 9-3. Emissions from Groundwater Pumping.



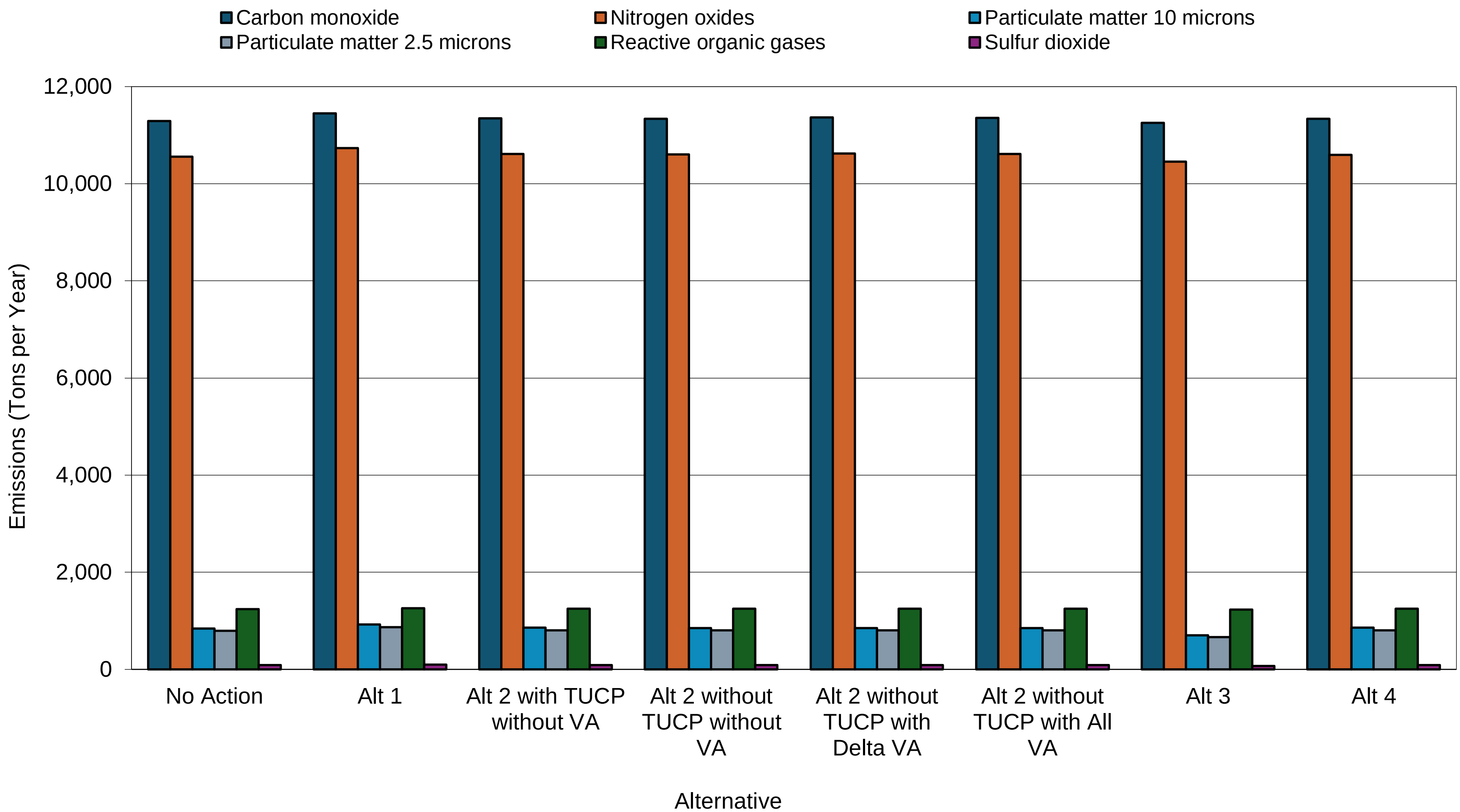
Notes: Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements
Emissions for the No Action Alternative are not shown because they are the baseline to which changes under the action alternatives are compared. These baseline emissions are indicated by the No Action bar in Figure 9-3.

Figure 9-4. Changes in Emissions from Groundwater Pumping Compared to the No Action Alternative.

Table 9-3. Total Project Emissions.

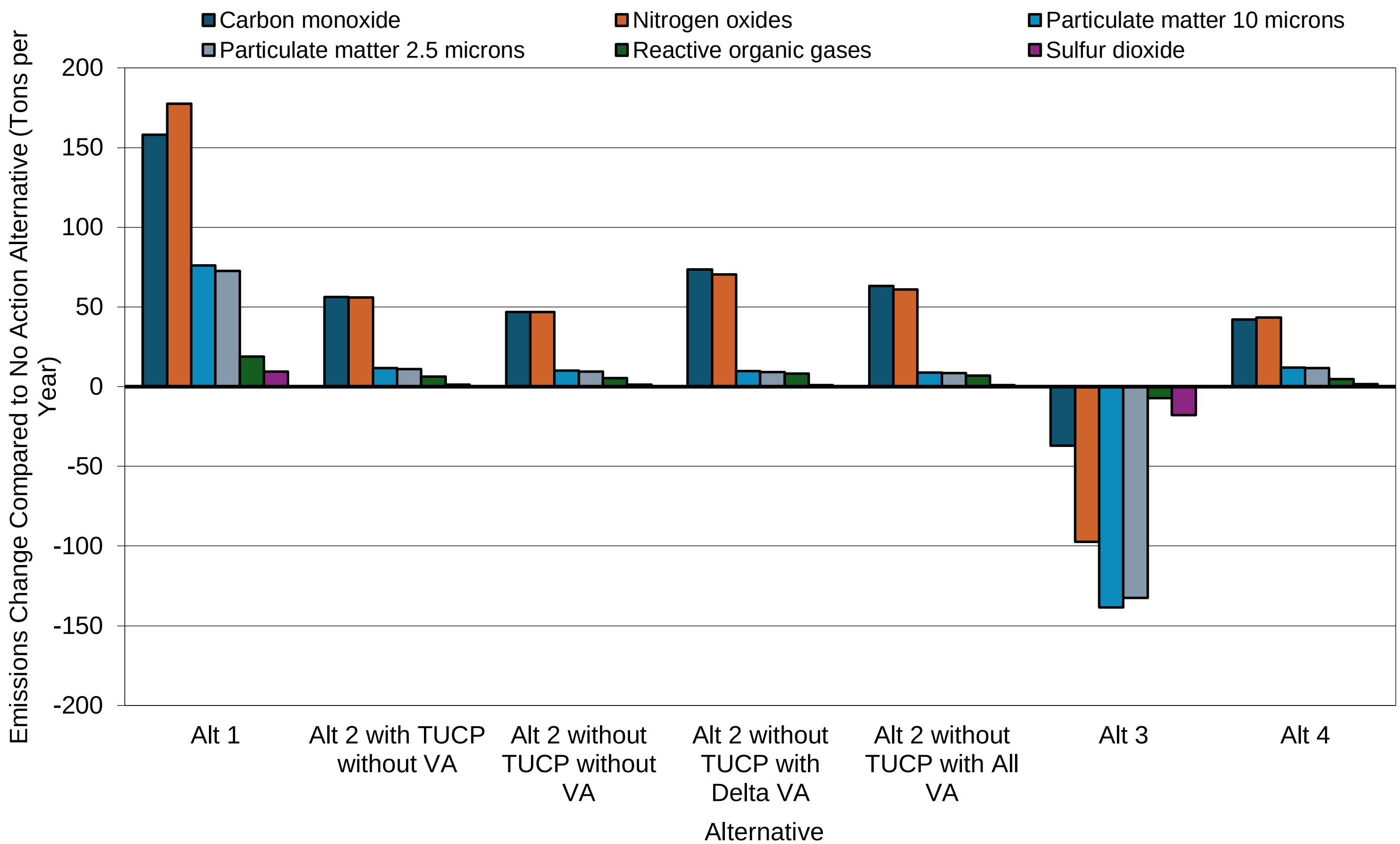
Pollutant	Emissions (U.S. tons per average year)							
	No Action	Alt 1	Alt 2 with TUCP without VA	Alt 2 without TUCP without VA	Alt 2 without TUCP with Delta VA	Alt 2 without TUCP with All VA	Alt 3	Alt 4
CO	11,293	11,451	11,349	11,339	11,366	11,356	11,256	11,335
NO_x	10,554	10,732	10,611	10,601	10,625	10,616	10,457	10,598
PM_{10}	844	920	856	854	854	853	706	856
$PM_{2.5}$	794	867	805	804	803	803	661	806
ROG	1,242	1,261	1,248	1,247	1,250	1,249	1,235	1,247
SO_2	87	96	88	88	88	88	69	88

Notes: Values represent the sum of emissions from fossil-fueled power plants (for CVP/SWP purchases of grid power and for electrically-powered groundwater pumps) and emissions from diesel engines (for engine-powered groundwater pumps).
CO = carbon monoxide; NO_x = nitrogen oxides; PM_{10} = particulate matter of 10 microns diameter and smaller; $PM_{2.5}$ = particulate matter of 2.5 microns diameter and smaller; ROG = reactive organic gases; SO_2 = sulfur dioxide; Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements



Notes: Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements

Figure 9-5. Emissions from All Sources.



Notes: Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements
Emissions for the No Action Alternative are not shown because they are the baseline to which changes under the action alternatives are compared. These baseline emissions are indicated by the No Action bar in Figure 9-5.

Figure 9-6. Changes in Emissions from All Sources Compared to the No Action Alternative.

9.2.4 Alternative 2B

Analysis of Alternative 2B, although qualitative, builds on the quantitative analysis provided for Alternative 2. Only components under Alternative 2B that are expected to result in changes to air quality resources compared to Alternative 2 are discussed.

Alternative 2b is anticipated to be more restrictive on Delta exports than Alternative 2 and the No Action Alternative. Please see *Chapter 5 Water Supply* for a description of the restrictions associated with the QWEST criteria under Alternative 2B. These restrictions on exports may result in less consumption in power from the CVP and SWP Delta export facilities that could result in a surplus of hydropower and, thus, less need for fossil-fueled power purchased from the grid. This may result in a net decrease of harmful air quality emissions. Conversely, these export restrictions would result in a decrease of water supply. There may be an increase in groundwater pumping to meet water supply demands. An increase in groundwater pumping would result in an increase of power consumption and a potential increase for fossil-fuel power sources that may increase harmful air pollutant emissions.

In addition to the more restrictive QWEST criteria, Alternative 2B includes an extension of the CCF operation period to December 1 through March 31 from mid-December through mid-March, effectively increasing the operation of the SWP by one month. This extended operation would result in an increase of power consumption from this SWP facility and the need to purchase additional power from fossil fuel sources. The increase in consumption of power from higher-emitting sources may increase harmful air pollutant emissions. This potentially negative impact on air quality may be ameliorated if less groundwater pumping results from this increase in surface water supply from the extended operation of the CCF.

Conversely, this extension in the operation of the CCF may result in more frequently exceeding seasonal and weekly salvage thresholds that may not have otherwise been exceeded. Exceeding these thresholds would result in additional export restrictions and less consumption in power under Alternative 2B, potentially resulting in a decrease of harmful air pollutant emissions. This potential beneficial effect on air quality may be lessened if the additional export restrictions encourage more groundwater pumping under Alternative 2B. In this case, more fossil-fueled power sources may be needed that may increase harmful air pollutant emissions.

9.3 Mitigation Measures

No avoidance and minimization measures or mitigation measures have been identified for air quality.

9.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and may result in potential changes to air quality from fossil-fueled powerplant emissions from hydropower generation and groundwater pumping. The action alternatives will result in changes to air quality from fossil-fueled powerplant emissions from hydropower generation and groundwater pumping.

The magnitude of the changes is dependent on alternative and water year type. Therefore, the No Action Alternative and action alternatives may contribute to cumulative changes to air quality as described in Appendix L, *Air Quality* and Appendix Y, *Cumulative Impacts Technical Appendix*.

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Chapter 10 Greenhouse Gas Emissions

This chapter is based on the background information and technical analysis documented in Appendix M, *Greenhouse Gas Emissions Technical Appendix*, which includes additional information on greenhouse gases (GHGs) and technical analysis of the effects of each alternative.

10.1 Affected Environment

Global warming is the name given to the increase in the average temperature of the Earth's near-surface air and oceans since the mid-twentieth century and its projected continuation. Warming of the climate system is now considered to be unequivocal (International Panel on Climate Change 2023) with global surface temperature increasing approximately 1.1 degrees Celsius (°C) above 1850-1900 in 2011-2020. Continued warming is projected to likely increase global average temperature above 1.5°C during the 21st century.

Observed warming since 1850 is human-caused, with warming from GHGs dominated by carbon dioxide (CO_2) and methane (CH_4). Increases in GHG concentrations in the Earth's atmosphere since around 1750 are unequivocally caused by GHG emissions from human activities (International Panel on Climate Change 2023). GHGs naturally trap heat by impeding the exit of solar radiation that has hit the Earth and is reflected back into space. Some GHGs occur naturally and are necessary for keeping the Earth's surface inhabitable. However, increases in the concentrations of these gases in the atmosphere have decreased the amount of solar radiation that is reflected back into space, intensifying the natural greenhouse effect and resulting in the increase of global average temperature. (International Panel on Climate Change 2023).

Warming of the atmosphere has broad implications for the environment. In California, one of the effects of climate change could be increases in temperature that could affect the timing and quantity of precipitation. Over the past century, the precipitation mix between snow and rain has shifted in favor of more rainfall and less snow, and snowpack in the Sierra Nevada is melting earlier in the spring (California Department of Water Resources 2010). The average early spring snowpack in the Sierra Nevada has decreased by about 10% during the last century, a loss of 1.5 million acre-feet of snowpack storage. These changes have significant implications for water supply, flooding, aquatic ecosystems, energy generation, and recreation throughout the state (California Department of Water Resources 2010).

Total gross statewide GHG emissions in 2021 were estimated to be 381.3 metric tons per year of CO_2e (California Air Resources Board 2023). The two largest sectors contributing to emissions in California are transportation (38%) and industrial (19%). The agricultural sector represents 10% of the total gross statewide emissions. The agricultural sector includes manure management, enteric fermentation, agricultural residue burning, and soils management.

10.2 Effects of the Alternatives

The impact analysis considers changes in greenhouse gas emissions related to changes in CVP and SWP operation under the alternatives as compared with the No Action Alternative.

The No Action Alternative is based on 2040 conditions. Changes that would occur over that time frame without implementation of the action alternatives are not analyzed in this chapter. However, the changes related to greenhouse gases that are assumed to occur by 2040 under the No Action Alternative are summarized in this section.

The changes to GHGs that are assumed to occur by 2040 under the No Action Alternative conditions would be different from existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

Under the No Action Alternative, Reclamation would continue with the current operation of the CVP, as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the SWP represent current management direction or intensity pursuant to 43 CFR Section 46.30.

- The No Action Alternative, thus, is expected to result in potential changes in GHG emissions from potential changes in emissions from fossil-fueled power plants, hydropower generation, and groundwater pumping. These changes were described and considered in the 2020 Record of Decision.

10.2.1 Impacts from potential changes in GHG emissions from fossil-fueled power plants (hydropower generation)

For the purposes of this analysis, the changes in operations and flows are linked to changes in greenhouse gas emissions because changes in operations and flows affect the amount of power the hydroelectric facilities in the system can generate. Where flows increase on rivers that have hydroelectric facilities then hydropower generation could increase. The additional hydroelectric power is expected to displace power that must be purchased from suppliers connected to the regional electric system (grid). To the extent that the displaced power would have been generated by fossil-fueled power plants, emissions of GHGs from these plants would decrease. Conversely, if hydropower generation decreases, the decrease must be offset by purchased power from the grid to meet demand for power. To the extent that the additional purchased power would have been generated by fossil-fueled power plants, GHG emissions from these plants would increase.

The action alternatives would change operations of the CVP and SWP, which change river flows and reservoir levels. These changes could affect the amount of hydroelectric energy generated, as well as the amount of energy used for operations and pumping, at CVP and SWP facilities. Net energy is the difference between energy generated and energy used. When net energy is positive the CVP and SWP sell the excess to the grid, and GHG emissions from power plants decrease.

When net energy is negative the CVP and SWP purchase power from the grid, and GHG emissions from power plants (to the extent fossil-fueled) supplying that power increase.

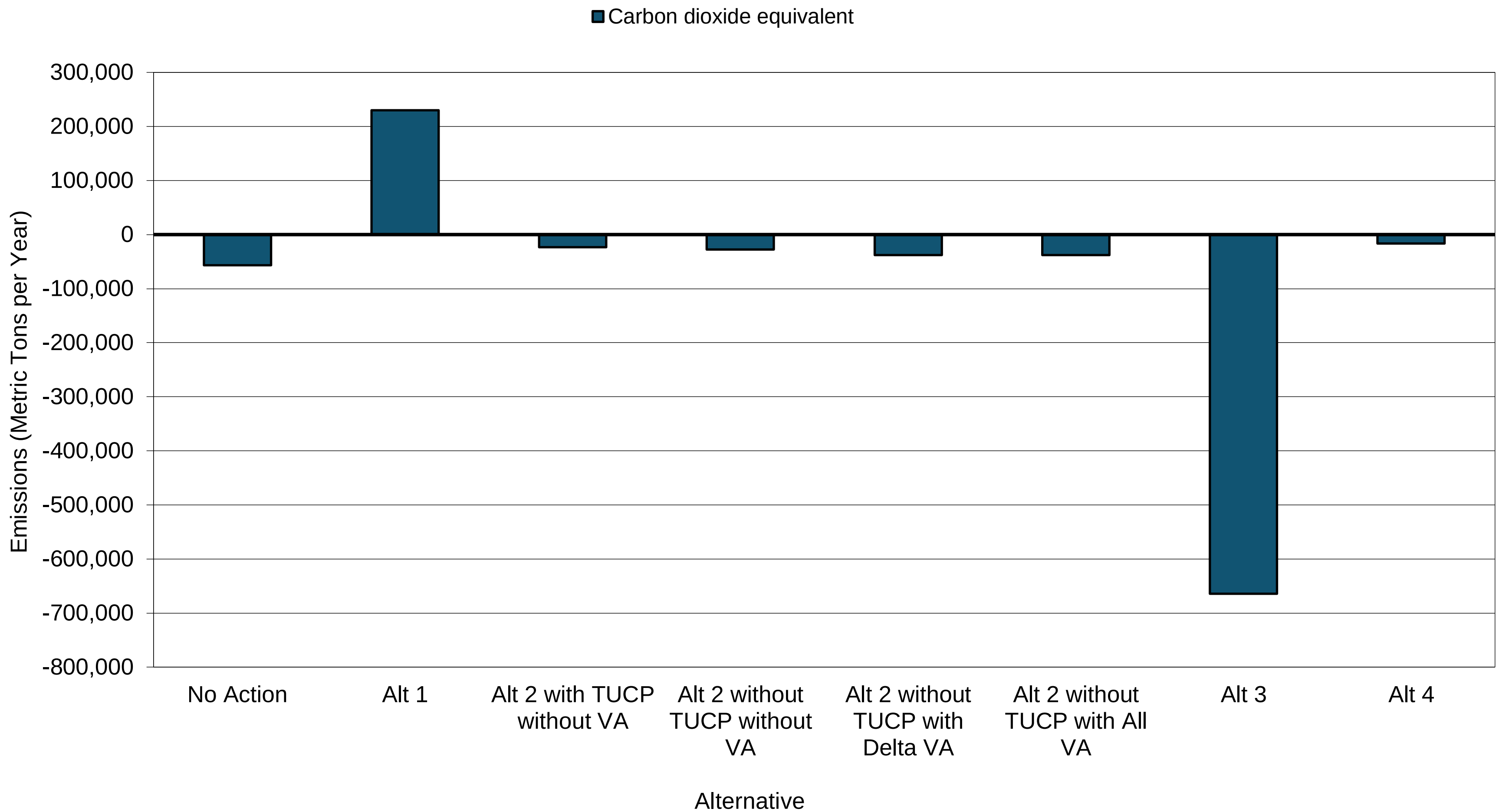
With alternatives 1, 2 (all four phases), and 4, net energy would decrease compared to the No Action Alternative (decreases of long-term averages from 4% to 42% for SWP and no change to 4% for CVP), and as a result GHG emissions would increase. The increases would be largest with Alternative 1, less with Alternative 2 (all four phases), and least with Alternative 4. With Alternative 3 net energy would increase compared to the No Action Alternative (increases of long-term averages of 77% for SWP and 21% for CVP), and as a result GHG emissions would decrease.

Table 10-1 shows the estimated emissions from fossil-fueled grid power plants associated with net generation. Figure 10-1 and Figure 10-2 show the emissions of each GHG for grid power generation and the changes compared to the No Action Alternative, respectively.

Table 10-1. GHG Emissions from Net Generation.

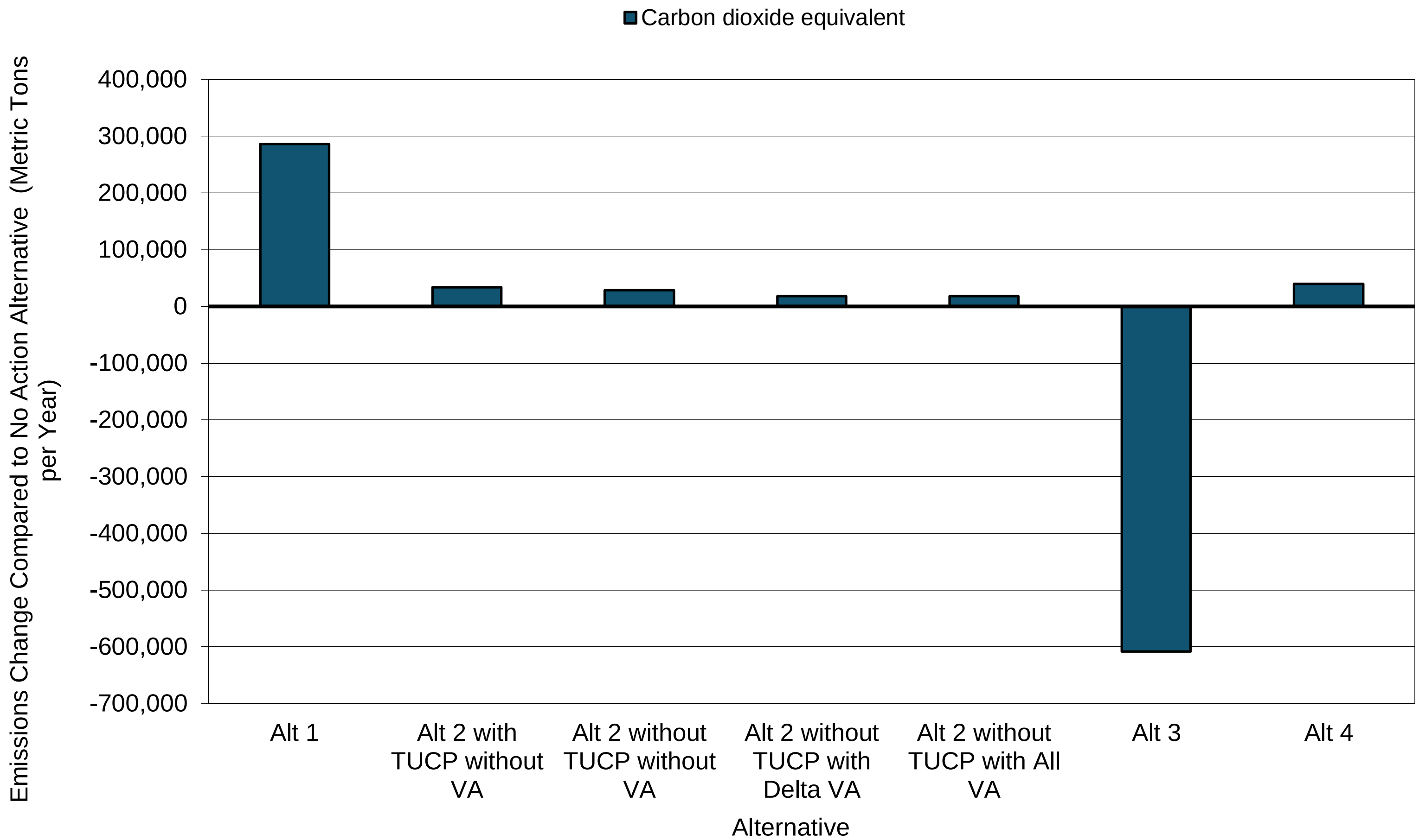
	GHG Emissions (metric tons per average year)							
GHG	**No Action**	**Alt 1**	**Alt 2 with TUCP without VA**	**Alt 2 without TUCP without VA**	**Alt 2 without TUCP with Delta VA**	**Alt 2 without TUCP with All VA**	**Alt 3**	**Alt 4**
CO_2	-56,252	229,352	-22,956	-27,713	-38,053	-38,053	-662,412	-16,545
CH_4	-3.208	13.079	-1.309	-1.580	-2.170	-2.170	-37.774	-0.943
N_2O	-0.370	1.509	-0.151	-0.182	-0.250	-0.250	-4.359	-0.109
CO_2e	-56,443	230,129	-23,034	-27,806	-38,182	-38,182	-664,655	-16,601

Notes:
Values represent the emissions effects of net generation, i.e., CVP/SWP hydropower generation minus CVP/SVP energy use. Emissions of zero would indicate that CVP/SWP hydropower generation exactly equals CVP/SWP energy use. Negative emission values indicate decreases in emissions because net generation is positive and displaces grid power; positive emission values indicate increases in emissions because net generation is negative and CVP/SWP purchases the needed power from the grid.
CO_2 = carbon dioxide; CH_4 = methane; GHG = greenhouse gas; N_2O = nitrous oxide; CO2e = carbon dioxide equivalent; Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements, < = less than



Notes: Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements

Figure 10-1. GHG Emissions from Grid Power Generation.



Notes: Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements
Emissions for the No Action Alternative are not shown because they are the baseline to which changes under the action alternatives are compared. These baseline emissions are indicated by the No Action bar in Figure 10-1.

Figure 10-2. Changes in GHG Emissions from Grid Power Generation Compared to the No Action Alternative.

10.2.2 Impacts from potential changes in GHG emissions from fossil-fueled power plants (groundwater pumping)

The action alternatives would change operation of the CVP and SWP, which could change river flows and reservoir levels. These changes could affect the amount of water available for agricultural irrigation. If surface water availability decreases, farmers could make up the difference in water supply by increasing groundwater pumping. To the extent that the additional purchased power would be generated by fossil-fueled power plants, GHG emissions from these plants could increase. Conversely, if surface water availability increases, farmers could decrease the amount of groundwater they pump, which could lead to a decrease in GHG emissions.

GHG emissions resulting from changes in groundwater pumping were evaluated on a project-wide basis in terms of emissions from the fossil-fueled power plants (for electrically-powered pumps) and from engines (for engine-powered pumps). For the details of the groundwater modeling on which the GHG analysis was based and the project-wide quantities of water pumped, see Appendix I, *Groundwater Technical Appendix*. Table 10-2 shows the estimated emissions from fossil-fueled grid power plants associated with net generation. Figure 10-3 and Figure show the GHG emissions for grid power generation and the changes compared to the No Action Alternative, respectively.

Table 10-2. GHG Emissions from Groundwater Pumping GHG Emissions from Groundwater Pumping.

GHG	Emissions (metric tons per average year)							
	No Action	Alt 1	Alt 2 with TUCP without VA	Alt 2 without TUCP without VA	Alt 2 without TUCP with Delta VA	Alt 2 without TUCP with All VA	Alt 3	Alt 4
ELECTRIC PUMPS								
CO_2	1,990,165	1,971,247	1,994,599	1,993,713	2,000,068	1,998,294	2,082,690	1,991,052
CH_4	113	112	114	114	114	114	119	114
N_2O	13	13	13	13	13	13	14	13
CO_2e	1,996,905	1,977,922	2,001,354	2,000,464	2,006,841	2,005,062	2,089,743	1,997,795
DIESEL PUMPS								
CO_2	1,231,405	1,219,699	1,234,149	1,233,600	1,237,532	1,236,435	1,288,654	1,231,954
CH_4	50	49	50	50	50	50	52	50
N_2O	11	11	11	11	11	11	11	11
CO_2e	1,235,879	1,224,131	1,238,633	1,238,082	1,242,029	1,240,928	1,293,337	1,236,430
TOTAL PUMPING EMISSIONS [1]								
CO_2	3,221,570	3,190,946	3,228,748	3,227,312	3,237,600	3,234,729	3,371,344	3,223,006
CH_4	163	162	164	164	164	164	171	163
N_2O	24	24	24	24	24	24	25	24
CO_2e	3,232,784	3,202,053	3,239,987	3,238,546	3,248,870	3,245,989	3,383,079	3,234,225

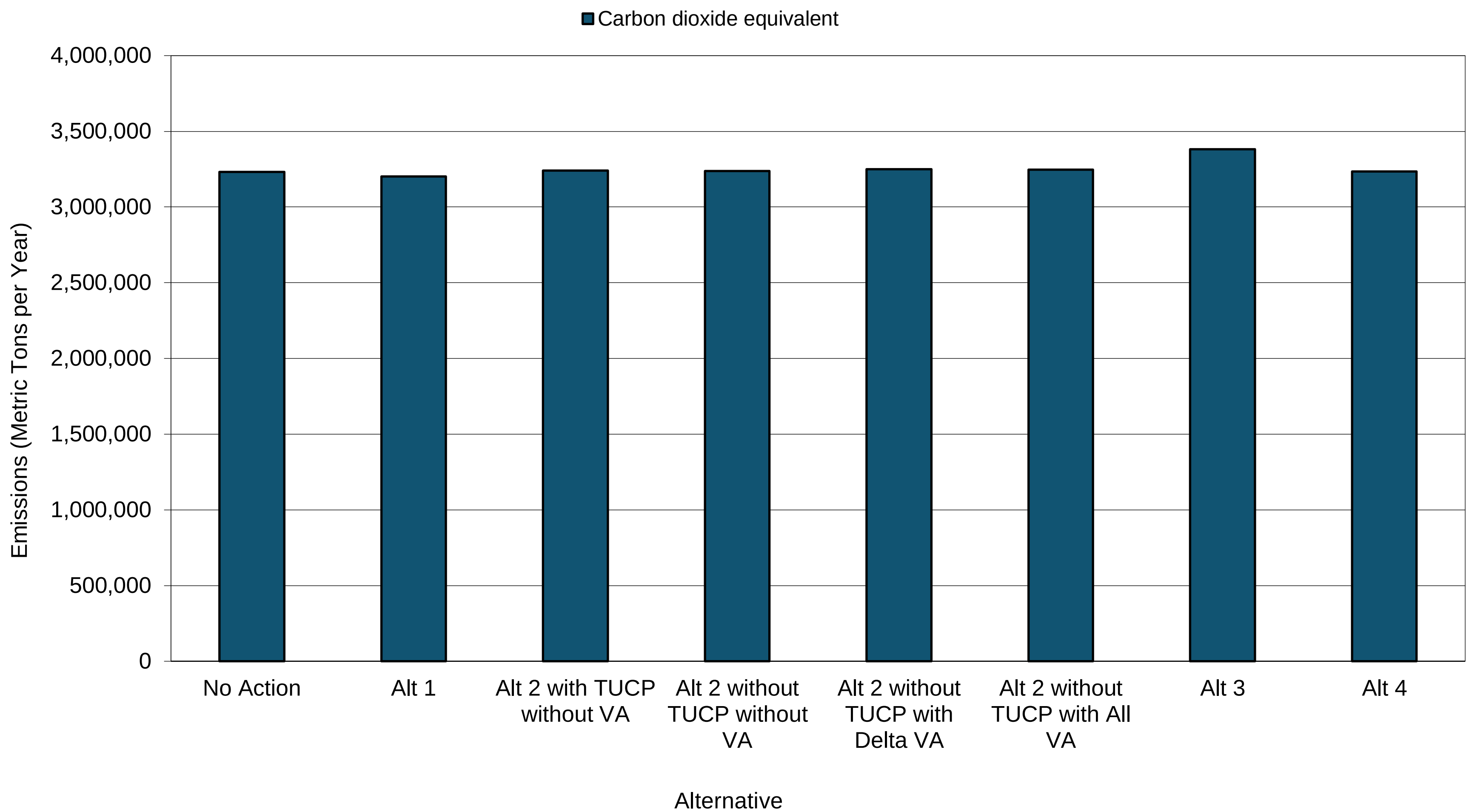
Notes: CO_2 = carbon dioxide; CH_4 = methane; GHG = greenhouse gas; N_2O = nitrous oxide; CO2e = carbon dioxide equivalent; Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements, < = less than; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements

[1] Sum of individual values may not equal total due to rounding.

10.2.3 Impacts from combined potential changes in GHG emissions

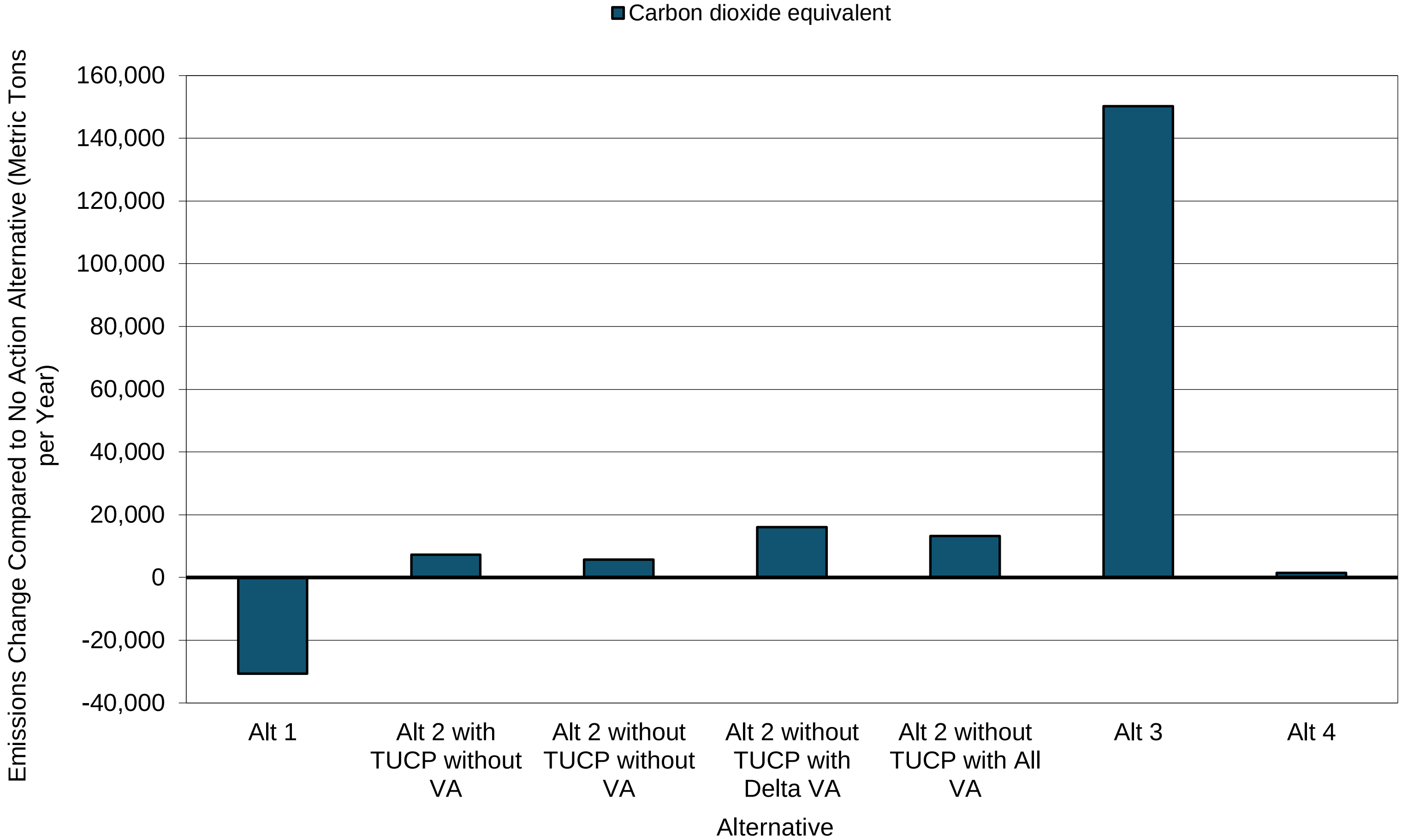
The total GHG emissions associated with the project are the sum of the emissions from net generation (Table 10-1) and groundwater pumping (Table 10-2). Table 10-3 shows the estimated total project emissions for a long-term average year. Figure 10-5 and Figure 10-6 show the GHG emissions for all emission sources, and the changes in emissions compared to the No Action Alternative, respectively.

Alternative 1 would lead to an increase in CO_2e emissions compared to the No Action Alternative by 8.1%. Alternative 2, including all four phases, would lead to increases in CO_2e emissions compared to the No Action Alternative by 1.0% to 1.3%. Alternative 3 would lead to a decrease in CO_2e emissions compared to the No Action Alternative by 14.4%. Alternative 4 would lead to an increase in CO_2e emissions compared to the No Action Alternative by 1.3%.



Notes: Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements
GHG Emissions from Groundwater Pumping

Figure 10-3. GHG Emissions from Groundwater Pumping.



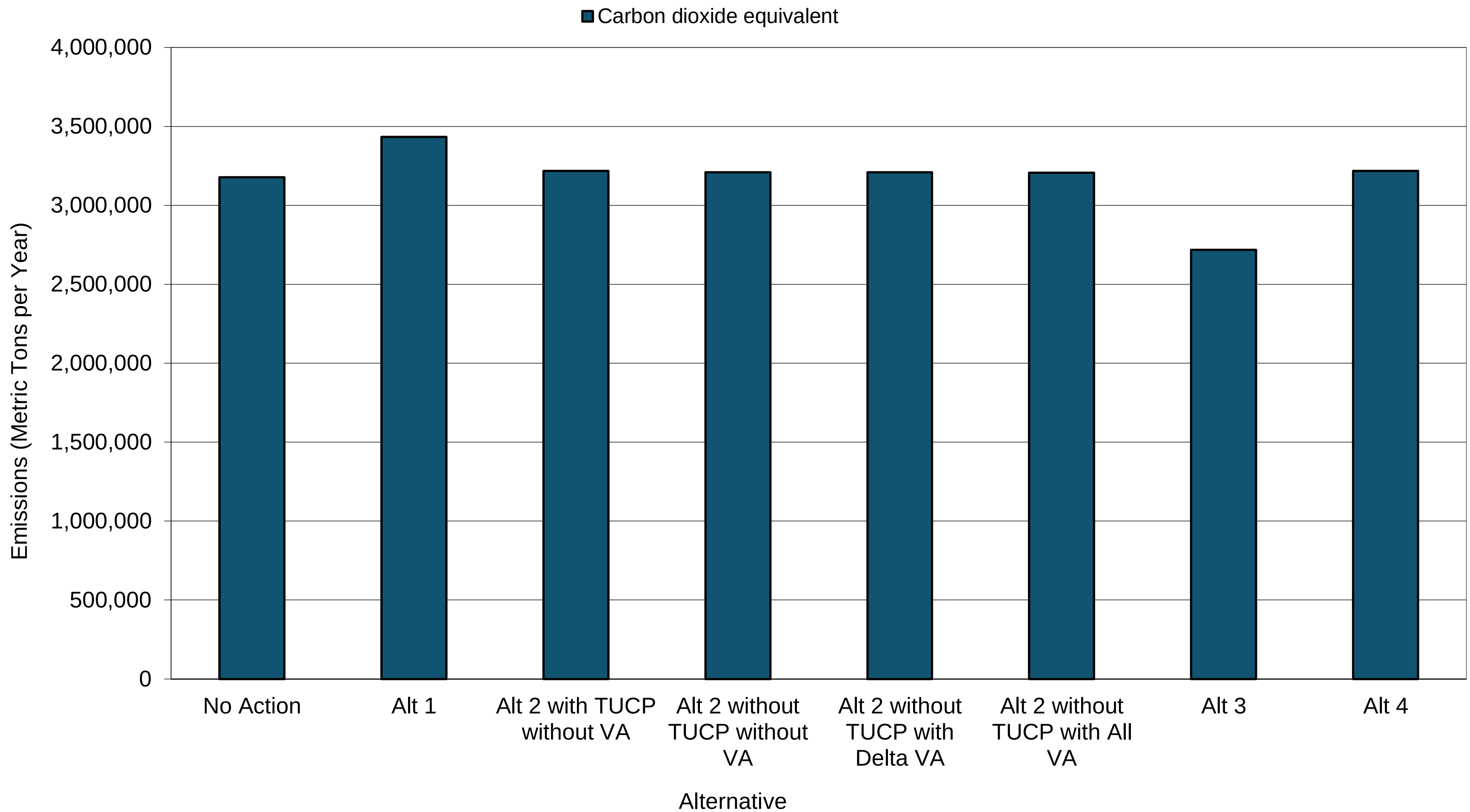
Notes: Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements
Emissions for the No Action Alternative are not shown because they are the baseline to which changes under the action alternatives are compared. These baseline emissions are indicated by the No Action bar in Figure 10-3.

Figure 10-4. Changes in GHG Emissions from Groundwater Pumping Compared to the No Action Alternative

Table 10-3. Total Project GHG Emissions

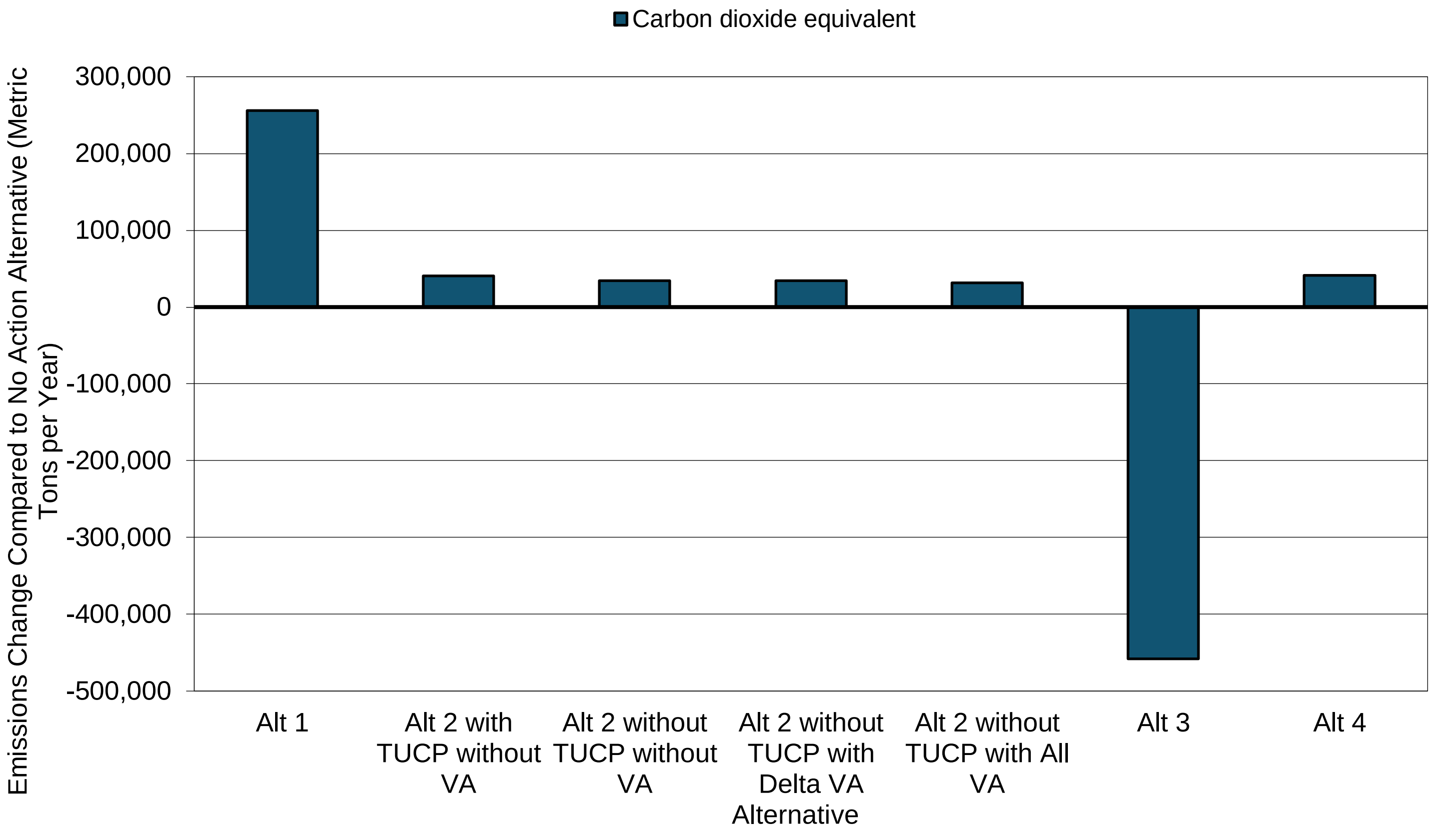
GHG	Emissions (metric tons per average year)							
	No Action	Alt 1	Alt 2 with TUCP without VA	Alt 2 without TUCP without VA	Alt 2 without TUCP with Delta VA	Alt 2 without TUCP with All VA	Alt 3	Alt 4
CO_2	3,165,318	3,420,298	3,205,792	3,199,600	3,199,547	3,196,676	2,708,932	3,206,461
CH_4	160	175	162	162	162	162	133	162
N_2O	24	25	24	24	24	24	21	24
CO_2e	3,176,341	3,432,182	3,216,953	3,210,740	3,210,688	3,207,807	2,718,424	3,217,624

Notes: Values represent the sum of emissions from fossil-fueled power plants (for CVP/SWP purchases of grid power and for electrically-powered groundwater pumps) and emissions from diesel engines (for engine-powered groundwater pumps).
CO_2 = carbon dioxide; CH_4 = methane; GHG = greenhouse gas; N_2O = nitrous oxide; CO2e = carbon dioxide equivalent; Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements, < = less than; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements



Notes: Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements

Figure 10-5. GHG Emissions from All Sources.



Notes:
Emissions for the No Action Alternative are not shown because they are the baseline to which changes under the action alternatives are compared. These baseline emissions are indicated by the No Action bar in Figure 10-5.
Alt = Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreements

Figure 10-6. Changes in GHG Emissions from All Sources Compared to the No Action Alternative.

10.2.3.1 Alternative 2B

Analysis of Alternative 2B, although qualitative, builds on the quantitative analysis provided for Alternative 2. Only components under Alternative 2B that are expected to result in changes to GHG emissions compared to Alternative 2 are discussed.

Alternative 2b is anticipated to be more restrictive on Delta exports than Alternative 2 and the No Action Alternative. Please see *Chapter 5 Water Supply* for a description of the restrictions associated with the QWEST criteria under Alternative 2B. These restrictions on exports may result in less consumption in power from the CVP and SWP Delta export facilities that could result in a surplus of hydropower and, thus, less need for fossil-fueled power purchased from the grid. This surplus of hydropower may result in a net decrease of harmful GHG emissions. Conversely, these export restrictions would result in a decrease of water supply. There may be an increase in groundwater pumping to meet water supply demands. An increase in groundwater pumping would result in an increase of power consumption, and a potential increase for fossil-fuel power sources that may increase harmful GHG emissions.

In addition to the more restrictive QWEST criteria, Alternative 2B includes an extension of the CCF operation period to December 1 through March 31 from mid-December through mid-March, effectively increasing the operation of the SWP by one month. This extended operation would result in an increase of power consumption from this SWP facility and the need to purchase additional power from fossil fuel sources. The increase in consumption of power from higher-emitting sources may increase harmful GHG emissions. This potentially negative impact on associated with increased GHG emissions may be ameliorated if less groundwater pumping results from this increase in surface water supply from the extended operation of the CCF.

Conversely, this extension in the operation of the CCF may result in more frequently exceeding seasonal and weekly salvage thresholds that may not have otherwise been exceeded. Exceeding these thresholds would result in additional export restrictions and less consumption of less clean power under Alternative 2B, potentially resulting in a decrease of harmful GHG emissions. This potential beneficial effect on air quality may be lessened if the additional export restrictions encourage more groundwater pumping under Alternative 2B. In this case, more fossil-fueled power sources may be necessary thereby increasing GHG emissions.

10.2.3.2 Alternative 4B

Alternative 4B is expected to be within the range of effects for greenhouse gas emissions described for Alternative 4.

10.3 Mitigation Measures

No avoidance and minimization measures or mitigation measures have been identified for greenhouse gas emissions.

10.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and may result in potential changes to greenhouse gas emissions from fossil-fueled powerplant emissions from hydropower generation and groundwater pumping. The action alternatives will result in changes to greenhouse gas emissions from fossil-fueled powerplant emissions from hydropower generation and groundwater pumping. The magnitude of the changes is dependent on alternative and water year type. Therefore, the No Action Alternative and action alternatives may contribute to cumulative changes to greenhouse gas emissions as described in Appendix M, *Greenhouse Gas Emissions* and Appendix Y, *Cumulative Impacts Technical Appendix*.

Chapter 11 Visual Resources

This chapter is based on the background information and technical analysis documented in Appendix N, *Visual Resources Technical Appendix*, which includes additional information on visual resource conditions and technical analysis of the effects of each alternative.

11.1 Affected Environment

11.1.1 Trinity River Watershed

The Trinity River Region includes Trinity Reservoir, Lewiston Reservoir, the Trinity River between Lewiston Reservoir and the confluence with the Klamath River, and along the lower Klamath River. The Trinity River flows through lightly populated and heavily forested, mountainous terrain with jagged cliffs that are in view when people pursue recreational activities, such as fishing, hiking, rafting, kayaking, and canoeing. The forests offer visual resources that include snow-covered peaks, volcanoes, rock outcroppings, mountain creeks, lakes, meadows, and a wide variety of trees and vegetation. Downstream of Lewiston Dam, the Trinity River corridor is characterized by gravel bars, riparian vegetation, and human-built features.

11.1.2 Sacramento Valley

The Sacramento Valley extends from the northern mountainous areas to the flat, agricultural landscapes of the Central Valley at the lower elevations. The mountainous areas are characterized by rugged and deep river canyons and valleys that extend from jagged peaks to forested areas with pine and deciduous trees. Large rivers flow from the mountain areas through the foothills into the agricultural areas and communities along the valley floor.

11.1.3 San Joaquin Valley

For the purposes of this analysis, the San Joaquin Valley includes the San Joaquin River and Stanislaus River regions. The San Joaquin Valley land cover ranges from high alpine vegetation near the crest of the Sierra Nevada, through coniferous forest, mixed forest, oak woodlands, and oak savanna to grasslands and agricultural areas at the lower elevations (Bureau of Reclamation 1997, 2005a, 2005b). Water bodies include reservoirs, natural lakes and ponds, rivers, and tributary streams.

11.1.4 Bay-Delta Operations

The Bay-Delta region includes the Delta and Suisun Marsh, which extends south to San Francisco Bay. Most of the Delta is used for agricultural purposes with major waterways and sloughs that connect the Sacramento, San Joaquin, Mokelumne, Cosumnes, and Calaveras rivers (CALFED Bay-Delta Program 2000). Flood management and irrigation facilities include levees, impoundments, pumping plants, and control gate structures. Bodies of open water occur where historic levee failures were not repaired, including Franks Tract and Liberty Island. The Sacramento Deep Water Ship Channel is a large water feature between levees that extends from the Sacramento River near Rio Vista to West Sacramento. Vistas of the Delta can be seen from residences and agricultural areas in the Delta, open water areas used by recreationists, and from vehicles on roadways and railroads that cross the Delta. Waterfront industries are located along the rivers, especially along the San Joaquin River.

11.1.5 Southern California Region

The Southern California region includes portions of Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties served by the State Water Project. From a visual perspective, in total, Southern California contains over 2 million acres irrigated agricultural land. Overall, Southern California saw a decrease of approximately 60,000 acres in Important Farmland in the 10-year period from 2008–2018.

11.2 Effects of the Alternatives

The impact analysis considers changes in visual conditions related to changes in CVP and SWP operation under the alternatives as compared with the No Action Alternative.

The No Action Alternative is based on 2040 conditions. The changes to visual resources that are assumed to occur by 2040 under the No Action Alternative conditions would be different than existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

In the long term, it is anticipated that climate change, and development throughout California, could affect water supply deliveries.

Under the No Action Alternative, Reclamation would continue with the current operation of the Central Valley Project (CVP), as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the State Water Project represent current management direction or intensity pursuant to 43 Code of Federal Regulations Section 46.30.

Although the No Action Alternative included habitat restoration projects at a programmatic level, the 2020 ROD did not provide environmental coverage for these projects, and all of the habitat projects considered under the No Action required or will require additional environmental documentation. Thus, ground disturbance for habitat restoration projects did not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

Under the No Action Alternative, land uses in 2040 would occur in accordance with adopted general plans, which could also result in impacts on visual resources. In terms of CVP operations, under the No Action Alternative, by the end of September, the surface water elevations at CVP reservoirs generally decline. It is anticipated that climate change would result in more short-duration high-rainfall events and less snowpack in the winter and early spring months. As water is released in the spring, there would be less snowpack to refill the reservoirs. This condition would reduce flow within streams. The No Action Alternative, thus, is expected to result in potential changes in visual resources at reservoirs that store CVP water, tributaries, and in irrigated agricultural land vistas. These changes were described and considered in the 2020 Record of Decision.

Alternatives 2B and 4B are expected to be within the range of effects for visual resources described below for Alternatives 2 and 4, respectively.

11.2.1 Potential changes in visual resources at reservoirs that store CVP water and tributaries that flow to and from reservoirs that store CVP water.

For the purposes of this analysis, the changes in operations and flows are linked to changes in visual resources at tributaries and reservoirs because they are related to water levels. Compared with the No Action Alternative, Alternatives 1 through 4 would make changes to a number of different operational parameters, such as Shasta Dam releases (Sacramento River/Shasta Reservoir/Keswick Dam), Whiskeytown Dam releases (Clear Creek/Whiskeytown Reservoir), American River minimum instream flows (Nimbus Dam/Folsom Dam), Delta Outflow, and New Melones Reservoir releases (Stanislaus River).

These various operational changes have the potential to result in visual impacts at the facility itself or at other facilities based on broader effects on system operation. Visual resources impacts are related to surface water elevations that determine the size of the "bathtub ring" in the reservoirs mentioned above that store CVP water supplies. Within tributaries, a similar effect could occur if low water levels expose scoured banks or results in the drainage of inundated areas, which could leave exposed and muddy areas visible, or high water levels result in the inundation of previously non-inundated areas.

Average changes to storage, flow, and reservoir elevation under Alternatives 1 through 4 are relatively small at each end of month as modeled when compared with the No Action Alternative so that resultant changes in the bathtub ring would not result in adverse changes to visual resources. Some reservoirs would experience increases in storage that would reduce the bathtub ring and contrast and result in visual improvements. However, flow changes at Clear Creek under Alternative 1 would be adverse. As an example, flows in October under the No Action Alternative would be about 200 cubic feet per second, while under Alternative 1 they would be about 61 cubic feet per second, a reduction of about 70%. Mitigation Measure VIS-1, Develop a Visual Resources Monitoring and Mitigation Program for Clear Creek (Alternative 1), could be implemented to reduce impacts. Additionally, modeling outputs also show a substantial decrease in storage at San Luis Reservoir in some times of year under Alternative 3. Storage reductions range from 13 to 40% compared with the No Action Alternative. Mitigation Measure VIS-2, Develop a Visual Resources Monitoring and Mitigation Program for San Luis Reservoir (Alternative 3), could be implemented to reduce impacts.

11.2.2 Potential changes in vistas at irrigated agricultural lands

The evaluation of views of agricultural lands is based on the potential for each alternative to affect irrigation water deliveries, and to the extent they reduce deliveries, the potential for water to be obtained from other sources such as groundwater.

Under Alternative 1, long-term average and dry and critical year average deliveries for agricultural uses would increase in the San Joaquin River Region (21% and 38%), San Francisco Bay Area Region (12% and 41%), and Southern California Region (43% and 67%), so no conversion of agricultural land to nonagricultural use is anticipated for these regions. There would also be an increase (955 more acres) in irrigated crops in the Sacramento region. Therefore, no visual impact would occur under Alternative 1 related to fallowing of irrigated agricultural lands.

In both the long-term average and dry and critical year conditions, overall crop acreage would primarily decrease in the San Joaquin River and Sacramento River regions under Alternative 2 when compared with the No Action Alternative. In average water years, the reduction in acreage would range from a decrease in 650 acres to a decrease in 7,038 in the Sacramento River Region. In the San Joaquin River Region, decreases would range from 14,994 to 47,769 acres, with an increase of 4,701 acres occurring under Alternative 2 without Temporary Urgency Change Petition without Voluntary Agreement (VA). Under dry and critical conditions, across all phases there would be decreases in irrigated acreage compared with the No Action Alternative, with decreases from 4,320 acres to 5,589 acres for the Sacramento River region and 22,585 acres to 26,171 acres in the San Joaquin River Region for phases without VAs and 41,527 acres to 47,500 acres for phases with VAs. Some conversion of agricultural land to nonagricultural is expected to occur in the San Joaquin River and Sacramento River regions. Therefore, a visual impact could occur under Alternative 2 related to fallowing of irrigated agricultural lands, and this impact could be adverse due to the reduction in active agriculture and increase in fallowed land. Mitigation Measure AG-1 would help reduce some of the anticipated conversion of agricultural land.

In both the average and dry and critical year conditions there would be a decrease in irrigated crops under Alternative 3 compared with the No Action Alternative. There would be approximately 22,818 fewer acres of irrigated farmland in the Sacramento River region and approximately 303,764 fewer acres in the San Joaquin River region in the long-term average year condition. In the dry and critical year condition, the Sacramento River region would have approximately 21,123 fewer irrigated acres, and the San Joaquin River region would have 210,633 fewer irrigated acres compared with the No Action Alternative. Therefore, conversion of agricultural land to non-agricultural use is anticipated. An adverse visual impact could occur under Alternative 3 related to fallowing of irrigated agricultural lands.

Under Alternative 4, under dry and critical year conditions, there would be decreases in irrigated acreage in the Sacramento and San Joaquin River regions. There would be approximately 1,316 more acres of irrigated farmland in the Sacramento River region and approximately 14,094 more acres in the San Joaquin River region in the long-term average year condition. In the dry and critical year conditions there would be approximately 814 fewer acres of irrigated farmland in the Sacramento River region and approximately 10,343 fewer acres in the San Joaquin River region. Therefore, an adverse visual impact could occur under Alternative 4 related to fallowing of irrigated agricultural land.

11.3 Mitigation Measures

Appendix D includes a detailed description of mitigation measures identified for visual resources per alternative. These mitigation measures include avoidance and minimization measures that are part of each alternative and, where appropriate, additional mitigation to lessen impacts of the alternatives. For visual resources, no avoidance and minimization measures have been identified. Additional mitigation measures have been identified for visual resources.

11.3.1 Avoidance and Minimization Measures

11.3.1.1 Alternatives 1-4

No avoidance and minimization measures have been identified.

11.3.2 Additional Mitigation

11.3.2.1 Alternative 1

Alternative 1 would result in changes in visual resources at tributaries that flow to and from reservoirs that store CVP water compared with the No Action Alternative.

- Mitigation Measure VIS-1, *Develop a Visual Resources Monitoring and Mitigation Program for Clear Creek* (Alternative 1) could be implemented to reduce impacts

11.3.2.2 Alternative 2

Alternative 2 would make changes in vistas at irrigated agricultural lands that could be adverse to visual resources due to a reduction in active agriculture and increase in fallowed land compared with the No Action Alternative.

- Mitigation Measure AG-1: *Diversify Water Portfolios* would help reduce some of the anticipated conversion of agricultural land

11.3.2.3 Alternative 3

Same as Alternative 2. Additionally, Alternative 3 would result in changes in visual resources at reservoirs that store CVP water compared with the No Action Alternative.

- Mitigation Measure VIS-2, *Develop a Visual Resources Monitoring and Mitigation Program for San Luis Reservoir* (Alternative 3), could be implemented to reduce impacts

11.3.2.4 Alternative 4

Same as Alternative 2.

11.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and may result in potential changes in visual resources at reservoirs that store CVP water, tributaries, and in irrigated agricultural land vistas. The action alternatives will result in changes to visual resources at reservoirs that store CVP water, tributaries, and in irrigated agricultural land vistas. The magnitude of the changes is dependent on alternative and water year type. Therefore, the No Action Alternative and action alternatives may contribute to cumulative changes to visual resources as described in Appendix N, *Visual Resources* and Appendix Y, *Cumulative Impacts Technical Appendix*.

Chapter 12 Fish and Aquatic Resources

This impact assessment is based on the background information and technical analysis documented in *Appendix O, Fish and Aquatic Resources Technical Appendix*, which includes additional information on fish and aquatic resource conditions and technical analysis of the effects of each alternative.

Using multiple lines of evidence, the analysis described below considers both context and intensity (40 CFR 1508.27) the alternatives may have on fish and aquatics resources.

12.1 Affected Environment

The Central Valley and Trinity River support a diverse number of special status, anadromous and recreationally important species (Table 12-1).

Table 12-1. Focal Fish Species in the Central Valley and Trinity River

Species or *Population*	**Federal Status**	**State Status**	**Tribal[1], Commercial[2], or Recreational Importance**	**Occurrence within Area of Analysis**
Chinook Salmon *Sacramento River Winter-Run ESU*	Endangered	Endangered	Yes	Sacramento River, Bay-Delta
Chinook Salmon *Central Valley Spring-Run ESU*	Threatened	Threatened	Yes	Clear Creek, Sacramento River, Bay-Delta
Steelhead *California Central Valley DPS*	Threatened	None	Yes	Clear Creek, Sacramento River, Lower American River, Stanislaus River, San Joaquin River, Bay-Delta
Green Sturgeon *Southern DPS*	Threatened	SSC	Yes	Sacramento River, Bay-Delta
Delta Smelt	Threatened	Endangered	Yes	Bay-Delta
Longfin Smelt *San Francisco Bay-Delta DPS*	Proposed Endangered	Threatened, SSC	Yes	Bay-Delta
Chinook Salmon *Central Valley Fall-Run/Late Fall–Run ESU*	None	SSC	Yes	Clear Creek, Sacramento River, Lower American River, Stanislaus River, Bay-Delta, San Joaquin River

[1] Tribal importance was noted based on Shilling et al. (2014:15–46).

[2] Commercially important species with Essential Fish Habitat under the Magnuson-Stevens Fishery Conservation and Management Act.

Species or *Population*	Federal Status	State Status	Tribal[1], Commercial[2], or Recreational Importance	Occurrence within Area of Analysis
White Sturgeon	None	SSC	Yes	Sacramento River, Lower American River, Bay-Delta, San Joaquin River
Native Minnows (Sacramento Splittail, Hardhead, Sacramento Hitch)	None	SSC	Yes	Clear Creek, Sacramento River, Lower American River, Bay-Delta, Stanislaus River, San Joaquin River
Pacific Lamprey	None	SSC	Yes	Trinity River, Clear Creek, Sacramento River, Lower American River, Bay-Delta, Stanislaus River, San Joaquin River
Western River Lamprey	None	SSC	Yes	Sacramento River, Lower American River, Stanislaus River, Bay-Delta, San Joaquin River
Striped Bass	None	None	Yes	Sacramento River, Lower American River, Bay-Delta, Stanislaus River, San Joaquin River
American Shad and Threadfin Shad	None	None	Yes	Lower American River, Sacramento River, Bay-Delta, Stanislaus River, San Joaquin River
Black Basses (Largemouth, Smallmouth, Spotted)	None	None	Yes	Trinity Lake, Sacramento River, Lower American River, Bay-Delta, Stanislaus River, San Joaquin River
Starry Flounder	None	SSC	Yes	Bay-Delta
Coho Salmon *Southern Oregon/Northern California Coast ESU*	Threatened	Threatened	Yes	Trinity River
Chinook Salmon *Upper Klamath-Trinity River Spring-Run ESU*	Candidate	SSC	Yes	Trinity River
Chinook Salmon *Upper Klamath-Trinity River Fall-Run ESU*	Candidate	SSC	Yes	Trinity River
Steelhead *Klamath Mountains Province DPS*	None	SSC	Yes	Trinity River
Eulachon *Southern DPS*	Threatened	SSC	Yes	Lower Klamath River
Green Sturgeon *Northern DPS*	None	SSC	Yes	Trinity River, Lower Klamath River
Coastal Cutthroat Trout	None	SSC	Yes	Lower Klamath River

Species or *Population*	Federal Status	State Status	Tribal[1], Commercial[2], or Recreational Importance	Occurrence within Area of Analysis
Brown Trout	None	None	Yes	Trinity River, Lower Klamath River, Trinity Lake
Rainbow Trout	None	None	Yes	Trinity Lake
Kokanee Salmon (landlocked Sockeye Salmon)	None	None	Yes	Trinity Lake

ESU = evolutionary significant unit; DPS = distinct population segment; SSC = species of special concern

12.1.1 Trinity River

This section describes some of the focal fish species expected to occur in the Trinity River watershed including Trinity Reservoir. The Trinity River watershed also supports populations of Pacific lamprey, coastal cutthroat trout, brown trout, Kokanee, black basses, white catfish, and brown bullhead, as discussed in Appendix O.

12.1.1.1 Coho Salmon, Southern Oregon/Northern California Coast Evolutionarily Significant Unit

Coho salmon exhibit a three-year life cycle in the Trinity River during which they spend the first year in fresh water before migrating to the ocean. In the ocean, they spend the next two years maturing before returning to their natal stream to spawn and die. Juveniles remain in the river year-round. Adult coho salmon typically enter the Trinity River between August and January, with the year-specific timing influenced by genetics, stage of maturity, and river discharge. Coho salmon spawning occurs mostly in November and December in the mainstem Trinity River and its tributaries with peak coho salmon spawning activities in the mainstem Trinity River occurring between Lewiston Dam and the North Fork Trinity River. Spawning is concentrated in riffles or in gravel deposits at the downstream end of pools with suitable water depth, velocity, and substrate size.

Approximately 109 miles of coho salmon habitat in the Trinity Basin became inaccessible after construction of Lewiston and Trinity dams (National Marine Fisheries Service 2014b). To mitigate for the loss of upstream habitat, the Trinity River Salmon and Steelhead Hatchery was constructed near Lewiston Dam and produces coho salmon with an annual production goal of 500,000 yearling fish (California Hatchery Scientific Review Group 2012). Today, wild coho salmon are not abundant in the Trinity River, and most of the coho salmon that return to the river are of hatchery origin. The National Marine Fisheries Service (NMFS) (National Marine Fisheries Service; 2014b) considers this proportion of hatchery fish in the population a high-level risk factor for the continued existence of coho salmon in the Trinity River Basin.

In 2014, annual coho salmon production was reduced to 300,000 yearlings pending adoption of a Trinity River Hatchery Genetics Management Plan (HGMP). The HGMP for the operation of the Trinity River Hatchery was approved by NMFS in 2019 and efforts began in 2021 to focus on natural environmental selection for the Trinity Coho salmon population and incorporating more natural origin fish into the breeding population at the Trinity River Hatchery (Hoopa Valley Tribe et al. 2022). In 2000, the Trinity River Restoration Program (TRRP) was created to improve aquatic habitat conditions on the 40-mile reach from Lewiston Dam downstream to the North Fork Trinity River confluence. The TRRP has implemented a variety of restoration actions to improve aquatic habitat conditions for coho salmon in the Trinity River that include flow management, channel rehabilitation, sediment management, watershed restoration, and adaptive management.

12.1.1.2 Chinook Salmon, Upper Klamath-Trinity River Spring-Run Evolutionarily Significant Unit

Adult spring-run Chinook salmon typically enter the Trinity River from April through September. Most fish have arrived at the mouth of the North Fork Trinity by the end of July. Spawning is concentrated in the reaches immediately downstream of Lewiston Dam to the mouth of the North Fork Trinity River. After entering fresh water, spring-run Chinook salmon remain in deep pools until the onset of the spawning season, which usually peaks in October but typically ranges from the third week of September through November. In the Trinity River, spring-run Chinook salmon fry emerge from the gravel beginning in December, and emergence can last into mid-April. Juvenile spring-run Chinook salmon typically out-migrate after less than a year of growth in the Trinity River. Peak out-migration occurs in May and June as based on monitoring in the lower Trinity River near the town of Willow Creek.

Historically, the spring-run Chinook salmon were the most abundant salmonid in the Trinity River (Snyder 1931; LaFaunce 1967). Spring-run Chinook salmon historically spawned in the Trinity River and several of its tributaries upstream of Lewiston Dam (e.g., East Fork Trinity River, Stuart Fork, Coffee Creek, Hayfork Creek [Gibbs 1956; Campbell and Moyle 1991]). Completion of dams on the Trinity River in the 1960s blocked access to 59 miles of adult holding, spawning, and nursery habitat (Moffett and Smith 1950).

To supplement the decline in population sizes of Chinook salmon, the Trinity River Hatchery below Lewiston Dam propagates Trinity River origin spring-run Chinook salmon. The TRRP has implemented a variety of restoration actions to improve aquatic habitat conditions for Chinook salmon in the Trinity River that included implementation of natural flow variability, temperature moderation, and elevated flows during fry emergence.

12.1.1.3 Fall-run Chinook Salmon, Upper Klamath-Trinity River Fall-Run Evolutionarily Significant Unit

Adult fall-run Chinook salmon typically enter the Trinity River from August through December. Spawning activity usually occurs between October and December with peak spawning activity occurring in November. Spawning activity typically begins just downstream of Lewiston Dam, then extends farther downstream as the season progresses. Fall-run Chinook salmon spawn throughout the mainstem Trinity River from Lewiston Dam to the Hoopa Valley (Myers et al. 1998). Similar to spring-run Chinook salmon, emergence of fall-run Chinook salmon fry begins in December and continues into mid-April. Juvenile fall-run Chinook salmon typically spend a few months rearing in the Trinity River before they out-migrate. Within the Trinity River near Lewiston Dam, out-migration occurs from March through May, with peak out-migration occurring in early May while out-migration farther downstream peaks in May and June.

Fall-run Chinook salmon historically were less abundant than spring-run Chinook in the Klamath-Trinity Basin. However, records from the previous century reveal that fall-run Chinook became the major component of Klamath salmon populations. Estimated run sizes ranged from 141,000 to 400,000 fall-run Chinook from 1912-1928 (Moyle 2002). However, overharvest and changes to the Klamath-Trinity watershed through the construction of dams greatly reduced the population size to an average of 3,000 fish from 1956-1969 (Moyle 2002). Production estimates of fall-run Chinook salmon was almost equally distributed between the Klamath and Trinity river basins.

Restoration of fall-run Chinook salmon populations included artificial supplementation of salmon from the Trinity River Hatchery. The TRRP has implemented a variety of restoration actions to improve aquatic habitat conditions for Chinook salmon in the Trinity River that included implementation of natural flow variability, temperature moderation, and elevated flows during fry emergence.

12.1.1.4 Steelhead, Klamath Mountains Province Distinct Population Segment

Spawning across the three run types in the Trinity River may occur anytime from December through May but occurs primarily from December through February. Adult summer-run steelhead enter the Klamath Basin between April and August and arrive in the Trinity River primarily in April and May (Moyle et al. 2017, Moyle et al. 2015, Pinnix et al 2007). Summer-steelhead hold until the spawning season, in deep pools within the mainstem or upper reaches of cool tributaries while they mature (Moyle 2002; Busby et al. 1996). Summer-run steelhead tend to spawn in smaller streams higher in the drainage network than fall- or winter-run steelhead (Roelofs 1983). Adult fall-run steelhead enter the Klamath River basin between July and November, arrive in the Trinity River primarily in July and August, and spawn primarily from January through May (Pinnix et al. 2007, Moyle et al. 2015, Moyle et al. 2017). Adult winter-run steelhead begin their upstream migration in the Klamath River from November through March (U.S. Fish and Wildlife Service 1997) and primarily spawn in the Trinity River from January through April (U.S. Fish and Wildlife Service 1997), with peak spawn timing in February and March (National Research Council 2004). Steelhead fry emerge in the spring, and juveniles remain in fresh water for up to three years. Most steelhead (86%) that return to the Klamath River basin are estimated to spend two years in freshwater before outmigrating to the ocean (Hopelain 1998).

Steelhead in the Trinity River exhibit two primary life history strategies, including a summer-run steelhead that matures after entering fresh water and a winter-run that matures in the ocean. The ocean maturing strategy is often further divided into a third group for fall-run steelhead based upon the timing of the adult migration. Steelhead also exhibit the “half-pounder” life history, which is limited to several rivers in northern California and southern Oregon, including both Klamath and Trinity rivers. Half-pounders are steelhead that return to fresh water in late summer through fall as immature fish after spending just three–five months at sea and support valuable freshwater fisheries. In the Trinity River, historically and at present, the half-pounder life history remains common among fall-run steelhead.

The TRRP has implemented a variety of restoration actions to improve aquatic habitat conditions for salmon and steelhead on the 40-mile reach from Lewiston Dam downstream to the North

Fork Trinity River confluence that included implementation of natural flow variability, temperature moderation, and floodplain connectivity.

12.1.1.5 Green Sturgeon, Northern Distinct Population Segment

Green sturgeon in the Trinity River region belong to the Northern distinct population segment; however, data from the Trinity River are limited, so most information on life history characteristics for green sturgeon in the Trinity River is based on data from the Klamath River. Adult migration from the Pacific Ocean to the Trinity River occurs from March through July with most spawning taking place from the middle of April to the middle of June (National Research Council 2004). Green sturgeon spawn in deep pools in the lower section of mainstem Trinity River from the confluence with the Klamath River upstream to Grays Falls (Benson et al. 2007). After spawning, most green sturgeon hold in mainstem pools until the fall when they move downstream and leave the river system (Benson et al. 2007). A small proportion (around 25%) of green sturgeon migrate directly back to the ocean after spawning (Benson et al. 2007). Green sturgeon eggs hatch approximately a week after fertilization (van Eenennaam et al. 2005), and larvae rear in the river from March through September until they reach the juvenile stage (up to 150 cm TL). Juveniles slowly migrate downstream to rear in the lower Klamath River for up to a year (Moyle 2002, Mayfield and Cech, Jr. 2004). After moving downstream, juvenile green sturgeon may rear in larger river sections or in the Klamath River estuary for another year or two before they migrate to the Pacific Ocean (National Research Council 2004; Federal Energy Regulatory Commission 2007; Israel and Klimley 2008).

As of 2006, green sturgeon in the Trinity River Basin are Federally listed as a species of special concern. The green sturgeon historic range in the Trinity River is unknown, but the Trinity Dam and irrigation diversions are known to alter flow and water temperatures downstream (Benson et al. 2007) which could affect the species. In addition to downstream flow and temperature changes, green sturgeon face other potential threats in the Trinity River system including decreases in spawning habitat, lack of population data, and harvest impacts (Adams et al. 2002). However, the fact that the Trinity River spawning population occurs in a separate basin from the Klamath River spawning population helps to protect the nDPS green sturgeon from catastrophic events. A reduction in harvest and low entrainment risk in the Trinity River also help maintain the population (Adams et al. 2007).

12.1.1.6 Eulachon, Southern Distinct Population Segment

Eulachon are an anadromous smelt species that were important to local tribes and once supported a subsistence fishery on the lower Klamath River. The spawning migration period for adult eulachon in the Klamath River begins in December and continues until May, with peak migration occurring in March and April (Yurok Tribal Fisheries Program 1998; Larson and Belchik 1998). Eulachon can become sexually mature at two years but spawning typically occurs at ages three, four, or five (Scott and Crossman 1973). Spawning occurs in the lower reaches of rivers and tributaries. Eulachon are broadcast spawners and usually die after spawning.

Although specific spawning areas are unknown, adult eulachon are generally only observed in the lower 24 miles (40 kilometers) of the Klamath River, except during rare years when they are sometimes observed as high as Pecwan Creek and Weitchpec (Yurok Tribal Fisheries Program 1998). Eulachon eggs hatch in 20 to 40 days depending on water temperature, with cooler temperatures leading to longer incubation times. Once eggs hatch, larval eulachon are carried out to the ocean by river currents (Scott and Crossman 1973).

The current population status of eulachon in the Trinity River is unknown, and threats indicated in the recovery plan for Southern DPS eulachon were limited to major river basins. In the Klamath basin, dams and water quality were stated as moderate threats to the subpopulation (NMFS 2017). Dam removals in the upper Klamath River, and ongoing efforts from TRRP for reduced sedimentation and temperature moderation will likely benefit spawning populations in the lower Klamath River.

12.1.2 Sacramento River

This section describes some of the focal fish species expected to occur in the Sacramento River watershed. The Sacramento River also supports populations of white sturgeon, native minnows, Pacific lamprey, Western River lamprey, striped bass, threadfin shad, American shad, black basses, and starry flounder, as discussed in Appendix O.

12.1.2.1 Chinook Salmon, Sacramento River Winter-Run Evolutionarily Significant Unit

Adult winter-run Chinook salmon return to fresh water entering the San Francisco Bay in November and migrate upstream past the former location of the Red Bluff Diversion Dam (RBDD) beginning in mid-December. Most of the run passes RBDD between January and May, with a peak mid-March (Hallock and Fisher 1985). Adults enter fresh water in an immature reproductive state, move upstream quickly, then hold in the cool waters downstream of Keswick Dam for an extended period before spawning above RBDD in the upper Sacramento River and tributaries in spring and summer. Juveniles spend five to nine months in the river and estuary systems before entering the ocean.

Access to approximately 58% of the original winter-run Chinook salmon habitat has been blocked by the existence of dams (Bureau of Reclamation 2008). The remaining accessible habitat occurs in the Sacramento River downstream of Keswick Dam and in Battle Creek. In addition, juveniles rear in the lower American River, lower Feather River, Mill Creek, Deer Creek, and the Delta before emigrating to the ocean (Phillis et al. 2018). Central Valley-wide escapement data indicate that the winter-run Chinook salmon population declined from levels in the 1970s to relatively low levels through the 1980s and 1990s, with a moderate rebound in the early 2000s (Azat 2023).

In 1998, the Livingston Stone National Fish Hatchery (LSNFH) was constructed to help boost the winter-run Chinook salmon population while conserving both genetic and life history diversity (U.S. Fish and Wildlife Service 2016). LSNFH releases up to 250,000 winter-run Chinook salmon a year, while working to minimize hatchery effects in the population by preferentially collecting wild adult winter-run Chinook salmon for brood stock (U.S. Fish and Wildlife Service 2011b). In addition to supplementing populations, restoration activities are being conducted to help improve instream and floodplain habitat for the species. Restoration within Battle Creek aims to create additional spawning and rearing habitat. The NMFS 2021 – 2025 priority actions identify several restoration efforts to help with the recovery of winter-run Chinook salmon, including but not limited to reintroduction of the species above Shasta Dam, improving management of Shasta Reservoir cold water storage, and improving Yolo Bypass fish habitat and passage.

12.1.2.2 Chinook Salmon, Central Valley Spring-Run Evolutionarily Significant Unit

Upstream adult migration of spring-run Chinook salmon in the upper Sacramento River typically extends from mid-March through July with peak migration in late May and early June (California Department of Fish and Wildlife 1998). Individuals enter freshwater as immature fish and hold in deep cold pools near spawning areas until they are sexually mature. Spawning occurs from late-August through October and fry emerge from November through March (Williams 2006). Juvenile spring-run Chinook salmon rear in natal tributaries, the Sacramento River mainstem, and nonnatal tributaries to the Sacramento River (California Department of Fish and Wildlife 1998). Outmigration timing is highly variable, as they may migrate downstream as young of the year (YOY) or as juveniles or yearlings. The out-migration period for spring-run Chinook salmon extends from November to early May, with up to 69% of the YOY fish out-migrating through the lower Sacramento River and Delta during this period (California Department of Fish and Wildlife 1998).-Juveniles that remain in the Sacramento River over summer are confined to approximately 100 miles of the upper mainstem where dam releases maintain cool water temperatures.

Historically, spring-run Chinook salmon in the Sacramento River basin were found in the upper and middle reaches of the American, Yuba, Feather, Sacramento, McCloud and Pit rivers, as well as smaller tributaries of the upper Sacramento River downstream of present-day Shasta Dam (National Marine Fisheries Service 2009). Estimates indicate that 82% of the approximately 2,000 miles of salmon spawning and rearing habitat available in the mid-1800s are unavailable or inaccessible today (Yoshiyama et al. 1996). Spring-run Chinook salmon abundance in the Sacramento River mainstem has declined sharply since the 1970s. Operation of Feather River Fish Hatchery (FRFH) may pose threats to spring-run Chinook salmon stock genetic integrity (National Marine Fisheries Service 1998). A large portion of Central Valley spring-run Chinook salmon is of hatchery-origin, and naturally spawning populations may be interbreeding with both fall-run/late fall–run and hatchery raised spring-run Chinook salmon. Hatchery broodstock management has attempted to segregate the two runs; but despite these efforts, substantial hybridization has occurred, resulting in substantial genetic introgression (Clemento et al. 2014; Meek et al. 2016). Installation of NMFS-approved fish screens at the Tehama Colusa Canal diversion and implementation of monitoring, evaluating, and adaptively managing the new fish screens to ensure the screens are working properly and impacts to listed species are minimized was completed in 2013 (National Marine Fisheries Service 2009c).

The development and implementation of a river flow management plan downstream of Shasta and Keswick dams that considers the effects of climate change, and flow and water temperature needs of spring-run Chinook salmon is ongoing. A recovery action that will operate and maintain temperature control curtains in Lewiston and Whiskeytown Reservoirs to minimize warming of water from the Trinity River and Clear Creek is authorized. The CVPIA long-term gravel augmentation plan will continue through 2024 with the goal of increasing and maintaining spawning habitat for spring-run Chinook salmon in the Sacramento River downstream of Keswick Dam.

12.1.2.3 Chinook Salmon, Central Valley Fall-Run and Late Fall-Run Evolutionarily Significant Unit

Fall-run Chinook salmon are an ocean-maturing type of salmon adapted for spawning in lowland reaches of big rivers, including the mainstem Sacramento River, and late fall–run Chinook salmon are mostly a stream-maturing type (Moyle 2002). Adult late fall–run Chinook salmon typically hold in the river for one to three months before spawning while fall-run Chinook salmon generally spawn shortly after entering fresh water. Fall-run Chinook salmon migrate upstream past RBDD on the Sacramento River between July and December, typically spawning in upstream reaches from October through March. Late fall–run Chinook salmon migrate upstream past RBDD from August to March and spawn from January to April (National Marine Fisheries Service 2009; Tehama-Colusa Canal Authority 2008). The primary spawning area for both runs is Keswick Dam downstream to RBDD. The majority of young fall-run Chinook salmon migrate to the ocean during the first few months following emergence, although some may remain in fresh water and migrate as yearlings. Late fall–run juveniles typically enter the ocean after seven to thirteen months of rearing in fresh water, at 150–170 millimeters (mm) in fork length, considerably larger and older than fall-run Chinook salmon (Moyle 2002).

Fall-run and late-fall run Chinook salmon are found throughout the Sacramento River and its tributaries from Keswick Dam down into the Delta. Spawning densities for both runs are generally highest between Keswick Dam and RBDD, individuals spawn downstream of RBDD to approximately Princeton Ferry (U.S. Fish and Wildlife Service 2003; California Department of Fish and Wildlife aerial redd survey unpublished data; Azat 2022). Annual fall-run and late fall–run Chinook salmon escapement to the Sacramento River and its tributaries has generally been declining over the last decade, following peaks in the late 1990s to early 2000s (Azat 2023). Hatchery fall-run escapement was relatively consistent at approximately 50,000–60,000 fish during 2014–2018, with hatchery escapement of late fall–run Chinook salmon in recent years estimated to be greater than in-river numbers (Figure 11A-13).

The Feather River Fish Hatchery, Coleman National Fish Hatchery, and Nimbus Fish Hatchery all produce fall run and or late-fall run Chinook salmon to serve as mitigation for loss of habitat, to enhance wild populations, and to support recreational and commercial fisheries in the region.

12.1.2.4 Steelhead, California Central Valley Distinct Population Segment

Steelhead are broadly divided into life history types based on the state of sexual maturity at the time of river entry. Only winter-run steelhead are currently found in Central Valley rivers and streams. Adult California Central Valley steelhead migrate into the Sacramento River from the Delta in late summer and throughout the winter, into early spring. Steelhead exhibit life histories in which they spawn within a few months of entering freshwater or stage in pools for more extended periods until the first high flows (Moyle 2002; Williams 2006). Unlike salmon, steelhead may live to spawn more than once and generally rear in freshwater streams for two to four years before out-migrating to the ocean. The Sacramento River functions primarily as a migration channel, although some rearing habitat remains in areas with setback levees (primarily upstream of Colusa) and flood bypasses (e.g., Yolo Bypass) (National Marine Fisheries Service 2009).-Steelhead fry rear and migrate downstream in the Sacramento River during most months of the year, with peak emigration January to June, and juvenile steelhead can be rearing and migrating in the Sacramento River year-round (Hallock et al. 1961; McEwan 2001).

Central Valley steelhead are currently found in the Sacramento River downstream of the Keswick Dam and in the major tributaries and creeks of the Sacramento River watershed (Bureau of Reclamation 2023). Steelhead mostly use the Sacramento River as a migratory corridor for reaching other tributaries to spawn. Data on steelhead spawning in the mainstem Sacramento River is limited and likely restricted to the area upstream of Red Bluff (National Marine Fisheries Service 2009a). Adult steelhead abundance in the upper tributaries of the Sacramento River are based on monitoring in Battle Creek and Clear Creek. Escapement estimates for Battle Creek ranged from 633 to 2,035 individuals from 2001 through 2004, but dropped below 500 individuals from 2005 through 2019 with the exception of 2013 and 2014 (Stanley et al. 2020).

The spawning distribution of steelhead in the upper Sacramento River is poorly known, but the suitability of spawning habitat is largely determined by instream flow and the availability of suitable spawning gravel (U.S. Fish and Wildlife Service 2011c, 2011d). In the upper Sacramento River during WY 2023, 24.5 acres of rearing habitat or spawning habitat were completed, on-going, or scheduled to start in the near future. Roughly 15.5 more acres are needed to meet the 40 to 60 acre goal by 2030 (Reclamation 2024). The goal of 15,000 to 40,000 tons of gravel injected into the Sacramento River has been met each year and is anticipated to be met in WY 2024.

12.1.2.5 Green Sturgeon, Southern Distinct Population Segment

The Sacramento River provides habitat for southern DPS green sturgeon spawning, adult holding, foraging, and juvenile rearing. Suitable spawning temperatures and spawning substrate exist for green sturgeon in the Sacramento River upstream and downstream of RBDD (Bureau of Reclamation 2008). Although the upstream extent of historical green sturgeon spawning in the Sacramento River is unknown, the observed distribution of sturgeon eggs, larvae, and juveniles indicates that spawning occurs from Hamilton City upstream to Inks Creek confluence and possibly up to the Cow Creek confluence (Brown 2007; Poytress et al. 2013, 2015). California Department of Fish and Wildlife (2002) indicated that green sturgeon spawn in late spring and early summer. Adult green sturgeon that migrate upstream in April, May, and June are completely blocked by the Anderson-Cottonwood Irrigation District diversion dam (74 Federal Register 52300–52351), rendering approximately three miles of spawning habitat upstream of the diversion dam inaccessible. The number of green sturgeon accessing the upper Sacramento River appears to have increased following the decommissioning of RBDD (Steel et al. 2019). Young green sturgeon appear to rear for the first one to two months in the Sacramento River between the Clear Creek confluence and Hamilton City (Heublein et al. 2017).

The current green sturgeon population status is unknown (Beamesderfer et al. 2007; Adams et al. 2007). Mora et al. (2018) employed acoustic telemetry and sonar studies to derive a total population size estimate of 17,548 individuals (95% confidence interval = 12,614–22,482)). The estimate does not include spawning adults in the lower Feather or Yuba Rivers (National Marine Fisheries Service 2019). Battaile et al. (2023) estimated lower adult green sturgeon abundance numbers from 2020-2022 (742 to 1,208 individuals).

The CVP and CVPIA have begun habitat restoration, environmental water acquisitions, and fish screening projects that will benefit green sturgeon (NMFS 2018). The construction of structures that will provide volitional passage for upstream migrating adults is an ongoing recovery action that began with the construction of the Fremont Weir Adult Fish Passage Modification Project in

2018. The Yolo Bypass Salmonid Habitat and Fish Passage Project (Big Notch Project) is also a part of this recovery action and is expected to be constructed in 2024. The development of temperature and flow targets in accessible spawning, incubation, and rearing habitat through long-term monitoring is ongoing, as well as planned research to determine the effects from the operation of the Delta Cross Channel gates on green sturgeon.

12.1.3 Clear Creek

This section describes some of the focal fish species expected to occur in the Clear Creek watershed. Clear Creek also supports populations of native minnows and Pacific lamprey which are discussed in greater detail in Appendix O.

12.1.3.1 Chinook Salmon, Central Valley Spring-Run Evolutionarily Significant Unit

Central Valley spring-run Chinook salmon have re-established in Clear Creek following implementation of the Clear Creek Restoration Program (CCRP). Adult Central Valley spring-run Chinook salmon migrate upstream into lower Clear Creek beginning in early June and spawn in the uppermost reaches from September through early to mid-October. Rotary screw trap data on spring-run Chinook salmon outmigration from Clear Creek show spring-run Chinook juveniles emigrating during late October through late May (Schraml and Chamberlain 2019; Schraml et al. 2020). Peak emigration of spring-run Chinook salmon juveniles occurs in November, with fewer fish exiting each week through the end of May (Figure O.1 3). The majority of the outmigrating juveniles are fry, generally under 40 mm fork length (Schraml et al. 2018).

Spring-run Chinook salmon utilize approximately 18 miles of habitat downstream of Whiskeytown Dam. Since 2000, Whiskeytown Dam has been the only remaining dam on Clear Creek, which provides cold water to sustain spring-run Chinook salmon spawning and rearing.

The CVPIA Clear Creek Adaptive Restoration Program is anticipated to begin in 2024 and will include gravel augmentation, wood supplementation, and channel rehabilitation translating to about 24 acres of floodplain habitat, 10 acres of perennial rearing habitat, 5 acres of new spawning habitat, 25 acres of new cover, and maintain 26 acres of existing spawning habitat (Reclamation 2023). Water temperature criteria (maximum mean daily 56°F) in Clear Creek are set to be protective of spring-run Chinook salmon during spawning and incubation (September 15 to October 31) (Clear Creek Technical Team 2018). Since 2003, the USFWS has installed a temporary picket weir from late August through early November to allow spawning spring-run Chinook salmon to be spatially separated from fall-run Chinook salmon, which have an overlap in spawning timing (National Marine Fisheries Service 2014c). The Clear Creek Restoration Program (CCRP) identified and implemented a variety of actions to improve salmon and steelhead habitat. To combat the elimination of gravel recruitment from upstream of Whiskeytown Dam, spawning gravels have been added to Clear Creek downstream of Whiskeytown Dam every year since 2002.

12.1.3.2 Steelhead, California Central Valley Distinct Population Segment

Central Valley steelhead have re-established in Clear Creek following implementation of the Clear Creek Restoration Program (CCRP), and adult Central Valley steelhead and non-anadromous rainbow trout (*O. mykiss*) are present in Clear Creek. *O. mykiss* >16 inches have been seen migrating upstream as early as August and through February (Killam 2022). Based on the number of redds observed, most spawning appears to occur near to the confluence with the Sacramento River, with peak spawning occurring from December–January (Provins and Chamberlain 2019a, 2019b). Occurrence of yearlings and juveniles at the monitoring traps goes from November through June (Schraml and Chamberlain 2019a, 2019b, 2020, 2021).

Steelhead utilize approximately 18 miles of habitat downstream of Whiskeytown Dam. Since 2000, Whiskeytown Dam has been the only remaining dam on Clear Creek, which provides cold water to sustain steelhead spawning and rearing.

Since 1995, the CVPIA and later the CALFED Bay-Delta Program have conducted salmonid habitat and flow restoration in Clear Creek and re-established runs of California Central Valley steelhead. The Clear Creek Restoration Program (CCRP) identified and implemented a variety of actions to improve salmon and steelhead habitat, including increased minimum flows, summer water temperature control through flow management, removal of a low-head dam, large-scale stream and floodplain restoration, gravel augmentation, spring and early summer pulse flows, and erosion control (Clear Creek Technical Team 2018). To combat the elimination of gravel recruitment from upstream of Whiskeytown Dam, spawning gravels have been added to Clear Creek downstream of Whiskeytown Dam every year since 2002. The gravel augmentation program on Clear Creek continues to enhance the spawning habitat available to Central Valley fall- and spring-run Chinook salmon and Central Valley steelhead (Bureau of Land Management and National Park Service 2008).

12.1.3.3 Chinook Salmon, Central Valley Fall-Run and Late Fall-Run Evolutionarily Significant Unit

Clear Creek below Whiskeytown reservoir provides suitable spawning habitat for both fall-run and late fall-run Chinook salmon. Based on carcass surveys and juvenile outmigration trapping, fall-run Chinook salmon typically spawn in Clear Creek from late September through early December, and peak outmigration of juveniles occurs in January and February (Earley et al. 2013). Late-fall run Chinook salmon enter the upper Sacramento watershed in December and spawn through April (Vogel and Marine 1991), however based on the seasonal flows, turbidity, cold temperatures, and limited daylight, it can be difficult to survey spawning activity in tributaries (USFWS 2008). Fall-run Chinook salmon spawn primarily in the lower 6.5 miles of the 8.5 lower alluvial segment of Clear Creek (USFWS 2015).Chinook salmon and steelhead populations in Clear Creek are doing well relative to other Central Valley populations. Anadromous fish escapement, redd counts, and carcass indices in Clear Creek have either increased, remained stable, or decreased substantially less than their Central Valley counterparts in the years after implementation of habitat improvements.

Beginning in 1995, restoration actions in Clear Creek have had an effect on fall-run Chinook salmon populations. The actions have contributed to a near fourfold increase in escapement of fall-run Chinook salmon to Clear Creek (population estimates average 1,749 from 1967 to 1991 and 7,333 from 1992 to 2017) (Clear Creek Technical Team 2018).

12.1.4 Lower American River

This section describes some of the focal fish species expected to occur in the lower American River watershed. The lower American River also supports populations of white sturgeon, native minnows, Pacific lamprey, Western river lamprey, striped bass, black basses, threadfin shad, and American shad (Table 12-1), all of which are discussed in greater detail in Appendix O.

12.1.4.1 Steelhead, California Central Valley Distinct Population Segment

Adult steelhead enter the lower American River from November through April with a peak occurring from December through March (Surface Water Resources 2001). A spawning survey conducted in 2001–2007 indicates that steelhead spawning occurs in the lower American River from late December through early April, with peak occurrence in late February to early March (Hannon and Deason 2008). Redd count based population estimates indicated that there were approximately 200 to 500 in-river spawners in those years.

Prior to the construction of Folsom and Nimbus dams, steelhead would seek out coldwater refuges in higher elevation habitats of the basin and spawned only in the upper reaches (Sacramento Water Forum 2015). Although some spawning by steelhead in the lower American River occurs naturally (Hannon and Deason 2008), the population is supported primarily by the Nimbus Fish Hatchery (NFH). Lindley et al. (2007) classifies the listed (i.e., naturally spawning) population of lower American River steelhead at a high risk of extinction because it is reportedly mostly composed of winter-run steelhead originating from NFH; possibly up to 90% of spawners are of hatchery origin (Hannon and Deason 2008). NMFS considers the lower American River population to be important to the survival and recovery of the species (National Marine Fisheries Service 2009). Hatchery origin-fish from NFH are not considered part of the CCV steelhead DPS.

Currently, spawning density of steelhead in the lower American River is highest in the upper seven miles of the river, but spawning occurs as far downstream as Paradise Beach. About 90% of spawning occurs upstream of the Watt Avenue Bridge (Hannon and Deason 2008). The presence and operation of the dams reduce the recruitment of spawning gravel in the lower American River below Nimbus Dam. To mitigate those effects, in the lower American River, roughly 24 acres have been devoted to gravel augmentation, while approximately 50 acres have focused on side channel creation. Habitat restoration projects completed in October 2022 at Nimbus Basin and Lower Sailor Bar enhanced habitat for steelhead by laying approximately 41,000 cubic yards of clean gravel into the river and excavated side channel habitat (Water Forum 2022). Those projects have improved spawning habitat for both Chinook salmon and steelhead spawning in the lower American River. Reclamation's habitat programs will continue through separate environmental compliance and future restoration plans as independent programs.

12.1.4.2 Chinook Salmon, Central Valley Fall-Run Evolutionarily Significant Unit

Adult fall-run Chinook salmon enter the lower American River from mid-September through January, with peak migration from approximately mid-October through December (Williams 2001). Spawning occurs from about mid-October through early February, with peak spawning from mid-October through December. Chinook salmon spawning occurs within an 18-mile stretch from Paradise Beach to Nimbus Dam; however, most spawning occurs in the uppermost three miles (California Department of Fish and Wildlife 2012). Fall-run chinook salmon egg and alevin incubation occurs in the lower American River from about mid-October through April. There is high variability from year to year; however, most incubation occurs from about mid-October through February. Chinook salmon fry emergence occurs from January through mid-April, and juvenile rearing extends from January to about mid-July (Williams 2001). Most Chinook salmon out-migrate from the lower American River as fry between December and July, peaking in February to March (Snider and Titus 2002; Pacific States Marine Fisheries Commission 2014). There is evidence that late-fall run Chinook salmon presence in the lower American River is a result of straying from fish released from the Coleman National Fish Hatchery (Lasko 2012).

The lower American River historically supported fall-run and perhaps late fall–run Chinook salmon (Williams 2001). Both natural-origin and hatchery-produced Chinook salmon spawn in the lower American River. An analysis by Palmer-Zwahlen et al. (2018) found that constant fractional marking results from 2013 show that approximately 86% of the fall-run Chinook salmon spawners returning to Nimbus Hatchery were hatchery-origin. Further, 71% of fall-run Chinook salmon recorded at the Hatchery Weir and 65% of carcasses were identified as hatchery fish.

Restoration projects like the Upper River Bend Phase I and Nimbus Basin and Lower Sailor Bar aim to provide and enhance additional spawning habitat in the lower American River for anadromous species like the fall-run Chinook salmon.

12.1.5 Stanislaus River

This section describes some of the focal fish species expected to occur in the Stanislaus River watershed. The Stanislaus River also supports populations of native minnows, Pacific lamprey, Western River lamprey, striped bass, black basses, threadfin shad, and American shad (Table 12-1), all of which are discussed in greater detail in Appendix O.

12.1.5.1 Steelhead, California Central Valley Distinct Population Segment

Data on steelhead spawning in the Stanislaus River is limited, but adults appear to spawn primarily from January to April. In 2021, as part of the reasonable and prudent measure to accelerate steelhead monitoring and research in the NMFS (2019) LTO Biological Opinion, CDFW initiated the Stanislaus River Life Cycle Monitoring Program. Based on the initial redd survey report, which had a late start due to COVID-19 restrictions, spawning appears to start in February and last until April (Kok and Keller 2023). Although few steelhead spawning surveys have been conducted in the Stanislaus River, spawning *O. mykiss* have been documented upstream of the Highway 120 Bridge in Oakdale, between Goodwin Dam and the Oakdale Recreation Area.

On the Stanislaus River, the completion of Goodwin Dam in 1912 has excluded salmon and steelhead from 100 percent of their historical spawning and rearing habitat on the Stanislaus River (Lindley et al. 2006). Since that time, salmon and steelhead spawn downstream of Goodwin Dam on the Stanislaus River which experiences warmer water temperatures. None of the three dams on the Stanislaus River have a temperature control device, so the only mechanism for temperature management on the Stanislaus River is direct flow management. Reclamation currently operates New Melones Dam, located upstream of Goodwin Dam.

Past operational releases from New Melones Dam have influenced the extent of coolwater habitat available below Goodwin Dam. Since 2019, Reclamation has implemented a Stepped Release Plan (SRP) for the Stanislaus River. The SRP does not set water temperature standards for the Stanislaus River, but it does include minimum flow targets that are intended to benefit steelhead, including water temperature benefits and preservation of coldwater pool. Under the CVPIA 3406(b)(13) program, Reclamation's annual goal of gravel placement is approximately 4,500 tons in the Stanislaus River. Between 2009 and 2022, approximately 54,450 tons of gravel were added to the Stanislaus River for steelhead and salmon habitat restoration (Reclamation 2022). Reclamation proposes to construct an additional 50 acres of rearing habitat adjacent to the Stanislaus River by 2030 (Reclamation 2024).

12.1.5.2 Chinook Salmon, Central Valley Fall-Run

The Stanislaus River provides important spawning habitat for fall-run Chinook salmon. The majority of fall-run Chinook salmon adults migrate upstream to the Stanislaus River between late September through December with peak migration from late October through early November. Most fall-run Chinook salmon spawning occurs between Riverbank and Goodwin Dam (Bureau of Reclamation 2012a). By late October, the amount of spawning in downstream locations increases as water temperatures decrease, and the median redd location is typically around Knights Ferry (State Water Resources Control Board 2015). About 99% of salmon juveniles migrate out of the Stanislaus River January through May (Stanislaus River Fish Group 2004). Fry migration generally occurs from January through March, followed by smolt migration from April through May (Bureau of Reclamation 2012a).

Historic spawning areas of the Stanislaus River are no longer reachable due to the development of the Goodwin Dam, however fall-run Chinook salmon can still access suitable spawning habitat between Riverbank and the Goodwin Dam. Flows through this viable spawning section of the river are supported by releases from the New Melones Dam. Additionally, gold and gravel mining activities have further degraded potential spawning and rearing habitat for salmonids in the Stanislaus.

To promote and enhance spawning habitat within the Stanislaus, Reclamation implemented the Goodwin Canyon Salmonid Spawning Gravel Placement Project, which helped improve spawning and rearing habitat for juvenile salmonids in the system. As mentioned above, the CVPIA has also played an important role in enhancing habitat within the Stanislaus River for salmonids, including fall-run Chinook salmon.

12.1.6 San Joaquin River

This section describes some of the focal fish species expected to occur in the San Joaquin River watershed. The San Joaquin River also supports populations of native minnows, striped bass, black basses, and threadfin shad (Table 12-1), all of which are discussed in greater detail in Appendix O.

12.1.6.1 Steelhead, California Central Valley Distinct Population Segment

The San Joaquin River is primarily documented as a migratory corridor for adult and juvenile steelhead. Adults entering the San Joaquin River Basin appear to have a later spawning run, entering the system starting in late October through December. Outmigration of juveniles from the San Joaquin River into the Delta is monitored through the Mossdale Trawl, and median passage is April through May (Columbia Basin Research, University of Washington 2024). The sampling trawls capture steelhead smolts, although usually in small numbers. Steelhead were historically present in the San Joaquin River, though data on their population levels are lacking (McEwan 2001). The current steelhead population in the San Joaquin River is substantially reduced compared with historical levels, although resident rainbow trout occur throughout the major San Joaquin River tributaries. Additionally, small populations of steelhead persist in the lower San Joaquin River and tributaries (e.g., Stanislaus, Tuolumne, and possibly Merced Rivers) (Zimmerman et al. 2009; McEwan 2001). Steelhead/rainbow trout of anadromous parentage occur at low numbers in all three major San Joaquin River tributaries. These tributaries have a higher percentage of resident rainbow trout compared to the Sacramento River and its tributaries (Zimmerman et al. 2009).

Reclamation has undertaken river restoration projects and provided in-stream flows for the San Joaquin River. The San Joaquin River Restoration Program is outside of this consultation.

12.1.6.2 Green Sturgeon, Southern Distinct Population Segment

From 2007 to 2012, anglers reported catching six green sturgeon in the San Joaquin River (Jackson and Van Eenennaam 2013). Although the reported presence of green sturgeon in the San Joaquin River coincides with the spawning migration period of green sturgeon within the Sacramento River, no evidence of spawning has been detected (Jackson and Van Eenennaam 2013). The current status and historic range of green sturgeon in the San Joaquin River is unknown, though anglers report seeing green sturgeon in the San Joaquin River (CDFW 2023).

There are not specific protections in place for sDPS green sturgeon in the San Joaquin River.

12.1.6.3 Chinook Salmon, Central Valley Fall-Run

The San Joaquin River downstream of the Stanislaus River primarily provides upstream passage for adult fall-run Chinook salmon and downstream passage for juveniles and smolts as they out-migrate from the tributary spawning and rearing areas to the Delta and the Pacific Ocean. Weir counts in the Stanislaus River suggest that adult fall-run Chinook salmon in the San Joaquin River basin typically migrate into the upper rivers from late September to mid-November and spawn shortly thereafter (Pyper et al. 2006; Anderson et al. 2007; FISHBIO Environmental 2010a, 2011). The juvenile fall-run Chinook salmon out-migration in the San Joaquin River basin typically occurs during winter and spring, primarily from January through May. The out-migration consists primarily of fry in winter and smolts in spring (FISHBIO Environmental 2007, 2013b). Trawl sampling in the lower San Joaquin River from Mossdale to the Head of Old River (the Mossdale Trawl) captures Chinook salmon from February into July, with peak catches generally during April and May (Speegle et al. 2013).

Fall-run Chinook salmon are present in the San Joaquin River and its major tributaries upstream to and including the Merced River. Spawning and rearing occur in the major tributaries (Merced, Tuolumne, and Stanislaus rivers) downstream of the mainstem dams. Fall-run Chinook salmon are subject to the same potential impacts as other salmonids within the San Joaquin River system, which includes loss of important floodplain and estuarine habitat and water exports.

Programs like the San Joaquin River Restoration Program aim to restore flows to the San Joaquin River. While one of the main goals of this program is to restore spring-run Chinook populations, the program would also provide benefits to fall-run Chinook salmon and other native fish.

12.1.7 Bay-Delta

This section describes some of the focal fish species expected to occur in the Bay-Delta watershed. The Bay-Delta also supports populations of white sturgeon, native minnows, Pacific lamprey, Western River lamprey, striped bass, black basses, threadfin shad, American shad, and starry flounder (Table 12-1), all of which are discussed in greater detail in Appendix O.

12.1.7.1 Chinook Salmon, Sacramento River Winter-Run Evolutionarily Significant Unit

Winter-run Chinook salmon adults migrate through the Delta during winter and into late spring to spawning grounds in the mainstem Sacramento River downstream of Keswick Dam. Fry disperse from mid-June through mid-October to areas downstream for rearing (Vogel and Marine 1991) and juvenile occupancy in the greater Sacramento River and estuary system is expected to last between five to nine months prior to entering the ocean (California Department of Fish and Wildlife 1985, 1998). Phillis et al. (2018) demonstrated 82% of surviving winter-run Chinook salmon reared exclusively upstream of the Delta, suggesting less reliance on Delta habitats than previously recognized. Results of acoustic tagging studies indicate that migrating Chinook smolts can move through the Delta rapidly on the order of days to weeks (Perry et al. 2018). Telemetry studies of acoustically tagged, hatchery-origin winter-run juveniles indicate that migratory survival of smolts varies by route through the Delta and is a function of flow and temperature (Hance et al. 2022). The peak timing of the out-migration of juvenile winter-run Chinook salmon through the Delta is corroborated by recoveries of winter-run-sized juvenile Chinook salmon from the John E. Skinner Delta Fish Protective Facility, part of the SWP, and the Tracy Fish Collection Facility (CVP) in the south Delta (National Marine Fisheries Service 2009).

Winter-run Chinook salmon juveniles have been documented in many parts of the Delta: north (e.g., Sacramento River, Steamboat Slough, Sutter Slough, Miner Slough, Yolo Bypass, and Cache Slough complex); central (e.g., Georgiana Slough, Delta Cross Channel, Snodgrass Slough, and Mokelumne River complex below Dead Horse Island); south Delta channels, including Old and Middle rivers (OMRs), and the joining waterways between OMRs (e.g., Victoria Canal, Woodward Canal, and Connection Slough); and western central Delta, including the mainstem channels of the Sacramento and San Joaquin rivers and Threemile Slough (National Marine Fisheries Service 2009). Winter-run Chinook salmon exit the Delta at Chipps Island between December and May, with a peak in March (Brandes and McLain 2001; del Rosario et al. 2013).

Hatchery production at facilities like the Livingston Stone National Fish Hatchery help supplement the winter-run Chinook salmon population, which ultimately supports the population numbers found in the Bay-Delta. The Yolo Bypass Salmonid Habitat Restoration Project further supports benefits to Chinook salmon by improving connectivity with important floodplain habitats, which are valuable to salmonid rearing.

12.1.7.2 Chinook Salmon, Central Valley Spring-Run Evolutionarily Significant Unit

Adult spring-run Chinook salmon returning to spawn in the Sacramento River system enter the San Francisco Estuary from the ocean in January to late February and move through the Delta prior to entering the Sacramento River. Juvenile spring-run Chinook salmon show two distinct out-migration patterns in the Central Valley: migrating to the Delta and ocean during their first year of life as young of year (YOY; i.e., ocean-type life history), or holding over in their natal streams and migrating the following fall/winter as yearlings (i.e., stream-type life history) (Moyle 2002). YOY spring-run Chinook salmon presence in the Delta peaks during April and May, as suggested by the recoveries of Chinook salmon in the CVP and SWP salvage operations and in the Chipps Island trawls of a size consistent with the predicted size of spring-run Chinook salmon at that time of year. However, it is difficult to distinguish YOY spring-run Chinook salmon migration from that of fall-run Chinook salmon without employing genetic analysis due to the similarity in their spawning and emergence times and size. Typically, juvenile Spring-Run Chinook Salmon are not found in the channels of the eastern side of the Delta.

The Delta is an important migratory route for all remaining populations of Spring-run Chinook Salmon. Like all salmonids migrating up through the Delta, adult Spring-run Chinook salmon must navigate the many channels and avoid direct sources of mortality (e.g., fishing and predation), but also must minimize exposure to sources of nonlethal stress (e.g., high temperatures) that can contribute to prespawn mortality in adult salmonids (Budy et al. 2002; Naughton et al. 2005; Cooke et al. 2006; NMFS 2009). Habitat degradation in the Delta caused by factors such as channelization and changes in water quality can present challenges for out-migrating juveniles. Additionally, out-migrating juveniles are subjected to predation and entrainment in the project export facilities and smaller diversions (NMFS 2009).

The head of Old River agricultural barrier operations are constructed seasonally to maximize survival of spring-run Chinook salmon emigrating from the San Joaquin River. Closure of the DCC radial gates is intended to minimize spring-run straying, but some southward net flow still occurs naturally in Georgiana and Threemile sloughs. Reclamation and DWR continue to implement projects that will improve passage and habitat conditions in the Stockton Deep Water Ship Channel. The Delta Tidal Habitat Restoration project that aims to restore 8,396 acres of tidal habitat by 2026 and the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project (Big Notch Project) that aims to increase seasonal floodplain rearing habitat by 2030 will further support benefits to spring-run Chinook salmon.

12.1.7.3 Chinook Salmon, Central Valley Fall-Run and Late Fall-Run Evolutionarily Significant Unit

Adult fall-run Chinook salmon migrate through the Delta and into Central Valley rivers from June through December, whereas adult late fall–run Chinook salmon migrate through the Delta and into the Sacramento River from October through April. Adult Central Valley fall- and late fall–run Chinook salmon migrating into the Sacramento River and its tributaries primarily use the western and northern portions of the Delta, whereas adults entering the San Joaquin River system to spawn use the western, central, and southern Delta as a migration pathway. Most fall-run Chinook salmon fry rear in fresh water from December through June, with out-migration as smolts occurring primarily from January through June. Smolts that arrive in the estuary after rearing upstream migrate quickly through the Delta and Suisun and San Pablo Bays. A small number of juvenile fall-run Chinook salmon spend over a year in fresh water and migrate as yearling smolts the following November through April. Late fall–run fry rear in fresh water from April through the following April and migrate as smolts from October through February (Snider and Titus 2000a). Juvenile Chinook salmon were found to spend about 40 days migrating through the Delta to the mouth of San Francisco Bay (MacFarlane and Norton 2002).

Juvenile fall- and late fall–run Chinook salmon migrating through the Delta toward the Pacific Ocean use the Delta, Suisun Marsh, and Yolo Bypass for rearing to varying degrees, depending on their life stage (fry versus juvenile), size, river flows, and time of year. Movement of juvenile Chinook salmon in the estuarine environment is driven by the interaction between tidally influenced saltwater intrusion through San Francisco Bay and freshwater outflow from the Sacramento and San Joaquin rivers (Healey 1991). Survival of juvenile acoustically tagged, hatchery-origin late fall-run Chinook salmon from the Sacramento River varied among migration routes: fish routed to the interior Delta through either the Georgiana Slough or Delta Cross Channel exhibited lower survival than fish routed through Sutter Slough, Steamboat Slough, or the mainstem Sacramento River (Perry et al. 2018). In the Delta, tidal and floodplain habitat provide important rearing habitat for foraging juvenile salmonids, including fall-run Chinook salmon. Studies show juvenile salmon may spend two to three months rearing in these habitats.

Restoration of floodplain habitats from the Yolo Bypass Salmonid Habitat Restoration Project will provide access to rearing habitat for juvenile salmonids and supplementing wild populations with hatchery raised fish are done to enhance the population of fall-run and late-fall run Chinook salmon in the Bay-Delta and throughout the Central Valley.

12.1.7.4 Steelhead, California Central Valley Distinct Population Segment

Upstream migration of California Central Valley steelhead begins with estuarine entry from the ocean as early as July and continues through February or March in most years (McEwan and Jackson 1996; National Marine Fisheries Service 2009). Populations of steelhead occur primarily within the watersheds of the Sacramento River Basin, although not exclusively. Steelhead can spawn more than once, with post-spawn adults (typically females) potentially moving back downstream through the Delta after completion of spawning in natal streams. Upstream migrating adult steelhead enter the Sacramento River and San Joaquin River basins through their respective mainstem river channels. Steelhead entering the Mokelumne River system (including Dry Creek and the Cosumnes River) and the Calaveras River system to spawn are likely to move up the mainstem San Joaquin River channel before branching off into the channels of their natal rivers, although some may detour through the south Delta waterways and enter the San Joaquin River through the head of the Old River.

As mentioned in the San Joaquin River section above, steelhead entering the San Joaquin River Basin appear to have a later spawning run, indicating that migration up through the Delta may begin a few weeks earlier. During fall, warmwater temperatures in the south Delta waterways and water quality impairment because of low dissolved oxygen at the Port of Stockton have been suggested as potential barriers to upstream migration (National Marine Fisheries Service 2009). Reduced water temperatures, rainfall runoff, and flood control release flows provide the stimulus for adult steelhead holding in the Delta to move upriver toward their spawning reaches in the San Joaquin River tributaries. Adult steelhead may continue entering the San Joaquin River basin through winter. Juvenile steelhead are recovered in trawls October through July at Chipps Island and Mossdale. Chipps

Island catch data indicate a difference in migration timing between wild unmarked and hatchery-reared steelhead smolts from the Sacramento and east side tributaries. Hatchery fish are typically recovered at Chipps Island January through March, with a peak in February and March corresponding to the schedule of hatchery releases of steelhead smolts from the Central Valley hatcheries (Nobriga and Cadrett 2001; Bureau of Reclamation 2008). The timing of wild steelhead migration is more spread out, and based on salvage records at the CVP and SWP fish collection facilities, out-migration occurs over approximately six months with the highest levels of recovery in February through June (Aasen 2011, 2012).

The Yolo Bypass Project is intended to improve shallow water habitat and habitat connectivity for steelhead. Operations are expected to provide improved habitat connectivity for fish species to migrate between the Sacramento River and the Yolo Bypass. This enhanced habitat connectivity is expected to improve the ability of anadromous fish to access the Yolo Bypass, resulting in increased growth and decreased stranding events.

12.1.7.5 Green Sturgeon, Southern Distinct Population Segment

Adult green sturgeon move through the Delta from February through April, arriving at holding and spawning locations in the upper Sacramento River between April and June (Heublein 2006; Kelly et al. 2007). Following the initial spawning run upriver, adults may hold for a few weeks to months in the upper river before moving back downstream in fall (Vogel 2008; Heublein et al. 2009, Miller et al. 2020) or they may migrate back downstream through the Delta as early as the spring (Colborne et al. 2022). Adult green sturgeon have been tracked moving downstream past Knights Landing during summer and fall, typically in association with pulses of flow in the river, and congregate in the San Francisco Estuary (Heublein et al. 2009; Lindley et al. 2008). Juvenile green sturgeon are periodically, although rarely, collected from the lower San Joaquin River at south Delta water diversion facilities and other sites and salvaged from the SWP and CVP facilities (National Marine Fisheries Service 2009; Aasen 2011, 2012; Bureau of Reclamation 2008). Larvae and juveniles migrate downstream toward the Delta to rear for the first one to three years of their lives before moving out to the ocean. They are likely to be found in the main channels of the Delta and the larger interconnecting sloughs and waterways, especially within the central Delta and Suisun Bay and Marsh (Bureau of Reclamation 2008). Miller (2020) found that juvenile green sturgeon make short oceanic movements and return to the San Francisco Estuary before migrating out into the ocean as adults.

Green sturgeon are found in the Delta year-round, likely foraging and/or rearing before migrating into the ocean (Heublein et al. 2017a). Juvenile green sturgeon are known to be in the Sacramento River upstream of Sherman Lake during all months of the year, but most abundantly in late-June through mid-September (Beccio pers. comm.). Their movements through and behavior in the Delta are not well known or studied.

According to the NMFS 2018 Green Sturgeon Recovery Plan, channel control structures, impoundments, predation, and climate change are the main threats to juvenile and adult green sturgeon in the Delta. Non-point source contaminants are an additional high threat to juveniles in the Delta. The Yolo Bypass Salmonid Habitat Restoration project (Big Notch Project) is expected to benefit green sturgeon by decreasing stranding and migration delays due to passage barriers (Reclamation 2022).

12.1.7.6 Delta Smelt

Delta smelt have a mostly annual life cycle and are endemic to the Delta and the upper San Francisco Estuary (Moyle et al. 1992; Bennett 2005). Delta smelt are thought to spawn during winter and spring months over a wide area throughout much of the Delta, including the Sacramento River and San Joaquin River confluence, the upper Sacramento River, and Cache Slough as conditions allow (Brown et al. 2014; Murphy and Hamilton 2013). Substrates or habitats used for spawning by wild Delta smelt are unknown, but lab studies on wild fish have shown a preference for spawning over sandy or gravel substrates (Lindberg et al. 2020). During and after larval rearing in fresh water, many young Delta smelt move with river and tidal currents to remain in favorable rearing habitats, often moving increasingly into the low-salinity zone to avoid seasonally warm and highly transparent waters that typify many areas in the central Delta (Nobriga et al. 2008). Depending on hydrological conditions, this includes San Pablo Bay, the Napa River, Suisun Bay, Suisun Marsh, the Sacramento River and San Joaquin River confluence, and the lower Sacramento River (Mertz et al. 2011; Murphy and Hamilton 2013). During summer and fall, many juvenile Delta smelt continue to grow and rear in the low-salinity zone, until maturing the following winter (Bennett 2005). During the winter, adult Delta smelt initiate upstream spawning migrations in association with “first flush” freshets (Sommer et al. 2011). Some Delta smelt also rear and complete their life cycle in freshwater upstream areas such as the Cache Slough complex and Sacramento Deep Water Ship Channel, depending on habitat conditions (Sommer and Mejia 2013).

Delta smelt persist in the upper San Francisco Estuary and Delta; however, portions of the historical tidal marsh–floodplain habitat once totaling approximately 300,000 acres has been diked and reclaimed for agricultural or other human use. Water conveyance projects and river channelization have altered the regional physical habitat by armoring levees with riprap, building conveyance channels like the Delta Cross Channel (DCC), storage reservoirs like Clifton Court Forebay, and by building and operating temporary barriers in the south Delta and permanent gates and water distribution systems in Suisun Marsh. Export and diversion of water for human uses can result in the entrainment of Delta smelt into unsuitable habitat or into water operation facilities. Channels in Suisun Bay and the Delta have been dredged deeper to accommodate shipping traffic and requires more freshwater outflow to maintain the low-salinity zone, an important Delta smelt rearing habitat, in the large Suisun Bay/river confluence region than was once required. Recent research combining long-term monitoring data with three-dimensional hydrodynamic modeling shows that the spatial overlap of several of the key habitat attributes, such as salinity and turbidity, increases as Delta outflow increases (Bever et al. 2016). Additionally, a wide variety of non-native plants and animals have been introduced and have altered habitat and the lower trophic food web (Cohen and Carlton 1998, Light et al. 2005, Winder et al. 2011). Important zooplankton prey have experienced long term declines (Winder and Jassby 2011, Kimmerer 2002a).

Refugial populations of Delta smelt have been established at the UC Davis Fish Conservation and Culture Laboratory; the closed cycle is supplemented by wild broodstock collection. Recent supplementation efforts began in 2021 with experimental releases of cultured Delta smelt into the wild at various locations and have continued to the present day. Tidal habitat restoration projects in the Bay-Delta and the Suisun Marsh have also been ongoing meant to benefit native species including smelt. Additionally, several objectives and actions laid out in the 2016 Delta Smelt

Resiliency Plan are ongoing including the north Delta food web adaptive management projects, outflow augmentation, Roaring River distribution system food production, and the above-mentioned Delta smelt supplementation.

12.1.7.7 Longfin Smelt, San Francisco Bay-Delta Distinct Population Segment

Longfin smelt populations occur along the Pacific Coast of North America, and the San Francisco Estuary (SFE) represents the southernmost population. Longfin smelt generally occur in the Delta; Suisun, San Pablo, and San Francisco Bays; and the Gulf of the Farallones, just outside San Francisco Bay. Longfin smelt are anadromous and migrate upstream to spawn in fresh or low salinity water in the Bay-Delta (Grimaldo et al. 2017), generally at 2 years of age, with most spawning occurring from November through April (Moyle 2002, California Department of Fish and Wildlife 2009). Studies suggested that spawning occurs in the lower Sacramento River, the confluence of the Sacramento and San Joaquin rivers, and downstream of about Medford Island in the San Joaquin River (Moyle 2002). Other studies suggest hatching and early rearing occurs in a much broader region and higher salinity (2–12 parts per thousand) (Grimaldo et al. 2017), and that spawning distribution may also include portions of the south San Francisco Bay (Lewis et al. 2019), Suisun Marsh, and the Napa River (California Department of Fish and Wildlife 2009) depending on hydrological conditions. Longfin smelt larvae are typically most abundant in the water column January through April (Bureau of Reclamation 2008). As larvae transition into the juvenile life stage, a portion of the population migrates out of the upper estuary and Delta by summer; the population is at least partially anadromous and is likely only one of several life history strategies in the population (Rosenfield and Baxter 2007; Garwood 2017).

Longfin smelt utilize the upper San Francisco Estuary and Delta as spawning and rearing habitat; however, portions of the historical tidal marsh–floodplain habitat once totaling approximately 300,000 acres has been diked and reclaimed for agricultural or other human use. Water conveyance projects and river channelization have altered the regional physical habitat by armoring levees with riprap, building conveyance channels like the Delta Cross Channel (DCC), storage reservoirs like Clifton Court Forebay, and by building and operating temporary barriers in the south Delta and permanent gates and water distribution systems in Suisun Marsh. Export and diversion of water for human uses can result in the entrainment of longfin smelt into unsuitable habitat or into water operation facilities. Channels in Suisun Bay and the Delta have been dredged deeper to accommodate shipping traffic and requires more freshwater outflow to maintain the low-salinity zone, an important larval and juvenile longfin smelt rearing habitat, in the large Suisun Bay/river confluence region. Additionally, a wide variety of non-native plants and animals have been introduced and have altered habitat and the lower trophic food web (Cohen and Carlton 1998, Light et al. 2005, Winder et al. 2011). Important zooplankton prey have experienced long term declines (Winder and Jassby 2011, Kimmerer 2002a).

Ongoing efforts are continuing to develop a captive longfin smelt culture program at the UC Davis Fish Conservation and Culture Lab. Tidal habitat restoration projects in the Bay-Delta and the Suisun Marsh have also been ongoing meant to benefit native species including smelt.

12.1.8 Nearshore Pacific Ocean

Anadromous fish species use the Pacific Ocean as part of their life cycles. In addition, the Pacific Ocean supports the Southern Resident Killer Whale (SRKW) DPS, which relies on large anadromous fish in the ocean, particularly Chinook salmon, as preferred prey.

12.1.8.1 Killer Whale, Southern Resident Distinct Population Segment

The Pacific Ocean along the coast of northern California is part of the Southern Residents population’s critical habitat. The potential effect of the action, however, is limited to potential changes in the number of Chinook salmon produced in the Central Valley and Trinity River regions entering the Pacific Ocean which may contribute an important component of the Southern Residents diet. Southern Residents are known to occur frequently in the inland waters of Washington, USA, and British Columbia, Canada, the outer coastal waters (within ~50 km of shore) from Haida Gwaii, Canada down the West coast of Vancouver Island, Washington, Oregon, and California as far south as Monterey Bay (National Marine Fisheries Service 2021c).

According to the 2008 NMFS Recovery Plan for Southern Resident Killer Whales, prey availability is one of several threats to the species. Chinook salmon are SRKW preferred prey (Ford and Ellis 2005), and California Central Valley and Trinity River fall-run and spring-run Chinook salmon account for up to 19% of prey samples collected in outer coastal waters (Hanson et al. 2021). Several studies have identified correlations or connections between Chinook salmon abundance indices and Southern Residents health, survival, social cohesion, growth rate, body condition, and fecundity (Ward et al. 2009; Ayres et al. 2012; Ford et al. 2010; Fearnbach et al. 2011; Ward et al. 2013; Wasser et al. 2017; Fearnbach et al. 2020; Stewart et al. 2021). However, understanding demographic and health correlations with prey indices is complicated by differences in pod foraging patterns (Stewart et al. 2021); interactions with disturbance stressors (Ayres et al. 2012; Lacy et al. 2017); interaction with toxicant stressors (Lacy et al. 2017); residual demographic trends (Nelson et al. 2024); potential competition with the northern resident distinct population segment (Nelson et al. 2024); and inbreeding depression (Kardos et al. 2023).

12.2 Effects of the Alternatives

The impact assessment considers changes in fish and aquatic resources related to changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative. The environmental effects of sub-alternatives 2B and 4B are discussed qualitatively within the Alternative 2 and Alternative 4 sections of EIS Appendix O and are not further detailed within this chapter. This discussion describes some of the focal fish species; other fish species are described in greater detail in Appendix O including results from biological modeling. Attachments to Appendix O outline background, methods, results, assumptions and uncertainty, and references. Effects in this chapter describe beneficial and adverse impacts and not identify where impacts are negligible.

The No Action Alternative is based on 2040 conditions. The changes to fish and aquatic resources, such as changes in flow and temperature, that are assumed to occur by 2040 under the

No Action Alternative conditions would be different than existing conditions because of the following non exhaustive list of factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

In the long term, it is anticipated that climate change, and development throughout California, could affect water supply deliveries.

Under the No Action Alternative, Reclamation would continue with the current operation of the Central Valley Project (CVP), as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the State Water Project (SWP) represent current management direction or intensity pursuant to 43 CFR Section 46.30.

Although the No Action Alternative included habitat restoration projects at a programmatic level, the 2020 ROD did not provide environmental coverage for these projects, and all of the habitat projects considered under the No Action required or will require additional environmental documentation. Thus, ground disturbance for habitat restoration projects did not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

The No Action Alternative is expected to result in potential changes to fish and aquatic resources, such as temperature and flow. These changes were described and considered in the 2020 LTO Record of Decision and associated documents. These changes are also described in Appendix O in the Cumulative Impacts section.

12.2.1 Trinity River

Different alternatives may import water from the Trinity River to the Sacramento River to a different extent in different years and on different patterns. Flows under the Trinity River Restoration Program Record of Decision (2000) are common to all alternatives; therefore, impacts occur as a result of different reservoir levels and rare safety of dam releases. The simulated CalSim 3 results are attributed to modeling assumptions for Alternative 1-4 described in Appendix F.

12.2.1.1 Southern Oregon/Northern California Coast coho salmon

For Southern Oregon/Northern California Coast coho salmon, outlined below are the expected responses to survival ofincubating eggs and alevins, changes in rearing habitat for early life stages (fry and juveniles), and to spawning area from changes in operations primarily under each alternative relative to the No Action Alternative. The No Action Alternative would continue to improve coho habitat conditions (Appendix O). Appendix O provides detailed quantitative results of all model predictions.

- **Alternative 1** is expected to have spatially variable but negligible impacts of flow and water temperature on spawning and egg incubation and no adverse impacts on juvenile rearing habitat .
- **Alternative 2** is expected to have spatially variable impacts of flow and water temperature on spawning and egg incubation and juvenile rearing habitat, likely ranging from adverse (up to approximately a 12% decrease in spawning WUA in a more heavily used reach in December of below normal water years) to no adverse impacts.
- **Alternative 3** is expected to have spatially variable impacts of flow and water temperature on spawning and egg incubation and juvenile rearing habitat, likely ranging from negligible adverse to no adverse impacts.
- **Alternative 4** is expected to have no adverse impacts of flow and water temperature on spawning and egg incubation and juvenile rearing habitat.

Spring-run Chinook salmon

For upper Klamath-Trinity Rivers spring-run Chinook salmon, outlined below are the expected responses to survival of incubating eggs and alevins, changes in rearing habitat for early life stages (fry and juveniles), and to spawning area from changes in operations primarily under each alternative relative to the No Action Alternative. The No Action Alternative would continue to improve spring-run Chinook habitat conditions (Appendix O). Appendix O provides detailed quantitative results of all model predictions.

- **Alternative 1** is expected to have negligible impacts on spawning and egg incubation as well as rearing habitat.
- **Alternative 2** is expected to have negligible impacts on spawning and egg incubation as well as rearing habitat.
- **Alternative 3** is expected to have negligible impacts on spawning and egg incubation as well as rearing habitat.
- **Alternative 4** is expected to have negligible impacts on spawning and egg incubation as well as rearing habitat.

Fall-run Chinook salmon

For upper Klamath-Trinity Rivers fall-run Chinook salmon, outlined below are the expected responses to survival of incubating eggs and alevins, changes in rearing habitat for early life stages (fry and juveniles), and to spawning area from changes in operations primarily under each alternative relative to the No Action Alternative. The No Action Alternative would continue to improve fall-run Chinook habitat conditions (Appendix O). Appendix O provides detailed quantitative results of all model predictions.

- **Alternative 1** is expected to have spatially variable but negligible impacts of flow and water temperature on spawning and egg incubation and juvenile rearing habitat.
- **Alternative 2** is expected to have negligible impacts on spawning and egg incubation as well as rearing habitat.

- **Alternative 3** is expected to have negligible impacts on spawning and egg incubation as well as rearing habitat.
- **Alternative 4** is expected to have negligible impacts on spawning and egg incubation as well as rearing habitat.

Klamath Mountains Province steelhead

For Klamath Mountains Province steelhead, outlined below are the expected responses to survival of incubating eggs and alevins, changes in rearing habitat for early life stages (fry and juveniles), and to spawning area from changes in operations primarily under each alternative relative to the No Action Alternative. The No Action Alternative would continue to improve steelhead habitat conditions (Appendix O). *Appendix O* provides detailed quantitative results of all model predictions.

- **Alternative 1** is expected to have negligible adverse impacts from flow and water temperatures for all life stages.
- **Alternative 2** is expected to have negligible adverse impacts from flow and water temperatures for all life stages.
- **Alternative 3** is expected to have negligible adverse impacts from flow and water temperatures for all life stages.
- **Alternative 4** is expected to have minor adverse impacts from flow and water temperatures for all life stages, and adverse flow impacts to adult holding habitat (up to approximately a 30% decrease) in above normal years.

12.2.1.2 Northern DPS green sturgeon

For Northern DPS green sturgeon, outlined below are the expected responses to survival of incubating eggs and yolk-sac larvae, changes in rearing habitat for early life stages, and to spawning area from changes in operations primarily under each alternative relative to the No Action Alternative. The No Action Alternative would continue contributing to the maintenance of suitable habitat conditions for green sturgeon (Appendix O). Appendix O provides detailed quantitative results of all model predictions.

- **Alternative 1** is expected to have negligible adverse to no adverse impacts from flow and water temperatures for all life stages.
- **Alternative 2** is expected to have negligible adverse to no adverse impacts from flow and water temperatures for all life stages.
- **Alternative 3** is expected to have negligible adverse to no adverse impacts from flow and water temperatures for all life stages.
- **Alternative 4** is expected to have negligible adverse to no adverse impacts from flow and water temperatures for all life stages.

Eulachon

For Southern DPS eulachon, outlined below are the expected responses to survival of incubating eggs and yolk-sac larvae, changes in rearing habitat for early life stages, and to spawning area from changes in operations primarily under each alternative relative to the No Action Alternative. The No Action Alternative would continue contributing to the maintenance of suitable habitat conditions for eulachon (Appendix O). Appendix O provides detailed quantitative results of all model predictions.

- **Alternative 1** is expected to have negligible adverse to no adverse impacts from flow and water temperatures for all life stages.
- **Alternative 2** is expected to have negligible adverse to no adverse impacts from flow and water temperatures for all life stages.
- **Alternative 3** is expected to have negligible adverse to no adverse impacts from flow and water temperatures for incubating eggs and larvae and rearing habitatimpacts to juvenile emigration.
- **Alternative 4** is expected to have negligible adverse to no adverse impacts from flow and water temperatures for all life stages.

12.2.1.3 Other aquatic species

For aquatic species in the Trinity River not described above, including brown trout and Trinity Reservoir species, potential impacts range from adverse to no impact. There are little to no impacts on brown trout and coldwater reservoir species for Alternative 1-4. There are adverse impacts from flow and water temperature on warmwater species under Alternative 2 and Alternative 4 under some months and water year types.

12.2.2 Sacramento River

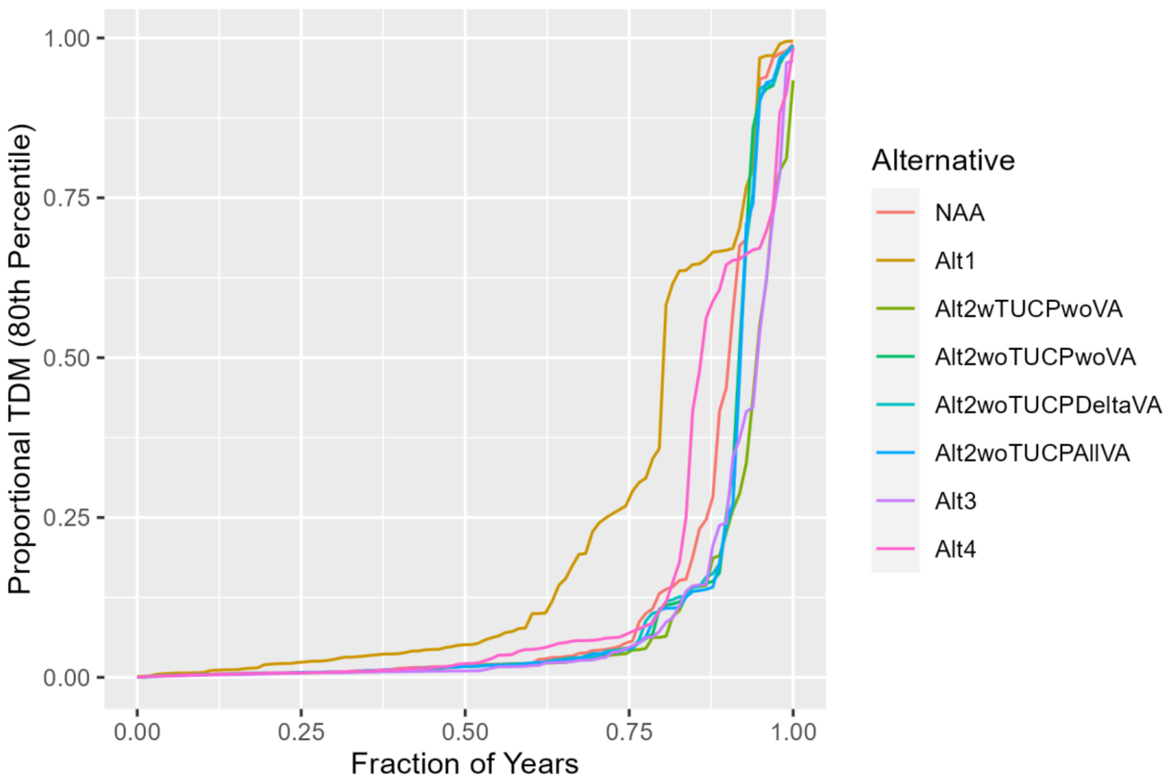
12.2.2.1 Winter-run Chinook salmon

For winter-run Chinook salmon, outlined are expected responses to survival for incubating eggs and alevins and for early life stages from changes in summer / fall water temperature management operations under each alternative relative to the No Action Alternative. In some cases, the direction of conclusions from multiple models may vary due to a differing suite of input variables, time-step of input data, or performance metric threshold. Appendix O provides detailed quantitative results of all model predictions.

- No Action Alternative is expected to have an adverse to beneficial impact on spawning and egg incubation that varies by the component.
- Alternative 1 is expected to have adverse impact resulting from decreased egg survival and increased temperature dependent mortality (Anderson predicted mean proportional TDM estimate, range of all non-critically dry water year types and critically dry water year type: 0.021 - 0.286 and 0.811; Martin TDM estimate, range of all non-critically dry water year types and critically dry water year type: 0.021 - 0.234 and 0.690; Figure 12-1), minimal impacts from less fry stranding. and little to no impact on fry and juvenile rearing (range of

predicted mean instream rearing habitat quantities across all water year types: 30.66 (July) – 61.54 (November) acres), redd dewatering potential, and fry survival, and beneficial impact on juvenile survival (average mean annual survival, range of all non-critically dry water year types and critically dry water year type: 14.45 – 26.19 and 9.64; Figure 12-2). Alternative 1 carries over less water in storage to contribute to the next year's cold water pool.

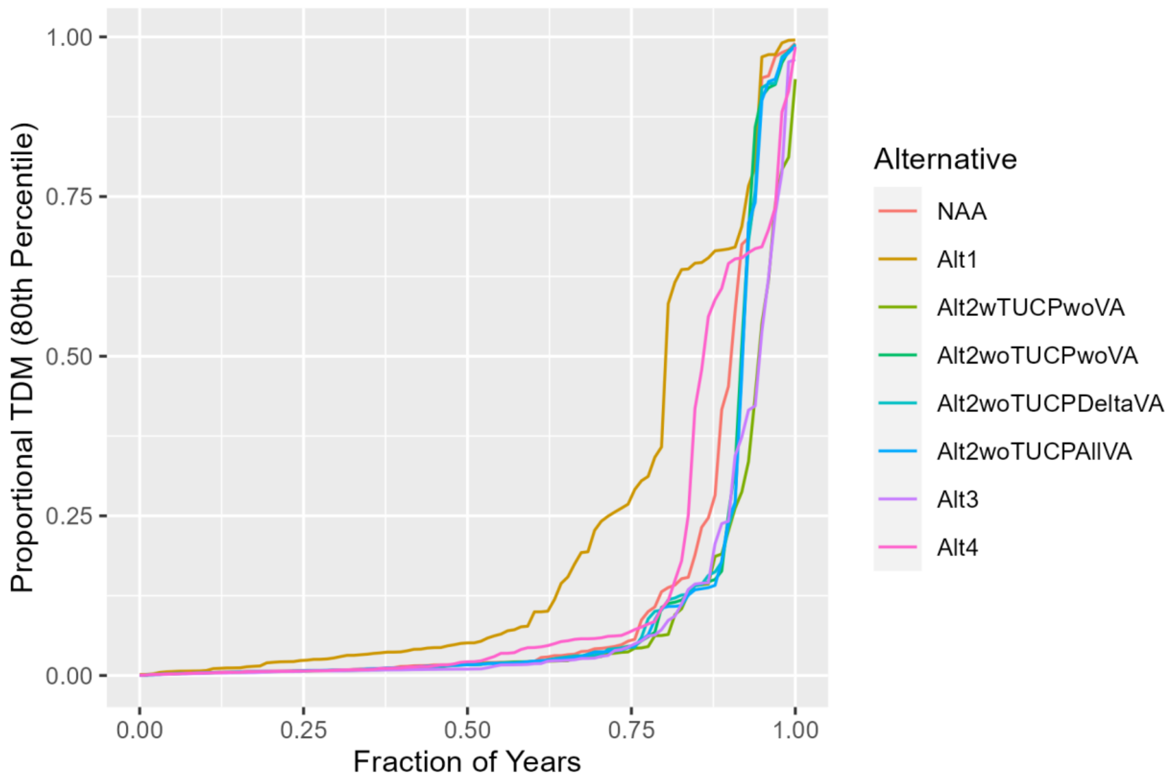
- Alternative 2 is expected to have minimal to beneficial impact resulting from increased egg survival and decreased temperature dependent mortality (Anderson predicted mean proportional TDM estimate, range of all non-critically dry water year types and critically dry water year type: 0.001 - 0.052 and 0.468; Martin TDM estimate, range of all non-critically dry water year types and critically dry water year type: 0.006 - 0.087 and 0.556;



- Figure 12-1), less fry stranding and lower redd dewatering potential, and little to no impact on fry and juvenile rearing (range of predicted mean instream rearing habitat quantities across all water year types: 31.06 (July) – 60.70 (October) acres), and beneficial impact on juvenile survival (average mean annual survival, range of all non-critically dry water year types and critically dry water year type: 11.72 – 26.12 and 6.98; Figure 12-2). Alternative 2 requires more storage in Shasta Reservoir for higher releases.

- Alternative 3 is expected to have adverse to beneficial impacts resulting from no impact on egg survival except an increase in survival in critically dry water year, decreased egg to fry survival and generally decreased temperature dependent mortality except wet water year types (Anderson predicted mean proportional TDM estimate, range of all non-critically dry water year types and critically dry water year type: 0.005 - 0.042 and 0.312; Martin TDM estimate, range of all non-critically dry water year types and critically dry water year type: 0.011 - 0.077 and 0.389;), less fry stranding and higher fry survival particularly in critically dry water year type, and little to no impact on fry and juvenile rearing (range of predicted mean instream rearing habitat quantities across all water year types: 32.87 (July) – 60.96 (October) acres) and redd dewatering potential, and beneficial impact on juvenile survival except minor adverse in below normal and dry water year types (average mean annual survival, range of all non-critically dry water year types and critically dry water year type: 11.76 – 28.91 and 7.32; Figure 12-2). Alternative 3 combines additional Delta outflow with measures to improve drought protection and temperature management through increased reservoir carryover storage.

- Alternative 4 is expected to have adverse to beneficial impacts resulting from no impact on egg survival except an increase in survival in critically dry water year, increased egg to fry survival and generally decreased temperature dependent mortality except wet water year types (Anderson predicted mean proportional TDM estimate, range of all non-critically dry water year types and critically dry water year type: 0.005 - 0.105 and 0.649; Martin TDM estimate, range of all non-critically dry water year types and critically dry water year type: 0.019 - 0.111 and 0.595;



- Figure 12-1), less fry stranding, lower redd dewatering potential particularly in critically dry water year type, and higher fry survival particularly in critically dry water year type, and little to no impact on fry and juvenile rearing (range of predicted mean instream rearing habitat quantities across all water year types: 31.85 (July) – 60.10 (October) acres), and beneficial impact on juvenile survival (average mean annual survival, range of all non-critically dry water year types and critically dry water year type: 14.90 – 26.13 and 7; Figure 12-2). Alternative 4 releases from Shasta Reservoir for water service contract deliveries to achieve an EOS storage of 2.0 MAF in Shasta Reservoir based on the 90% forecast unless a less conservative forecast requires more releases.

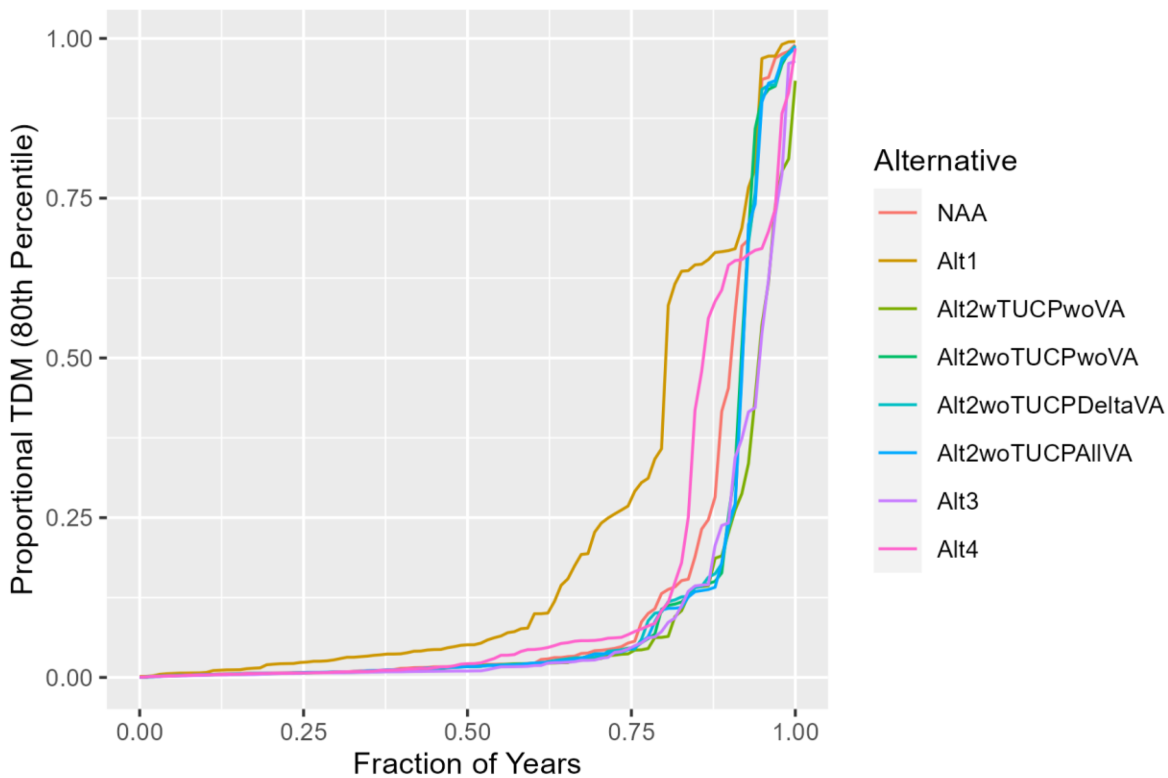


Figure 12-1. Exceedance plots of proportional Temperature Dependent Mortality (TDM) estimates across all water year types for the Martin TDM model, calculated using the 80th percentile of TDM for each water year type.

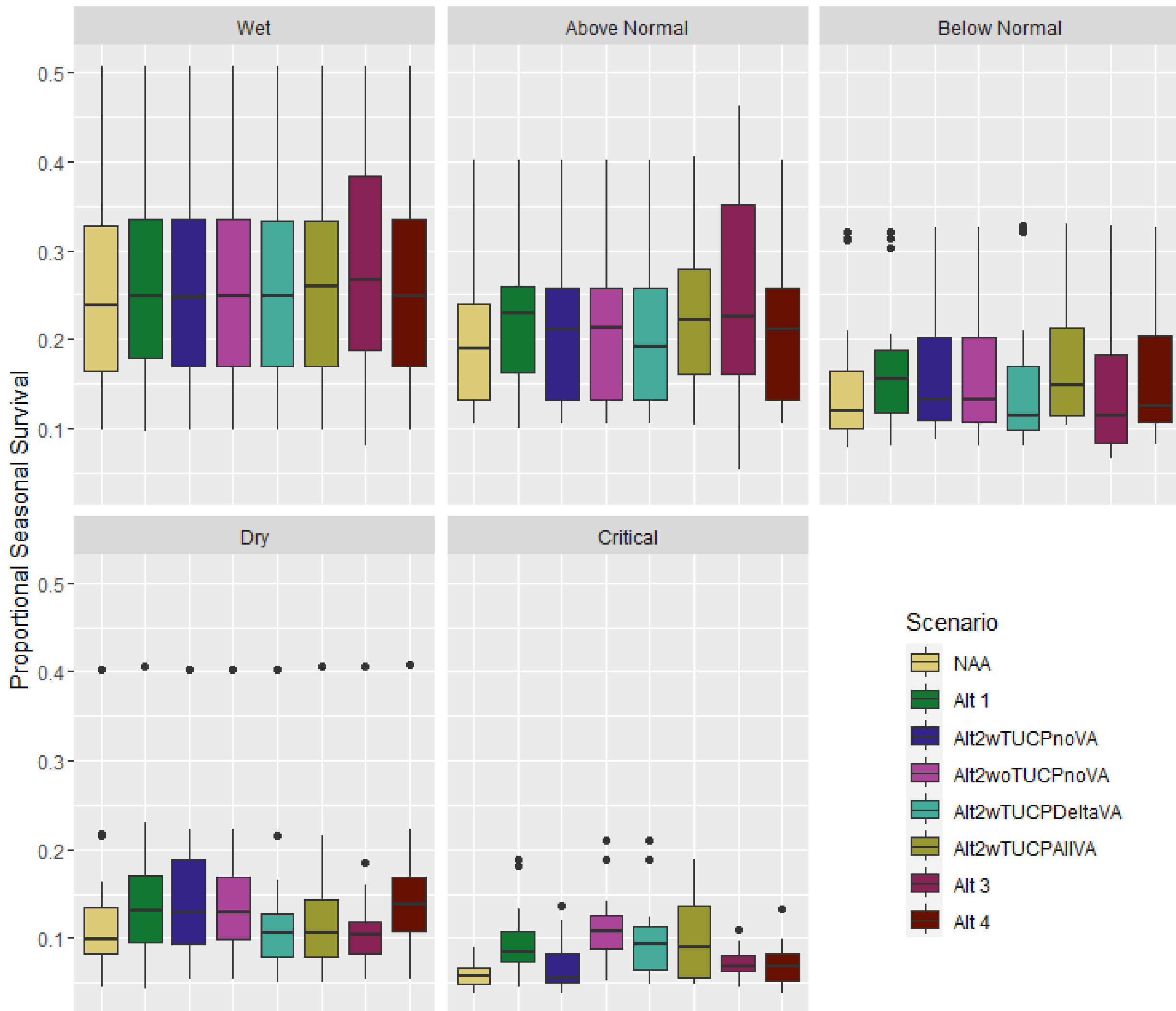


Figure 12-2. Boxplots of annual mean seasonal March 15th through June 15th probability of juvenile Chinook salmon survival in the Sacramento River, between the confluence of Deer Creek and Feather River, for each water year type.

12.2.2.2 Spring-run Chinook salmon

For spring-run Chinook salmon, outlined are expected responses to survival for incubating eggs and alevins, survival for early life stages, and changes to rearing habitat and stranding from changes in summer/fall water temperature management operations under each alternative relative to the No Action Alternative. In some cases, the direction of conclusions from multiple models may vary due to a differing suite of input variables, time-step of input data, or performance metric threshold. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.

- **Alternative 1** is expected to have negligible impacts from changes to flow on spawning, spawner abundance, and egg/alevin incubation, minor adverse impacts on redd dewatering during wet and above normal water year types from reductions in flow to store water in the winter, adverse and beneficial impacts from changes to the pattern of flow on rearing habitat (range of predicted mean instream rearing habitat quantities across all water year types: 30.66 (July) – 61.54 (November) acres), beneficial impact on survival (average mean annual survival, range of all non-critically dry water year types and critically dry water year type: 14.45 – 26.19 and 9.64; Figure 12-2), adverse impacts on juvenile stranding except in critically dry years, and adverse and beneficial impacts from water temperature on growth, smoltification, and predation vulnerability, depending on life stage and location from reduced cold water pool. Alternative 1 carries over less water in storage to contribute to the next year's cold water pool and implements spring pulses.
- **Alternative 2** is expected to have little impact from changes to flow on spawning, spawner abundance and egg/alevin incubation, adverse and beneficial impacts on redd dewatering habitat, minor beneficial impact from water temperature on spawning and egg/alevin incubation with few negative impacts at Keswick, negligible impacts from changes to the pattern of flow on rearing habitat (range of predicted mean instream rearing habitat quantities across all water year types: 31.06 (July) – 60.70 (October) acres), beneficial impact on survival (average mean annual survival, range of all non-critically dry water year types and critically dry water year type: 11.72 – 26.12 and 6.98; Figure 12-2), adverse impacts on juvenile stranding in drier water year types, and expected adverse and beneficial impacts from water temperature on juvenile and yearling growth, smoltification, and predation vulnerability. Alternative 2 requires more storage in Shasta Reservoir for higher releases and implements spring pulses.
- **Alternative 3** is expected to have minor adverse to beneficial impacts from changes to flow on spawning, spawner abundance, impacts on redd dewatering, and egg/alevin incubation, negligible impacts from water temperature on spawning and egg/alevin incubation, impacts from changes to the pattern of flow on rearing habitat and stranding (range of predicted mean instream rearing habitat quantities across all water year types: 32.87 (July) – 60.96 (October) acres), beneficial impact on survival except minor adverse in below normal and dry water year types (average mean annual survival, range of all non-critically dry water year types and critically dry water year type: 11.76 – 28.91 and 7.32; Figure 12-2), and adverse and beneficial impacts from water temperature on juvenile rearing and emigration, except below Keswick Dam where there would be an adverse impact on both juvenile and yearling life stages. Alternative 3 combines additional Delta outflow with measures to improve drought protection and temperature management through increased reservoir carryover storage and implements spring pulses.
- **Alternative 4** is expected to have impacts from changes to flow on spawning, spawning habitat, spawner abundance, and egg/alevin incubation, adverse to beneficial impacts on redd dewatering, expected beneficial impacts from water temperature on spawning and egg/alevin incubation, adverse to beneficial impacts from changes to the pattern of flow on rearing habitat (range of predicted mean instream rearing habitat quantities across all water year types: 31.85 (July) – 60.10 (October) acres), beneficial impact on survival (average mean

annual survival, range of all non-critically dry water year types and critically dry water year type: 14.90 – 26.13 and 7; Figure 12-2), and expected adverse and beneficial impacts from water temperature on juvenile rearing and emigration. Alternative 4 releases from Shasta Reservoir for water service contract deliveries to achieve an EOS storage of 2.0 MAF in Shasta Reservoir based on the 90% forecast unless a less conservative forecast requires more releases.

12.2.2.3 California Central Valley steelhead

For steelhead, outlined are expected responses to survival for incubating eggs and through the alevin life stage, to spawning, and changes to rearing habitat and stranding from changes in operations under each alternative relative to the No Action Alternative. In some cases, the direction of conclusions from multiple models may vary due to a differing suite of input variables, time-step of input data, or performance metric threshold. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.
- **Alternative 1** is expected to have changes in flow that result in minor adverse and minor beneficial impacts, with a -1.2% to 1.9% difference in rearing habitat area depending on water year type. Changes in flow are also expected to have a moderate adverse impact on fry stranding, with up to a 16.1% difference during wetter water year types, and a beneficial impact with up to 12.6% difference on fry stranding during drier water year types. Changes to water temperature are expected to have a beneficial impact on juvenile rearing and emigration. Alternative 1 carries over less water in storage to contribute to the next year's coldwater pool.
- **Alternative 2** is expected to have changes in flow that result in adverse and minor beneficial impacts, with a -1.4 % to 5.8% difference in rearing habitat area depending on water year type. Changes in flow are also expected to have general beneficial impacts on fry stranding, with a 30% reduction in below normal water year types, but may have adverse impact in critically dry water year types with up to 8.8% increase in fry stranding. Changes to water temperature are expected to have a beneficial impact on juvenile rearing and emigration. Alternative 2 requires more storage in Shasta Reservoir for higher releases.
- **Alternative 3** is expected to have changes in flow that result in minor adverse and minor beneficial impacts, with a -1.6% to 5.6% difference in rearing habitat area depending on water year type. Changes in flow are also expected to have adverse impacts on fry stranding during above normal/below normal water year types with up to a 25% increase, and minor beneficial impact on fry stranding during dry water year types with a 4.3% decrease. Changes to water temperature are expected to have frequent beneficial impacts on juvenile rearing and emigration. Alternative 3 combines additional Delta outflow with measures to improve drought protection and temperature management through increased reservoir carryover storage.
- **Alternative 4** is expected to have changes in flow that result in minor adverse and minor beneficial impacts, with a -0.8% to 3.9% difference in rearing habitat area depending on water year type. Changes in flow are also expected to have beneficial impacts on fry

stranding with up to a 23.4% decrease during dry water year types. Changes to water temperature are expected to have frequent beneficial impacts on juvenile rearing and emigration. Alternative 4 releases from Shasta Reservoir for water service contract deliveries to achieve an EOS storage of 2.0 MAF in Shasta Reservoir based on the 90% forecast unless a less conservative forecast requires more releases.

12.2.2.4 Fall-run Chinook salmon

For fall-run Chinook salmon, outlined are expected responses to survival for incubating eggs and through the alevin life stage, to spawning, and changes to rearing habitat and stranding from changes in operations under each alternative relative to the No Action Alternative. In some cases, the direction of conclusions from multiple models may vary due to a differing suite of input variables, time-step of input data, or performance metric threshold. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.

- **Alternative 1** is expected to have changes in flow that result in minor to moderate adverse and beneficial impacts; with up to a 4.2% increase in spawning habitat area in above normal water year types, up to a 26.6% reduction in redd dewatering potential in above normal water year types, a -2.6% to 0.1% difference in rearing habitat area, up to a 19% increase fry stranding during wetter water year types, and up to a 13.7% decrease in fry stranding in critically dry water year types. Changes in water temperature are expected to have frequent adverse impacts on spawning initiation, and adverse and beneficial impacts on juvenile rearing and emigration. Alternative 1 carries over less water in storage to contribute to the next year's coldwater pool.

- **Alternative 2** is expected to have changes in flow that result in minor to moderate adverse and beneficial impacts; with a -2.1% to 1.5% difference in spawning habitat area depending on water year type, up to 13.8% increase in redd dewatering potential in critically dry water year types, up to a 8.3% reduction in redd dewatering potential in below normal water year types, a -1.8% to 2.8% difference in rearing habitat area depending on water year type, and more frequent reductions in fry stranding that are greater than a >10% difference (compared to increases in fry stranding). Changes in water temperature are expected to have adverse impacts on spawning initiation, and adverse and beneficial impacts on juvenile rearing and emigration. Alternative 2 requires more storage in Shasta Reservoir for higher releases.

- **Alternative 3** is expected to have changes in flow that result in minor to moderate adverse and beneficial impacts; with a -2.5% to 2.5% difference in spawning habitat area depending on water year type, -11.2% to 12.7% difference in redd dewatering potential depending on water year type, a -2.3% to 3.5% difference in rearing habitat area depending on water year type, and a -6% to 12.5% difference in fry stranding depending on water year type. Changes in water temperature are expected to have negligible impacts on spawning and egg incubation, and adverse and beneficial impacts on juvenile rearing and emigration. Alternative 3 combines additional Delta outflow with measures to improve drought protection and temperature management through increased reservoir carryover storage.

- **Alternative 4** is expected to have changes in flow that result in minor to moderate adverse and beneficial impacts; with a -1.4% to 1.1% difference in spawning habitat area, up to a 22.1% increase in redd dewatering potential (an absolute difference of 1.4%) in critically dry water year types, a -0.9% to 2% difference in rearing habitat area, and reductions in fry stranding in all water year types (up to a -7.2% difference). Changes to water temperature are expected to have negligible impacts on spawning, egg incubation, and juvenile rearing and emigration. Alternative 4 releases from Shasta Reservoir for water service contract deliveries to achieve an EOS storage of 2.0 MAF in Shasta Reservoir based on the 90% forecast unless a less conservative forecast requires more releases.

12.2.2.5 Late fall-run Chinook salmon

For late fall-run Chinook salmon, outlined are expected responses to survival for incubating eggs and through the alevin life stage, to spawning, and changes to rearing habitat and stranding from changes in operations under each alternative relative to the No Action Alternative. In some cases, the direction of conclusions from multiple models may vary due to a differing suite of input variables, time-step of input data, or performance metric threshold. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.

- **Alternative 1** is expected to have changes in flow that result in adverse and beneficial impacts; with reductions in spawning habitat area in all water year types (up to a 7.4% reduction in above normal water years), generally small increases on redd dewatering potential with a maximum increase of 12.6% in above normal water years (absolute difference is 2.3%), a -3.5% to 1.3% difference in rearing habitat area depending on water year type, up to a 26.3% increase in fry stranding during critically dry water years, and up to a 17% reduction in fry stranding in below normal water years. Changes in water temperature are expected to have frequent beneficial impacts to spawning and egg incubation, and adverse and beneficial impacts for juvenile rearing and emigration. Alternative 1 carries over less water in storage to contribute to the next year's coldwater pool.
- **Alternative 2 is** expected to have changes in flow that result in adverse and beneficial impacts; with -2.0% to 0.4% difference in spawning habitat area depending on water year type, 57.6% increase to 15.3% in redd dewatering potential during critically dry water years depending on the phase (absolute difference is less than 3%), a -1.7% to 2.8% difference in rearing habitat area depending on water year type, up to a 41.4% increase in fry stranding during critically dry water years, and up to a 31.4% reduction in fry stranding in below normal water years. Changes in water temperature are expected to have frequent beneficial impacts on spawning and egg incubation, and adverse and beneficial impacts on juvenile rearing and emigration. Alternative 2 requires more storage in Shasta Reservoir for higher releases.
- **Alternative 3** is expected to have changes in flow that result in minor to moderate adverse and beneficial impacts; with up to a 5.9% reduction in spawning habitat area in above normal water year types, up to a 35.5% increase in redd dewatering potential during critically dry water years (absolute difference is less than 1%), a -1.2% to 5.6% difference in rearing

habitat area depending on water year type, and up to a 29% increase in fry stranding during above normal water years. Changes in water temperature are expected to have frequent beneficial impacts to spawning and incubation, and adverse and beneficial impacts for juvenile rearing and emigration. Alternative 3 combines additional Delta outflow with measures to improve drought protection and temperature management through increased reservoir carryover storage.

- **Alternative 4** is expected to have changes in flow that result in minor to moderate adverse and beneficial impacts; with -1.4 to 1.1% difference in spawning habitat area, up to a 49% increase in redd dewatering potential during critically dry water years (absolute difference is 1.2%), a -0.3% to 5.7% difference in rearing habitat area depending on water year type, and reductions in fry stranding in all water year types with up to a 21.8% reduction during dry water years. Changes in water temperature are expected to have frequent beneficial impacts to spawning and incubation, and adverse and beneficial impacts to juvenile rearing and emigration. Alternative 4 releases from Shasta Reservoir for water service contract deliveries to achieve an EOS storage of 2.0 MAF in Shasta Reservoir based on the 90% forecast unless a less conservative forecast requires more releases.

12.2.2.6 Southern DPS green sturgeon

For green sturgeon, outlined are expected responses for spawning adults and incubating eggs from changes in operations under each alternative relative to the No Action Alternative. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.

- **Alternative 1** is expected to have a minor adverse impact of flows decreasing up to 6% resulting in a potential impact on spawning habitat across all water year types and beneficial impacts from water temperature on spawning and egg incubation. Alternative 1 carries over less water in storage to contribute to the next year's coldwater pool.

- **Alternative 2** is expected to have beneficial impact of flows increasing up to 33% resulting in a potential impact on spawning habitat in critically dry years, and negligible impacts in all other water year types and minor adverse and beneficial impacts from water temperature on spawning and egg incubation. Alternative 2 requires more storage in Shasta Reservoir for higher releases.

- **Alternative 3** is expected to have a beneficial to adverse impact of flows decreasing up to 10% or increasing up to 8% depending on water year type resulting in a potential impact on spawning habitat and beneficial to adverse impacts from water temperature on spawning and egg incubation depending on water year type. Alternative 3 combines additional Delta outflow with measures to improve drought protection and temperature management through increased reservoir carryover storage.

- **Alternative 4** is expected to have negligible impacts of flow on spawning habitat across all water year types and beneficial or adverse impacts from water temperature on spawning and egg incubation depending on water year type. Alternative 4 releases from Shasta Reservoir for water service contract deliveries to achieve an EOS storage of 2.0 MAF in Shasta

Reservoir based on the 90% forecast unless a less conservative forecast requires more releases.

12.2.2.7 Other aquatic species

For aquatic species in the Sacramento River not described above, potential impacts range from adverse to beneficial, including no impacts, depending on species, life stage, month, and water year type. For example, Alternative 1 is expected to have no impact to beneficial impacts to white sturgeon, Alternative 2 and Alternative 4 are expected to have no impacts, and Alternative 3 is expected to have adverse and beneficial impacts. Alternative 1, Alternative 2, and Alternative 3 are expected to have adverse to beneficial impacts on Pacific lamprey and striped bass, whereas Alternative 4 is expected to have negligible to minor adverse impacts.

12.2.3 Clear Creek

12.2.3.1 Spring-run Chinook salmon

For spring-run Chinook salmon, outlined below are the expected responses to survival of incubating eggs and alevins, changes to spawning area, and changes to rearing habitat for early life stages from changes in operations primarily under each alternative relative to the No Action Alternative. In some cases, the direction of conclusions from multiple models vary due to a differing suite of input variables, time-step of input data, or performance metric threshold. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.

- **Alternative 1** is expected to have adverse impacts on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 1,134 - 1,200 and 1,017), fry rearing habitat (expected WUA for fry rearing, range of all non-critically dry water year types and critically dry water year type: 24,942 - 25,959 and 24,500), and juvenile (sub-yearling to yearling) rearing habitat, negligible impacts from water temperature on spawning and egg incubation, and negligible impacts from water temperature for juvenile and yearling criteria. Alternative 1 provides minimum instream flows and water temperature management and does not include specific pulse flows.

- **Alternative 2** is expected to have adverse impacts on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 4,530 - 5,064 and 4,123 - 4,577), minor beneficial impacts on fry rearing habitat (expected WUA for fry rearing, range of all non-critically dry water year types and critically dry water year type: 28,803 - 29,758 and 26,915 - 26,928), minor adverse impacts on juvenile (sub-yearling to yearling) rearing habitat, adverse impacts from water temperature on spawning and egg incubation, and adverse impacts from water temperature for juvenile and yearling criteria. Alternative 2 provides releases to emulate natural processes, water temperature management, and pulse flows.

- **Alternative 3** is expected to have adverse impacts on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 4,457 - 4,532 and 4,184), minor beneficial impacts on fry rearing habitat (expected

WUA for fry rearing, range of all non-critically dry water year types and critically dry water year type: 28,746 - 29,716 and 27,116), and a adverse impact on juvenile (sub-yearling to yearling) rearing habitat, no anticipated impacts from water temperature on spawning or egg incubation, no anticipated impacts from water temperature on juvenile and yearling rearing criteria. Alternative 3 provides releases to emulate natural processes, water temperature management, and pulse flows.

- **Alternative 4** is expected to have moderate adverse impacts on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 4,766 - 5,046 and 4,516), minor beneficial impacts on fry rearing habitat (expected WUA for fry rearing, range of all non-critically dry water year types and critically dry water year type: 28,874 - 29,838 and 27,007), adverse impact on juvenile (sub-yearling to yearling) rearing habitat, adverse impacts from water temperature on spawning and egg incubation, minor adverse impacts on upper temperature threshold for yearlings, and no anticipated impacts from water temperature for the other juvenile and yearling criteria. Alternative 4 provides releases to emulate natural processes, water temperature management, and pulse flows.

12.2.3.2 California Central Valley steelhead

For steelhead, outlined below are the expected responses to survival of incubating eggs and alevins, changes to spawning area, and changes to rearing habitat for early life stages from changes in operations primarily under each alternative relative to the No Action Alternative. In some cases, the direction of conclusions from multiple models vary due to a differing suite of input variables, time-step of input data, or performance metric threshold. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.

- **Alternative 1** is expected to have an adverse impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 14,338 - 15,690 and 13,957), adverse impact on fry and juvenile rearing habitat area (expected WUA for fry rearing, range of all non-critically dry water year types and critically dry water year type: 18,696 - 18,788 and 18,696), beneficial impacts from water temperature on spawning and egg incubation, and negligible impacts from water temperature on juvenile rearing and emigration. Alternative 1 provides minimum instream flows and water temperature management and does not include specific pulse flows.

- **Alternative 2** is expected to have a beneficial impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 14,338 - 15,690 and 13,957), a negligible impact on fry rearing habitat (expected WUA for fry rearing, range of all non-critically dry water year types and critically dry water year type: 17,564 - 17,708 and 17,240 - 17,275), an adverse impact on juvenile rearing habitat, negligible impacts from water temperature on spawning and egg incubation, and adverse impacts from water temperature on juvenile rearing and emigration. Alternative 2 provides releases to emulate natural processes, water temperature management, and pulse flows.

- **Alternative 3** is expected to have a beneficial impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 42,512 - 43,515 and 38,594), a negligible impact on fry rearing habitat (expected WUA for fry rearing, range of all non-critically dry water year types and critically dry water year type: 17,639 - 17,794 and 17,382), an adverse impact on juvenile rearing habitat, negligible impacts from water temperature on spawning and egg incubation, and negligible impacts from water temperatures for juvenile rearing and emigration. Alternative 3 provides releases to emulate natural processes, water temperature management, and pulse flows.
- **Alternative 4** is expected to have a minor to moderate beneficial impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 42,469 - 43,589 and 38,610), a negligible impact on fry rearing habitat (expected WUA for fry rearing, range of all non-critically dry water year types and critically dry water year type: 17,665 - 17,822 and 17,325), an adverse impact on juvenile rearing habitat, negligible impacts from water temperature on spawning and egg incubation, and negligible impacts from water temperature on juvenile rearing and emigration. Alternative 4 provides releases to emulate natural processes, water temperature management, and pulse flows.

12.2.3.3 Fall-run Chinook salmon

For fall-run Chinook salmon, outlined below are the expected responses to survival of incubating eggs and alevins, changes to spawning area, and changes to rearing habitat for early life stages from changes in operations primarily under each alternative relative to the No Action Alternative. In some cases, the direction of conclusions from multiple models vary due to a differing suite of input variables, time-step of input data, or performance metric threshold. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.
- **Alternative 1** is expected to have an adverse impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 112,033 - 114,579 and 81,290), an adverse impact on fry and juvenile rearing habitat area (expected WUA for fry rearing, range of all non-critically dry water year types and critically dry water year type: 44,136 - 44,681 and 44,680), minor adverse impacts from water temperature on spawning and egg incubation, and negligible impacts from water temperature on juvenile rearing and emigration. Alternative 1 provides minimum instream flows and water temperature management and does not include specific pulse flows.
- **Alternative 2** is expected to have a beneficial impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 197,831 - 201,120 and 141,779 - 145,932), minor adverse impacts on fry and juvenile rearing habitat (expected WUA for fry rearing, range of all non-critically dry water year types and critically dry water year type: 37,731 - 38,409 and 39,855), adverse impacts from water temperature on spawning and egg incubation, and negligible impacts from water temperature on juvenile rearing and emigration. Alternative 2 provides releases to emulate natural processes, water temperature management, and pulse flows.

- **Alternative 3** is expected to have a beneficial impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 196,781 and 154,459), an adverse impact on fry and juvenile rearing habitat (expected WUA for fry rearing, range of all non-critically dry water year types and critically dry water year type: 37,604 - 38,299 and 39,832), negligible impacts from water temperature on spawning and egg incubation, and negligible impacts from water temperature on juvenile rearing and emigration. Alternative 3 provides releases to emulate natural processes, water temperature management, and pulse flows.
- **Alternative 4** is expected to have beneficial impacts on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 200,941 - 201,120 and 143,347), a minor adverse impact on fry rearing habitat (expected WUA for fry rearing, range of all non-critically dry water year types and critically dry water year type: 37,731 - 38,409 and 39,855), adverse impact on juvenile rearing habitat, adverse impacts from water temperature on spawning and egg incubation, and negligible impacts from water temperature on juvenile rearing and emigration. Alternative 4 provides releases to emulate natural processes, water temperature management, and pulse flows.

12.2.3.4 Other aquatic species

For aquatic species in Clear Creek not described above, including hardhead and Pacific lamprey, potential impacts range from adverse to beneficial, including no impacts, depending on species, life stage, month, and water year type. Alternative 1 and Alternative 2 are expected to have negligible impacts to hardhead, whereas Alternative 3 and Alternative 4 are expected to have negligible impacts on migrating and spawning hardhead, and adverse impacts to juvenile and non-spawning adults. Alternatives 1-4 would have adverse to beneficial impacts to Pacific lamprey depending on month and water year type.

12.2.4 Lower American River

12.2.4.1 California Central Valley steelhead

For steelhead, outlined below are the expected responses to survival of incubating eggs and alevins, changes in rearing habitat for early life stages (fry and juveniles), and to spawning area from changes in operations primarily under each alternative relative to the No Action Alternative. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.
- **Alternative 1** is expected to have a minor to moderate adverse impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 28,692 - 96,053 and 105,814), an adverse impact on redd dewatering potential, adverse impact on rearing habitat area, adverse impacts from water temperature on spawning and egg incubation, and adverse and beneficial impacts from water temperature on juvenile rearing and emigration. Alternative 1 consists of minimum instream flows and water temperature management with no spring pulses or redd dewatering adjustments.

- **Alternative 2** is expected to have a minor adverse on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 29,222 - 108,278 and 115,178 - 116,689) and redd dewatering potential, an adverse or beneficial impact on rearing habitat area depending on the month in critically dry water year types, negligible impacts from water temperature on spawning and egg incubation, and negligible impacts from water temperature on juvenile rearing and emigration. Alternative 2 consists of a minimum release requirement, spring pulses, releases to limit potential steelhead redd dewatering, and water temperature management.
- **Alternative 3** is expected to have a minor adverse impact or beneficial impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 28,596 - 110,040 and 122,231), beneficial impact on redd dewatering potential, an adverse or beneficial impact on rearing habitat area, adverse impacts from water temperature on spawning and egg incubation, and adverse impacts from water temperature on juvenile rearing and emigration. Alternative 3 consists of minimum release requirements prioritizing minimum flows then storage, and winter and spring pulses.
- **Alternative 4** is expected to have a minor adverse impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 29,392 - 107,547 and 117,633) and a beneficial impact on redd dewatering potential, an adverse impact on rearing habitat area, an adverse impact from water temperature on spawning and egg incubation, and a beneficial impacts from water temperature on juvenile rearing and emigration. Alternative 4 consists of a minimum release requirement, spring pulses, releases to limit potential steelhead redd dewatering, and water temperature management.

12.2.4.2 Fall-run Chinook salmon

For fall-run Chinook salmon, outlined below are the expected responses to survival of incubating eggs and alevins, changes in rearing habitat for early life stages (fry and juveniles), and to spawning area from changes in operations primarily under each alternative relative to the No Action Alternative. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.
- **Alternative 1** is expected to have a adverse impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 104,927 - 123,537 and 123,463) and a impact on redd dewatering potential, an adverse or beneficial impact on rearing habitat area, beneficial and adverse impacts from water temperature on spawning and egg incubation, and adverse and beneficial impacts from water temperature on juvenile rearing and emigration. Alternative 1 consists of minimum instream flows and water temperature management with no spring pulses or redd dewatering adjustments.
- **Alternative 2 is** expected to have an adverse impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 108,538 - 139,838 and 123,661 - 126,791) and minor impact on redd dewatering

potential, an adverse or beneficial impact on rearing habitat area, negligible impacts from water temperature on spawning and egg incubation, and adverse and beneficial impacts from water temperature on juvenile rearing and emigration. Alternative 2 consists of a minimum release requirement, spring pulses, releases to limit potential steelhead redd dewatering, and water temperature management.

- **Alternative 3** is expected to have a beneficial impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 109,743 - 137,595 and 131,242) and on redd dewatering potential, an adverse impact on rearing habitat area (depending on the month), beneficial impact in dry years, adverse impacts from water temperature on spawning and egg incubation, and adverse beneficial impacts from water temperature on juvenile rearing and emigration. Alternative 3 consists of minimum release requirements prioritizing minimum flows then storage, and winter and spring pulses.
- **Alternative 4** is expected to have negligible impacts on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 109,148 - 139,916 and 126,721) and on redd dewatering potential except for adverse impacts in wet water year types and beneficial impacts in critically dry water year types, negligible impacts on rearing habitat area except in critically dry water year types when there would be both minor to moderate adverse and beneficial impacts, beneficial and adverse impacts from water temperature on spawning and egg incubation, and adverse and beneficial impacts from water temperature on juvenile rearing and emigration. Alternative 4 consists of a minimum release requirement, spring pulses, releases to limit potential steelhead redd dewatering, and water temperature management.

12.2.4.3 Other aquatic species

For aquatic species in the lower American River not described above, potential impacts range from adverse to beneficial, including no impacts, depending on species, life stage, month, and water year type. For example, Alternative 1 is expected to have negligible to beneficial impacts American shad, Alternative 2 is expected to have adverse to beneficial impacts, Alternative 3 is expected to have beneficial impacts, Alternative 4 is expected to have negligible to adverse impacts. Impacts for some species in the lower American River would be consistent among alternatives. For example, Alternatives 1-4 are expected to have no impacts to white sturgeon, negligible to adverse impacts to native minnows, and adverse to beneficial impacts to Pacific lamprey.

12.2.5 San Joaquin River

12.2.5.1 California Central Valley steelhead

For steelhead, outlined below are the expected responses to adult migration and juvenile emigration from changes in operations under each alternative relative to the No Action Alternative. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is not expected to result in additional impacts that those discussed in the environmental compliance for the San Joaquin River Restoration Project. Reclamation will operate the Friant Division consistent with the San Joaquin River Restoration Program Record of Decision.

- **Alternative 1** is expected to have negligible impacts on juvenile emigration and minor beneficial impacts on adult migration and holding (an increase of flows at Vernalis of up to 7% between July and September). Alternative 1 continues implementation of the San Joaquin River Restoration Program as an independent related activity.
- **Alternative 2** is expected to have negligible impacts on juvenile emigration and minor beneficial impacts on adult migration and holding (an increase of flows at Vernalis of up to 3% between July and September). Alternative 2 continues implementation of the San Joaquin River Restoration Program as an independent related activity.
- **Alternative 3** expected to have negligible impacts on juvenile emigration and negligible impacts on adult migration and holding. Alternative 3 continues implementation of the San Joaquin River Restoration Program as an independent related activity.
- **Alternative 4** is expected to have negligible impacts on juvenile emigration and minor beneficial impacts on adult migration and holding (an increase of flows at Vernalis of up to 2% between July and September). Alternative 4 continues implementation of the San Joaquin River Restoration Program as an independent related activity.

12.2.5.2 Fall-run Chinook salmon

For fall-run Chinook salmon, outlined below are the expected responses to adult migration and juvenile emigration from changes in operations under each alternative relative to the No Action Alternative. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is not expected to result in additional impacts that those discussed in the environmental compliance for the San Joaquin River Restoration Project. Reclamation will operate the Friant Division consistent with the San Joaquin River Restoration Program Record of Decision.
- **Alternative 1** is expected to have negligible impacts on juvenile emigration and beneficial impacts on adult migration and holding. Alternative 1 continues implementation of the San Joaquin River Restoration Program as an independent related activity.
- **Alternative 2 is** expected to have negligible impacts on juvenile emigration and minor beneficial impacts on adult migration and holding. Alternative 2 continues implementation of the San Joaquin River Restoration Program as an independent related activity.
- **Alternative 3** expected to have negligible impacts on juvenile emigration and negligible impacts on adult migration and holding. Alternative 3 continues implementation of the San Joaquin River Restoration Program as an independent related activity.
- **Alternative 4** is expected to have negligible impacts on juvenile emigration and minor beneficial impacts on adult migration and holding. Alternative 4 continues implementation of the San Joaquin River Restoration Program as an independent related activity.

12.2.5.3 Other aquatic species

For aquatic species in the San Joaquin River not described above, potential impacts range from adverse to beneficial, including no impacts, depending on species, life stage, month, and water year type. For example, Alternative 1, Alternative 2, and Alternative 4 are expected to have beneficial impacts to green sturgeon adults in the San Joaquin River, whereas Alternative 3 is expected to have no impacts. Alternative 1, Alternative 2, and Alternative 4 are expected to have negligible impacts to native minnows in the San Joaquin River, whereas Alternative 3 is expected to have negligible to adverse impacts. Alternatives 1-4 are expected to have no impacts to white sturgeon adults in the San Joaquin River. Alternative 1, Alternative 2, and Alternative 4 is expected to have a beneficial to negligible impact on black basses in the San Joaquin River, whereas Alternative 3 is expected to have adverse to beneficial impacts.

12.2.6 Stanislaus River

12.2.6.1 California Central Valley steelhead

For steelhead, outlined below are the expected responses to survival of incubating eggs and alevins and for fry and juveniles rearing habitat from changes in operations primarily in the winter and spring under each alternative relative to the No Action Alternative. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.
- **Alternative 1** is expected to have a minor to moderate adverse impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 314,401 - 528,577 and 609,693), a minor adverse or beneficial impact on juvenile and fry rearing habitat area (depending on the water year type), beneficial impacts from water temperature on spawning and egg incubation, and beneficial impacts from water temperature on juvenile emigration. Alternative 1 includes minimum instream flows and does not operate to pulse flows.
- **Alternative 2** is expected to have a minor adverse or beneficial impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 360,125 - 645,747 and 700,988 - 701,832), a minor adverse or beneficial impact on juvenile and fry rearing habitat area (depending on the water year type), adverse impacts from water temperature on spawning and egg incubation, and adverse impacts from water temperature on juvenile emigration. Alternative 2 includes minimum instream flows and pulse flows during the winter and fall seasons.
- **Alternative 3** is expected to have a adverse impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 277,294 - 528,713 and 715,068), an adverse or beneficial impact on juvenile and fry rearing habitat area (depending on the water year type), beneficial impacts from water temperature on spawning and egg incubation, and beneficial impacts from water temperature on juvenile emigration. Alternative 3 includes minimum instream flows, fall pulse flows, and unimpaired flow as minimum instream flows during the spring and winter seasons.

- **Alternative 4** is expected to have an adverse or beneficial impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 360,466 - 637,263 and 701,836), an adverse or beneficial impact on juvenile and fry rearing habitat area (depending on the water year type), negligible impacts from water temperature on spawning and egg incubation, and negligible impacts from water temperature on juvenile emigration. Alternative 4 includes minimum instream flows and pulse flows during the winter and fall seasons.

12.2.6.2 Fall-run Chinook salmon

For fall-run Chinook salmon, outlined below are the expected responses to survival of incubating eggs and alevins and for fry and juveniles rearing habitat from changes in operations primarily in the winter and spring under each alternative relative to the No Action Alternative. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.

- **Alternative 1** is expected to have a minor to moderate beneficial impact on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 694,035 - 980,894 and 917,477), an adverse or beneficial impact on juvenile and fry rearing habitat area (beneficial particularly during critically dry water year types), adverse impacts from water temperature on spawning and egg incubation, and beneficial and adverse impacts from water temperature on juvenile emigration. Alternative 1 includes minimum instream flows and does not operate to any pulse flows.

- **Alternative 2 is** expected to have minor adverse or beneficial impacts on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 653,205 - 891,602 and 920,810 - 921,084), minor or moderate beneficial impacts on juvenile and fry rearing habitat area (depending on the water year type), negligible impacts from water temperature on spawning and egg incubation, and beneficial and adverse impacts from water temperature on juvenile emigration. Alternative 2 includes minimum instream flows and pulse flows during the winter and fall seasons.

- **Alternative 3** is expected to have minor beneficial impacts on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 678,174 - 888,506 and 929,620), beneficial impacts on juvenile and fry rearing habitat area (depending on the water year type), minor adverse impacts from water temperature on spawning and egg incubation, and adverse impacts from water temperature on juvenile emigration. Alternative 3 includes minimum instream flows, fall pulse flows, and unimpaired flow as minimum instream flows during the spring and winter seasons.

- **Alternative 4** is expected to have negligible impacts on spawning habitat area (expected WUA for spawning, range of all non-critically dry water year types and critically dry water year type: 653,428 - 889,816 and 921,089), beneficial impacts on juvenile and fry rearing habitat area (depending on the water year type), negligible impacts from water temperature on spawning and egg incubation, and minor to moderate beneficial and adverse impacts from water temperature on juvenile emigration. Alternative 4 includes minimum instream flows and pulse flows during the winter and fall seasons.

12.2.6.3 Other aquatic species

For aquatic species in the Stanislaus River not described above, potential impacts range from adverse to beneficial, including no impacts, depending on species, life stage, month, and water year type. For example, Alternatives 1-4 are expected to have adverse to beneficial impacts on Pacific lamprey, Western River lamprey, and striped bass in the Stanislaus River. Alternative 1 is expected to have adverse to beneficial impacts to American shad in the Stanislaus River, whereas Alternative 2, Alternative 3, and Alternative 4 are expected to have negligible impacts.

12.2.7 Bay-Delta

12.2.7.1 Winter-run Chinook salmon

For winter-run Chinook salmon, outlined are expected changes in survival and entrainment from changes in water project operations under each alternative relative to the No Action Alternative. In some cases, the direction of conclusions from multiple models vary due to a differing suite of input variables, time-step of input data, or performance metric threshold. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on juvenile and adult life stages that varies by the component.
- **Alternative 1** is expected to have an adverse impact from increased entrainment of juvenile LAD winter-run Chinook salmon (predicted average December through April monthly salvage at the Delta fish collection facilities range, all non-critically dry water year types and critically dry water year type: 2 - 78 fish, 1 - 15 fish), negligible impact on proportion of juveniles salvaged, and adverse and beneficial impacts on survival (predicted December through April monthly through-Delta survival across all routes range, all non-critically dry water year types and critically dry water year type: 0.415 - 0.664, 0.372 - 0.468; Figure 12-3). Alternative 1 does not include Old and Middle River criteria resulting in lower Delta outflows and exports are not adjusted to minimize entrainment of fish and protection of critical habitat.
- **Alternative 2** is expected to have an adverse or beneficial impact from increased and decreased entrainment of juvenile LAD winter-run Chinook salmon (predicted average December through April monthly salvage at the Delta fish collection facilities range, all non-critically dry water year types and critically dry water year type: 1 - 43 fish, 1 - 9 fish), negligible impact on proportion of juveniles salvaged, and adverse and beneficial impacts on survival (predicted December through April monthly through-Delta survival across all routes range, all non-critically dry water year types and critically dry water year type: 0.440 - 0.664, 0.373 - 0.472; Figure 12-3). Alternative 2 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.
- **Alternative 3** is expected to have a beneficial impact resulting from decreased entrainment of juvenile LAD winter-run Chinook salmon (predicted average December through April monthly salvage at the Delta fish collection facilities range, all non-critically dry water year

types and critically dry water year type: 0 - 24 fish, 0 - 6 fish), negligible impact on the predicted proportion of juveniles salvaged, and adverse and beneficial impacts on survival (predicted December through April monthly through-Delta survival across all routes range, all non-critically dry water year types and critically dry water year type: 0.453 - 0.665, 0.383 - 0.469; Figure 12-3). Alternative 3 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

- **Alternative 4** is expected to have an adverse impact from increased entrainment of juvenile LAD winter-run Chinook salmon (predicted average December through April monthly salvage at the Delta fish collection facilities range, all non-critically dry water year types and critically dry water year type: 1 - 23 fish, 1 - 10 fish), negligible impact on the predicted proportion of juveniles salvaged, and adverse and beneficial impacts on survival (predicted December through April monthly through-Delta survival across all routes range, all non-critically dry water year types and critically dry water year type: 0.443 - 0.664, 0.374 - 0.467; Figure 12-3). Alternative 4 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

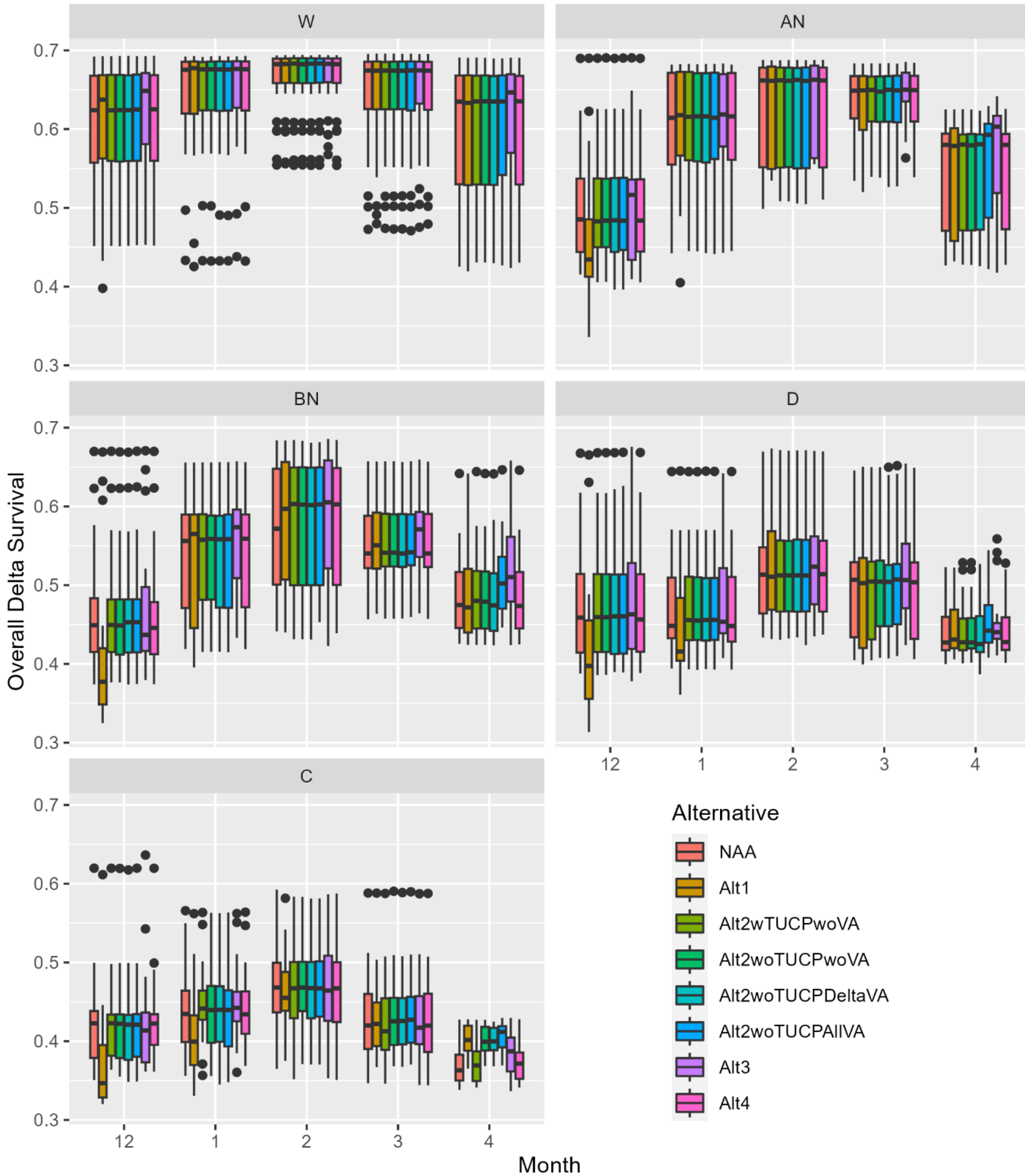


Figure 12-3. Boxplots of predicted mean through-Delta survival across all routes for relevant migratory months, box edges represent 25th and 75th percentiles, whiskers are the product of the interquartile range and 1.5, for each water year type.

12.2.7.2 *Spring-run Chinook salmon*

For spring-run Chinook salmon, outlined are expected changes in survival and entrainment from changes in water project operations under each alternative relative to the No Action Alternative. In some cases, the direction of conclusions from multiple models may vary due to a differing suite of input variables, time-step of input data, or performance metric threshold. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on juvenile and adult life stages that varies by the component.

- **Alternative 1** is expected to have an adverse impact from increased entrainment of juvenile spring-run Chinook salmon (predicted average March through June monthly salvage at the Delta fish collection facilities range, all non-critically dry water year types and critically dry water year type: 2 – 3,264 fish, 21 – 108 fish) and a negligible to beneficial impact on survival of outmigrating juveniles (mean predicted survival to Chipps Island range, all non-critically dry water year types and critically dry water year type: 0.179 – 0.326, 0.139). Alternative 1 does not include Old and Middle River criteria resulting in lower Delta outflows and exports are not adjusted to minimize entrainment of fish and protection of critical habitat.

- **Alternative 2** is expected to have beneficial and adverse impacts from decreased and increased entrainment (predicted average March through June monthly salvage at the Delta fish collection facilities range, all non-critically dry water year types and critically dry water year type: 1 – 3,544 fish, 7 – 105 fish) and a negligible to beneficial impact on survival of outmigrating juveniles (mean predicted survival to Chipps Island range, all non-critically dry water year types and critically dry water year type: 0.182 – 0.328, 0.134 – 0.143). Alternative 2 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

- **Alternative 3** is expected to have a beneficial impact from decreased entrainment (predicted average March through June monthly salvage at the Delta fish collection facilities range, all non-critically dry water year types and critically dry water year type: 0 – 593 fish, 4 – 53 fish) and a beneficial impact on survival of outmigrating juveniles (mean predicted survival to Chipps Island range, all non-critically dry water year types and critically dry water year type: 0.191 – 0.356, 0.141). Alternative 3 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

- **Alternative 4** is expected to have an adverse impact from increased entrainment (predicted average March through June monthly salvage at the Delta fish collection facilities range, all non-critically dry water year types and critically dry water year type: 1 – 3,106 fish, 9 – 105 fish) and a negligible impact on survival of outmigrating juveniles (mean predicted survival to Chipps Island range, all non-critically dry water year types and critically dry water year type: 0.182 – 0.326, 0.134). Alternative 4 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

12.2.7.3 California Central Valley steelhead

For steelhead, outlined are expected changes in survival and entrainment from changes in water project operations under each alternative relative to the No Action Alternative. In some cases, the direction of conclusions from multiple models may vary due to a differing suite of input variables, time-step of input data, or performance metric threshold. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.

- **Alternative 1** is expected to have an adverse impact resulting from increased entrainment (predicted average December through June monthly salvage at the Delta fish collection facilities range, all non-critically dry water year types and critically dry water year type: 65 – 11,661 fish, 18 – 1,716 fish) and a beneficial impact with a smaller proportion routed to Interior Delta between December and March, particularly in OMR groupings more negative than -5,500. Alternative 1 does not include Old and Middle River criteria resulting in lower Delta outflows and exports are not adjusted to minimize entrainment of fish and protection of critical habitat.
- **Alternative 2** is expected to have adverse and beneficial impacts from increased and decreased entrainment (predicted average December through June monthly salvage at the Delta fish collection facilities range, all non-critically dry water year types and critically dry water year type: 23 – 8,549 fish, 13 – 500 fish) and adverse and beneficial impacts on survival of outmigrating juvenile steelhead in the winter and spring, dependent on OMR conditions. Alternative 2 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.
- **Alternative 3** is expected to have a beneficial impact from decreased entrainment (predicted average December through June monthly salvage at the Delta fish collection facilities range, all non-critically dry water year types and critically dry water year type:5 – 2,962 fish, 3 – 270 fish) and adverse and beneficial impact on survival of outmigrating juvenile steelhead, dependent on OMR conditions. Alternative 3 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.
- **Alternative 4** is expected to have adverse and beneficial impacts from increased and decreased entrainment (predicted average December through June monthly salvage at the Delta fish collection facilities range, all non-critically dry water year types and critically dry water year type: 15 – 9,545 fish, 12 – 590 fish) and adverse and beneficial impacts on survival of outmigrating juvenile steelhead, dependent on OMR conditions. Alternative 4 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

12.2.7.4 Southern DPS green sturgeon

For green sturgeon, outlined are expected changes in entrainment from changes in operations under each alternative relative to the No Action Alternative. Appendix O provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.

- **Alternative 1** is expected to have a negligible impact on entrainment at both Delta fish collection facilities. Alternative 1 does not include Old and Middle River criteria resulting in lower Delta outflows and exports are not adjusted to minimize entrainment of fish and protection of critical habitat.

- **Alternative 2** is expected to have a negligible impact on entrainment at both Delta fish collection facilities. Alternative 2 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

- **Alternative 3** is expected to have a negligible impact on entrainment at both Delta fish collection facilities. Alternative 3 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

- **Alternative 4** is expected to have a negligible impact on entrainment at both Delta fish collection facilities. Alternative 4 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

12.2.7.5 Fall-run and late fall-run Chinook salmon

For fall-run Chinook salmon and late fall-run Chinook salmon, outlined are expected changes in entrainment and survival from changes in water project operations under each alternative relative to the No Action Alternative. In some cases, the direction of conclusions from multiple models may vary due to a differing suite of input variables, time-step of input data, or performance metric threshold. *Appendix O* provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.

- **Alternative 1** is expected to have an adverse and beneficial impact on both fall-run and late fall-run Chinook salmon from increased and decreased entrainment at both fish facilities (predicted fall-run Chinook salmon average monthly salvage at Banks range, all non-critically dry water year types and critically dry water year type: 0 – 15,130 fish, 0 – 357 fish; predicted fall-run average monthly salvage at Jones range, all non-critically dry water year types and critically dry water year type: 0 – 4,927 fish, 0 – 238 fish; predicted late fall-run Chinook salmon average monthly salvage at Banks range, all non-critically dry water year types and critically dry water year type: 0 – 1,182 fish, 0 – 339 fish; predicted late fall-run average monthly salvage at Jones range, all non-critically dry water year types and critically dry water year type: 0 - 225 fish, 0 - 36 fish) and an adverse impact for both fall-run and late fall-run Chinook salmon except for a beneficial impact in a critically dry water year type for fall-run Chinook salmon (mean predicted fall-run Chinook salmon survival to Chipps Island range, all non-critically dry water year types and critically dry water year type: 0.157 – 0.250, 0.129; mean predicted late fall-run Chinook salmon survival to Chipps Island range, all non-critically dry water year types and critically dry water year type: 0.144 – 0.254, 0.131). Alternative 1 does not include Old and Middle River criteria resulting in lower Delta outflows and exports are not adjusted to minimize entrainment of fish and protection of critical habitat.

- **Alternative 2** is expected to have an adverse and beneficial impact on both fall-run and late fall-run Chinook salmon from increased and decreased entrainment at both fish facilities (predicted fall-run Chinook salmon average monthly salvage at Banks range, all non-critically dry water year types and critically dry water year type: 0 – 15,229 fish, 0 – 336 fish; predicted fall-run average monthly salvage at Jones range, all non-critically dry water year types and critically dry water year type: 0 – 4,970 fish, 0 – 244 fish; predicted late fall-run Chinook salmon average monthly salvage at Banks range, all non-critically dry water year types and critically dry water year type: 0 – 700 fish, 0 - 269 fish; predicted late fall-run average monthly salvage at Jones range, all non-critically dry water year types and critically dry water year type: 0 - 210 fish, 0 - 67 fish) and negligible impacts on through-Delta survival of both fall-run and late fall-run Chinook salmon (mean predicted fall-run Chinook salmon survival to Chipps Island range, all non-critically dry water year types and critically dry water year type: 0.157 – 0.250, 0.123 – 0.131; mean predicted late fall-run Chinook salmon survival to Chipps Island range, all non-critically dry water year types and critically dry water year type: 0.151 – 0.265, 0.137 – 0.139). Alternative 2 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.
- **Alternative 3** is expected to have an adverse and beneficial impact on both fall-run and late fall-run Chinook salmon from increased and decreased entrainment at both fish facilities (predicted fall-run Chinook salmon average monthly salvage at Banks range, all non-critically dry water year types and critically dry water year type: 0 – 6,987 fish, 0 – 291 fish; predicted fall-run average monthly salvage at Jones range, all non-critically dry water year types and critically dry water year type: 0 – 1,466 fish, 0 – 49 fish; predicted late fall-run Chinook salmon average monthly salvage at Banks range, all non-critically dry water year types and critically dry water year type: 0 - 461 fish, 0 – 131 fish; predicted late fall-run average monthly salvage at Jones range, all non-critically dry water year types and critically dry water year type: 0- 138 fish, 0 - 36 fish) and beneficial impacts on through-Delta survival of both fall-run and late fall-run Chinook salmon (mean predicted fall-run Chinook salmon survival to Chipps Island range, all non-critically dry water year types and critically dry water year type: 0.163 – 0.272, 0.130; mean predicted late fall-run Chinook salmon survival to Chipps Island range, all non-critically dry water year types and critically dry water year type: 0.129 – 0.272, 0.141). Alternative 3 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.
- **Alternative 4** is expected to have an adverse and beneficial impact on both fall-run and late fall-run Chinook salmon from increased and decreased entrainment at both fish facilities (predicted fall-run Chinook salmon average monthly salvage at Banks range, all non-critically dry water year types and critically dry water year type: 0 – 14,888 fish, 0 – 357 fish; predicted fall-run average monthly salvage at Jones range, all non-critically dry water year types and critically dry water year type: 0 – 4,987 fish, 0 – 220 fish; predicted late fall-run Chinook salmon average monthly salvage at Banks range, all non-critically dry water year types and critically dry water year type: 0 - 644 fish, 0 - 237 fish; predicted late fall-run average monthly salvage at Jones range, all non-critically dry water year types and critically dry water year type: 0 - 197 fish, 0 - 65 fish) and negligible impacts on through-Delta survival of both fall-run and late fall-run Chinook salmon (mean predicted fall-run Chinook salmon survival to Chipps Island range, all non-critically dry water year types and critically

dry water year type: 0.157 – 0.249, 0.122; mean predicted late fall-run Chinook salmon survival to Chipps Island range, all non-critically dry water year types and critically dry water year type: 0.151 - 0.265, 0.138). Alternative 4 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

12.2.7.6 Delta smelt

For Delta smelt, outlined are expected changes in entrainment, habitat, and population abundance from changes in water project operations under each alternative relative to the No Action Alternative. In some cases, the direction of conclusions from multiple models may vary due to a differing suite of input variables, time-step of input data, or performance metric threshold. *Appendix O* provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.

- **Alternative 1** is expected to have adverse to beneficial impacts to larvae resulting from increased and decreased entrainment of larvae (Neutrally buoyant particle fate by inflow bin entrained at exports: 55% hihi – 95% himed; neutrally buoyant particle fate by OMR bins entrained at exports 56% at -2,000 cfs – 77% at -5,000 cfs). For juvenile summer-fall rearing habitat, there are expected adverse impacts on juveniles (Habitat Suitability Index (HSI) without temperature threshold of non-critically dry water year types and critically dry water year type: 0.48 – 0.543 and 0.404 and HSI with temperature threshold: 0.148 – 0.428 and 0.124). For population abundance, there is an expected negative impact on the population growth rate (LCME: Geometric mean of predicted population growth rate of wet and above normal water year types and below normal, dry, and critically dry water year types: 0.98 (Wet and Above Normal), 0.54 (Below Normal, Dry, and Critically Dry), Figure 12-4). Alternative 1 does not include Old and Middle River criteria resulting in lower Delta outflows and exports are not adjusted to minimize entrainment of fish and protection of critical habitat.

- **Alternative 2** is expected to have little to negligible impacts to larvae resulting from increased and decreased entrainment of larvae (Neutrally buoyant particle fate by inflow bin entrained at exports: 45% hihi – 90% hilo; neutrally buoyant particle fate by OMR bins entrained at exports 56% at -2,000 cfs – 79% at -5,000 cfs). For rearing habitat, there are expected minor adverse to minor beneficial impacts on juveniles (Habitat Suitability Index (HSI) without temperature threshold of non-critically dry water year types and critically dry water year type: 0.513 – 0.65 and 0.402 – 0.424 and HSI with temperature threshold: 0.203 – 0.525 and 0.129 – 0.137). For population abundance, there are expected adverse to beneficial impacts on the population growth rate (LCME: Geometric mean of predicted population growth rate of wet and above normal water year types and below normal, dry, and critically dry water year types: 1.24 (Wet and Above Normal) – 1.28 (Wet and Above Normal), 0.74 (Below Normal, Dry, and Critically Dry,) 0.74 – 0.77 (Below Normal, Dry, and Critically Dry), Figure 12-4). Alternative 2 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

- **Alternative 3** is expected to have beneficial to negligible impacts to larvae resulting from decreased entrainment of larvae (Neutrally buoyant particle fate by inflow bin entrained at exports: 22% hihi – 82% hilo; neutrally buoyant particle fate by OMR bins entrained at exports 51% at -2,000 cfs – 80% at -5,000 cfs). For rearing habitat, there are expected minor adverse to minor beneficial impacts on juveniles (Habitat Suitability Index (HSI) without temperature threshold of non-critically dry water year types and critically dry water year type: 0.544 – 0.613 and 0.415 and HSI with temperature threshold: 0.199 – 0.459 and 0.126. For population abundance, there is an expected positive impact on the population growth rate (LCME: Geometric mean of predicted population growth rate of wet and above normal water year types and below normal, dry, and critically dry water year types: 1.55 (Wet and Above Normal), 0.95 (Below Normal, Dry, and Critically Dry), Figure 12-4). Alternative 3 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

- **Alternative 4** is expected to have adverse to beneficial impacts larvae resulting from increased and decreased entrainment of larvae (Neutrally buoyant particle fate by inflow bin entrained at exports: 53% hihi – 92% hilo; neutrally buoyant particle fate by OMR bins entrained at exports 56% at -2000 cfs – 80% at -5000 cfs). For rearing habitat, there are expected negligible to minor adverse impacts on juveniles (Habitat Suitability Index (HSI) without temperature threshold of non-critically dry water year types and critically dry water year type: 0.483 – 0.638 and 0.387 and HSI with temperature threshold: 0.201 – 0.516 and 0.126). For population abundance, there is an expected minor negative impact on the population growth rate (LCME: Geometric mean of predicted population growth rate of wet and above normal water year types and below normal, dry, and critically dry water year types: 1.25 (Wet and Above Normal), 0.72 (Below Normal, Dry, and Critically Dry), Figure 12-4). Alternative 4 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

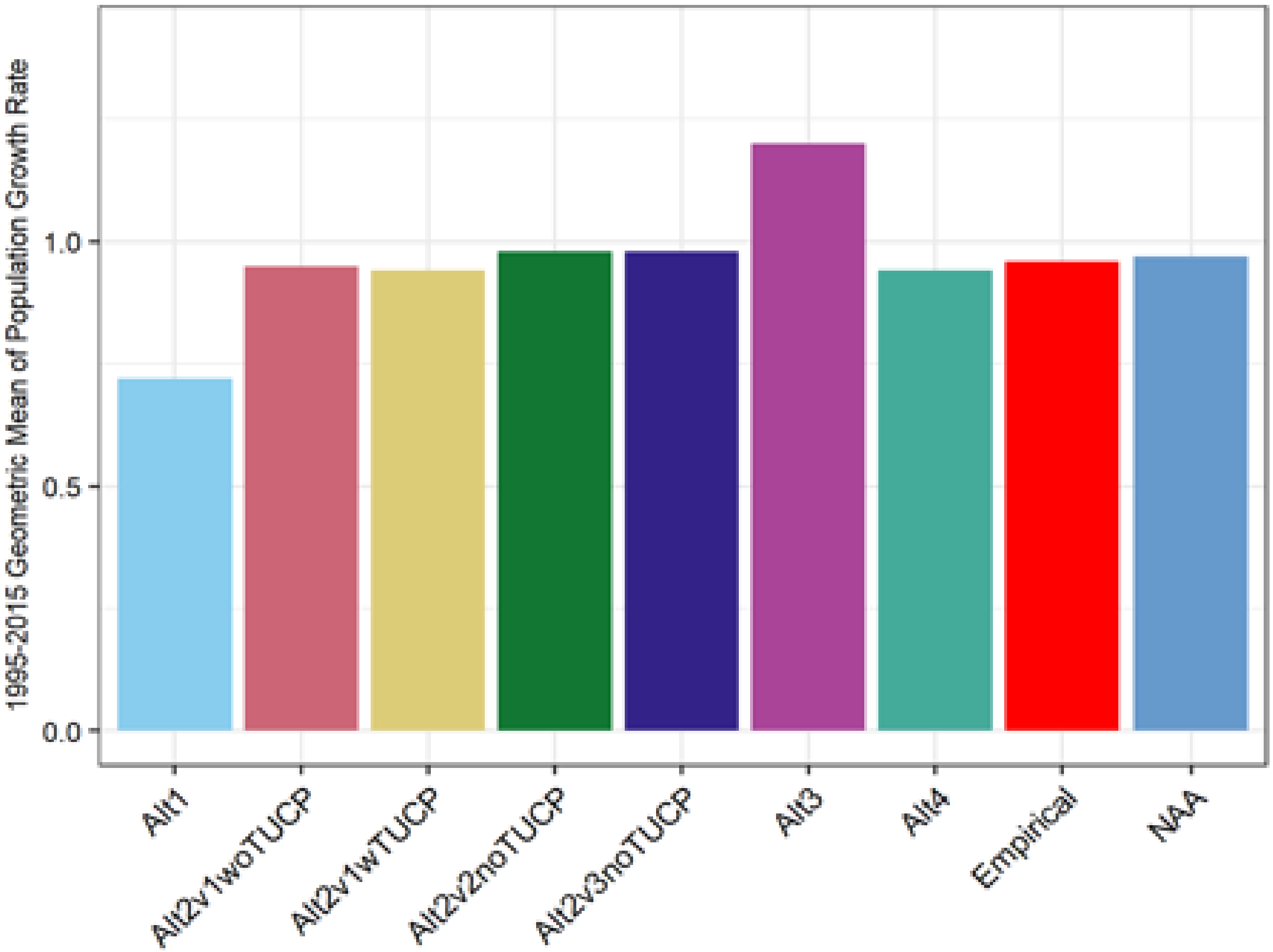


Figure 12-4. Mean population growth rates aggregated across the years. Bar plot demonstrating the geometric mean of population growth rate (lambda) from 1995 to 2015 for the various alternatives.

12.2.7.7 Longfin smelt

For longfin smelt, outlined are expected changes in entrainment, and population abundance from changes in water project operations under each alternative relative to the No Action Alternative. In some cases, the direction of conclusions from multiple models may vary due to a differing suite of input variables, time-step of input data, or performance metric threshold. *Appendix O* provides detailed quantitative results of all model predictions.

- **No Action Alternative** is expected to have an adverse to beneficial impact on all life stages that varies by the component.

- **Alternative 1** is expected to have adverse to beneficial impacts to larvae resulting from increased and decreased entrainment (Neutrally buoyant particle fate by inflow bin entrained at exports: 55% hihi – 95% himed; neutrally buoyant particle fate by OMR bins entrained at exports 56% at -2000 cfs – 77% at -5000 cfs), and substantial adverse impacts to juveniles resulting from increased entrainment (April – May predicted juvenile longfin smelt salvage range, all non-critically dry water year types and critically dry water year type: 2390 – 5280 fish, 1226 fish). For population abundance, there is an expected adverse impact on juveniles (Means of annual posterior predictive means for the FMWT index of longfin smelt abundance range, all non-critically dry water year types and critically dry water year type: 88.2 – 664.2, 72.3). Alternative 1 does not include Old and Middle River criteria resulting in lower Delta outflows and exports are not adjusted to minimize entrainment of fish and protection of critical habitat.

- **Alternative 2** is expected to have, adverse to beneficial impacts to larvae (Neutrally buoyant particle fate by inflow bin entrained at exports: 45% hihi – 90% hilo; neutrally buoyant particle fate by OMR bins entrained at exports 56% at -2000 cfs – 79% at -5000 cfs) and adverse to beneficial impacts to juveniles resulting from increased and decreased entrainment (April – May predicted juvenile longfin smelt salvage range, all non-critically dry water year types and critically dry water year type: 1403 – 3757 fish, 1110 – 1170 fish). For population abundance, there are expected minor adverse to beneficial impacts to juveniles (Means of annual posterior predictive means for the FMWT index of longfin smelt abundance range, all non-critically dry water year types and critically dry water year type: 94.7 – 716.3, 76.8 – 79.1). Alternative 2 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.
- **Alternative 3** is expected to have adverse to beneficial impacts to larvae resulting from increased to decreased entrainment (Neutrally buoyant particle fate by inflow bin entrained at exports: 22% hihi – 82% hilo; neutrally buoyant particle fate by OMR bins entrained at exports 51% at -2000 cfs – 80% at -5000 cfs), and substantial beneficial impacts on juveniles resulting from decreased entrainment (April – May predicted juvenile longfin smelt salvage range, all non-critically dry water year types and critically dry water year type: 109 – 449 fish, 447 fish). For population abundance, there is an expected positive impact on juveniles (Means of annual posterior predictive means for the FMWT index of longfin smelt abundance range, all non-critically dry water year types and critically dry water year type: 116.8 – 1015.7, 91.0). Alternative 3 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.
- **Alternative 4** is expected to have adverse to beneficial impacts on larvae resulting from increased to decreased entrainment (Neutrally buoyant particle fate by inflow bin entrained at exports: 53% hihi – 92% hilo; neutrally buoyant particle fate by OMR bins entrained at exports 56% at -2000 cfs – 80% at -5000 cfs), and substantial adverse impacts on juveniles resulting from increased entrainment (April – May predicted juvenile longfin smelt salvage range, all non-critically dry water year types and critically dry water year type: 2124 – 3813 fish, 1114 fish). For population abundance, there is an expected negligible to minor adverse impacts on juveniles (Means of annual posterior predictive means for the FMWT index of longfin smelt abundance range, all non-critically dry water year types and critically dry water year type: 94.6 – 702.5, 76.3). Alternative 4 includes Old and Middle River Flow Management which adjusts exports to minimize entrainment of fish and protection of critical habitat.

12.2.7.8 Other aquatic species

For aquatic species in the Bay-Delta not described above, potential impacts range from adverse to beneficial, including no impacts, depending on species, life stage, month, and water year type. For example, Alternative 1, Alternative 2, and Alternative 4 are expected to have beneficial to negligible impacts from seasonal operations on Pacific lamprey in the Bay-Delta, whereas Alternative 3 is expected to have adverse to beneficial impacts from seasonal operations. Alternative 1 is expected to have beneficial to negligible impacts from seasonal operations on striped bass, Alternative 2 and Alternative 3 are expected to have adverse and beneficial impacts, and Alternative 4 is expected to have beneficial impacts. Alternative 1 is expected to have adverse impacts from entrainment on striped bass, Alternative 2 and Alternative 4 are expected to have adverse and beneficial impacts, and Alternative 3 is expected to have beneficial impacts. Alternative 1-4 are expected to have negligible impacts from seasonal operations to threadfin shad, although impacts from entrainment are more variable. Alternative 1, Alternative 2, and Alternative 4 are expected to have adverse and beneficial impacts from entrainment, whereas Alternative 3 is expected to have beneficial impacts.

12.2.8 Nearshore Pacific Ocean

12.2.8.1 Southern Resident Killer Whale's Chinook Salmon prey

Changes in water operations under the alternatives could have the potential to impact Chinook salmon prey for Southern Residents relative to the No Action Alternative. The No Action Alternative is predicted to have negligible to no impacts on Southern Residents and the Central Valley and Trinity Rivers would continue to contribute about the same amount of Chinook salmon to the compilation of adult Chinook salmon in the Pacific Ocean available as prey to Southern Residents. Outlined below are expected changes in Southern Residents prey. *Appendix O* provides detailed quantitative results of all model predictions.

Alternatives 1-4 are expected to have minimal impact on the number of Chinook that would be produced by the Trinity River watershed and survive to adulthood in the ocean becoming prey available to Southern Residents.

Alternative 1, Alternative 2, and **Alternative 4** are expected to have minimal impact on the number of Chinook that would be produced by the Central Valley and survive to adulthood in the ocean becoming prey available to Southern Residents. **Alternative 3** would benefit Central Valley Chinook salmon that survive to adulthood in the ocean and are available as Southern Residents' prey.

12.2.9 Alternative 2B

Analysis of Alternative 2B, although qualitative, builds on the quantitative analysis provided for Alternative 2. Only components under Alternative 2B that are expected to result in changes to fish and aquatic resources compared to Alternative 2 are discussed.

Alternative 2b is anticipated to be more restrictive on Delta exports than Alternative 2 and the No Action Alternative. Please see *Chapter 5 Water Supply* for a description of the restrictions associated with the QWEST criteria under Alternative 2B. These restrictions on exports may result in increased outflow and a potential less adverse impact to fish and aquatic resources as larval and juvenile longfin smelt would be less likely to be entrained into the CVP and SWP Delta export facilities.

In addition to the more restrictive QWEST criteria, Alternative 2B includes an extension of the CCF operation period to December 1 through March 31 from mid-December through mid-March, effectively increasing the operation of the SWP by one month. This expansion may result in more frequently meeting water quality seasonal thresholds, and also meeting water quality weekly thresholds that may not have otherwise been met. Meeting these thresholds would result in additional export restriction under Alternative 2B that would result in increased outflow. Increased outflow could translate in less potential adverse impacts to fish and aquatic resources as larval and juvenile longfin smelt would be less likely to be entrained into the CVP and SWP Delta export facilities. On the other hand, an increase in water supply could materialize in the event that the water quality thresholds are not met during the extended operation of CCF under Alternative 2B. Then, Alternative 2B would result in additional exports that may decrease outflow and increase entrainment.

12.2.10 Alternative 4B

Alternative 4B builds upon Alternative 4. Operations criteria on the American River vary from Alternative 4 (See Chapter 3 – Alternatives). Unintended consequences outside the American River geography will be managed by realtime operations to ensure that implementation of Alternative 4B does not result on effects on other Central Valley rivers in the action area. If effects are anticipated, then actions under Alternative 2B will not be implemented.

12.2.10.1 Lower American River Sacramento River

Under the operations criteria of Alternative 4B Folsom Reservoir end-of-December (EOD) storage may be increased under certain hydrological conditions. The MRR could be decreased from 2,000 cfs to as low as 1,600 cfs. Average monthly storage in Folsom Reservoir would be higher under Alternative 4B compared to the No Action Alternative, Average monthly Folsom Reservoir releases to the American River is expected to be similar under Alternative 4B relative to the No Action Alternative and Alternative 4 . If, in a small number of years, storage in Folsom Reservoir is increased to up to 350 TAF and releases to the American River are decreased then Alternative 4B may result in have negative water temperature and flow impacts to fall-run Chinook salmon and steelhead. Conversely, decreased releases under Alternative 4B are expected to result in an increase of the coldwater pool volume in Folsom Reservoir, which would benefit other life stages of these species, including over-summering juvenile steelhead. Alternative 4B is expected to have negligible effects on American shad, striped bass and native minnows in the lower American River, given these species have a wider tolerable water temperature range.

12.2.10.2 Sacramento River

Under Alternative 4B, compared to the No Action Alternative and Alternative 4, modifications to Keswick Dam operations on the Sacramento River may occur under some hydrologic conditions to balance the increase in Folsom Reservoir storage and decreased flows on the American River and the Sacramento River below their confluence. Average monthly releases from Shasta Reservoir to the Sacramento River are expected to similar under Alternative 4B compared to the No Action Alternative and Alternative 4. If, in a small number of years, releases from Shasta

Reservoir to the Sacramento River are increased to meet Delta water quality requirements that normally would be from the lower American River, Alternative 4B may have a beneficial water temperature and flow impacts on listed species in the Sacramento River, Conversely, increased releases decrease the volume of the coldwater pool in Shasta Reservoir, which may adversely impact other life stages and species in the subsequent seasons in the Sacramento River. Real-time operation decision making will need to best balance the potential for tradeoffs.

If in a small number of years, releases from Shasta Reservoir to the Sacramento River are decreased under Alternative 4B, then differences in flow between Alternative 4B and the No Action Alternative may result in a negative water temperature and flow impact on listed species in the Sacramento River. On the other hand, decreased releases increase the volume of the coldwater pool volume in Shasta Reservoir which would benefit other life stages and species in subsequent seasons. Alternative 4B is expected to have negligible effects on other focal species in the Sacramento River, including American shad, striped bass and native minnows and black basses, given these species have a wider tolerable water temperature range.

12.2.10.3 Bay-Delta

Average monthly total exports are expected to be lower under Alternative 4B compared to the No Action Alternative in the winter, higher in the spring and similar in the summer and fall. Higher exports during spring, may increase entrainment of fish present like juvenile spring-run Chinook salmon, winter-run Chinook salmon, and steelhead . Lower exports during the winter may decrease entrainment of fish present like juvenile winter-run Chinook salmon.

12.3 Mitigation Measures

Appendix D includes a detailed description of mitigation measures identified for fish and aquatic resources per alternative. These mitigation measures include avoidance and minimization measures that are part of each alternative and, where appropriate, additional mitigation to lessen impacts of the alternatives. These measures include water temperature and storage management, minimum instream flows, ramping rates, pulse flows, fall and winter baseflows, rice decomposition smoothing, OMR management, increased Delta outflow, salinity management, a drought plan and toolkit, flow and non-flow measures from the Voluntary Agreements, rebalancing between CVP reservoirs, water supply reductions and allocations to conserver storage, modifying water transfers, coordinating on refuge needs to conserve storage, adjustments of minimum release requirements for redd dewatering purposes, DCC gates closures, pumping plant operations specific to timing and fish screening, and Delta smelt supplementation.

12.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and may result in potential effects to fish and aquatic resources storing, diverting, blending and releasing water. The action alternatives will also result potential effects to fish and aquatic resources storing, diverting, blending and releasing water. The magnitude of the changes is dependent on alternative, species present and water year type. Therefore, the No Action Alternative and action alternatives may contribute to cumulative effects to some of the species and life stages analyzed in this EIS, as described in *Appendix O*, *Fish and Aquatic Resources* and Appendix Y, *Cumulative Impacts Technical Appendix*.

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Chapter 13 Terrestrial Biological Resources

This chapter is based on the background information and technical analysis documented in Appendix P, *Terrestrial Biological Resources Technical Appendix*, which includes additional information on terrestrial biological resource conditions and technical analysis of the effects of each alternative.

13.1 Affected Environment

The study area includes the aquatic areas and associated aquatic margins of CVP reservoirs, rivers, and wetlands, including the Bay-Delta. Additionally, the study area includes irrigated agricultural lands of the Sacramento River Settlement (SRS) Contractors due to changes in the operation of Shasta Reservoir that make less water available for SRS actions.

Most of the rivers in the study area contain some riparian vegetation although many areas once supporting extensive riparian habitat now contain limited riparian habitat due to agricultural and residential development and dam installation. The Trinity River is characterized by montane habitats including annual grassland, fresh emergent wetland, montane riparian, valley-foothill riparian, and riverine habitats (California North Coast Regional Water Quality Control Board and Bureau of Reclamation 2009; North Coast Regional Water Quality Control Board et al. 2013). The Sacramento and American rivers support willow, valley oak, and alder-dominated riparian communities. Riparian vegetation is limited to a narrow band along the channel margins in the confined canyon reaches of Clear Creek between Whiskeytown Dam and Clear Creek Bridge. The lower reach of Clear Creek contains freshwater emergent wetlands where the valley widens, the channel becomes predominately alluvial, and floodplains and terraces allow riparian vegetation to be more extensive (California Bay-Delta Authority 2004). Near the Stanislaus River, vegetation is characterized by riparian woodland with cottonwood, willows, white alder, blue elderberry, and Himalayan blackberry. Some low-gradient areas in the Stanislaus River downstream of New Melones Dam along the shoreline of Goodwin Reservoir support small patches of emergent aquatic vegetation such as bulrush and cattail (Goodwin Power 2013). Along the San Joaquin River, the lower and intermediate terrace floodplains support riparian forest while the higher portion of the floodplain are dominated by valley oak. Appendix P, *Terrestrial Biological Resources Technical Appendix*, identifies the wildlife species that occupy each river or stream reach within the study area.

The Delta overlies the western portions of the Sacramento River and San Joaquin River watersheds. The Delta is a network of islands, channels, and marshland at the confluence of the Sacramento and San Joaquin rivers. Substantial areas of the Delta and Suisun Marsh have been modified by agricultural, urban and suburban, and recreational land uses (Bureau of Reclamation et al. 2011; San Francisco Estuary Institute–Aquatic Science Center 2012). The remaining natural vegetation is fragmented, and largely restricted to the edges of waterways, flooded islands, and small protected areas such as parks, wildlife areas, and nature reserves (Hickson and Keeler-Wolf 2007). A substantial portion of the emergent wetlands exists as thin strips along the margins of constructed levees (San Francisco Estuary Institute–Aquatic Science Center 2012). Current habitat along the Delta waterways includes seasonal wetlands, tidal wetlands, managed wetlands, riparian forests, and riparian scrub. The Delta provides habitat for waterfowl and shorebirds, California Ridgway's rail, California black rail, Suisun song sparrow, salt marsh common yellowthroat, and other ground nesting birds (Bureau of Reclamation et al. 2011).

Lakes and reservoirs in the study area support vegetation consistent with species associated with standing water, including floating species, rooted aquatic species, and emergent wetland species. Reservoirs in the study area include Contra Loma, San Justo, Bethany, Patterson, Lake Del Valle, Lewiston Reservoir, Los Vaqueros, Briones Reservoir, San Pablo Reservoir, Lafayette Reservoir, Upper San Leandro Reservoir, Lake Chabot, Goodwin Reservoir, Trinity Reservoir, and Whiskeytown Reservoir.

13.1.1 Special-Status Species

Species with special status are defined as species that are legally protected or otherwise considered sensitive by federal, state, or local resource agencies. Such species include the following:

- Species listed by the federal government as threatened or endangered.
- Species that are formally proposed for federal listing or are candidates for federal listing as threatened or endangered.
- Species identified by the U.S. Fish and Wildlife Service (USFWS) as Birds of Conservation Concern.
- Species considered sensitive by the Bureau of Land Management or U.S. Forest Service.
- Species listed by the state of California as threatened, endangered, or rare (rare status is for plants only).
- Species that are candidates for state listing as threatened or endangered.
- Species designated by California statute as fully protected (e.g., California Fish and Game Code, sections 3511 [birds], 4700 [mammals], and 5050 [reptiles and amphibians] and 5515 [fish]).
- Species, subspecies, and varieties of plants considered by the CDFW and California Native Plant Society (CNPS) to be rare, threatened, or endangered in California. The CNPS's *Inventory of Rare and Endangered Plants of California* assigns California Rare Plant Ranks (CRPR) categories for plant species of concern. Only plant species in CRPR categories 1 and 2 are considered special-status plant species in this document.
    - **CRPR 1A**—Plants presumed to be extinct in California.
    - **CRPR 1B**—Plants that are rare, threatened, or endangered in California and elsewhere.
    - **CRPR 2**—Plants that are rare, threatened, or endangered in California but more common elsewhere.

Lists of wildlife and plant species with special status that occur or may occur in portions of the study area are provided in Appendix P, *Terrestrial Biological Resources Technical Appendix,* Table P.1-1. and Table P.1-2.

13.1.2 Critical Habitat

The federally listed wildlife and plant species considered in this EIS that have designated critical habitat areas are presented in Appendix P, *Terrestrial Biological Resources Technical Appendix,* Table P.1-3.

13.1.3 Wetlands and Open Water

Wetlands and open water that occur in the study area are described in Appendix P, *Terrestrial Biological Resources Technical Appendix,* Section P.1.10.

13.2 Effects of the Alternatives

The impact assessment considers changes in terrestrial biological resources related to changes in CVP and SWP operations under the action alternatives as compared to the No Action Alternative. The CalSim 3 model simulation was utilized to analyze and compare the No Action Alternative and action alternatives. The CalSim 3 model (overview, methods) and associated results are summarized and fully described in Appendix F.

Under the No Action Alternative, Reclamation would continue with the current operation of the CVP, as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the SWP represent current management direction or intensity pursuant to 43 CFR Section 46.30.

The No Action Alternative is based on 2040 conditions. The changes to terrestrial biological resources that are assumed to occur by 2040 under the No Action Alternative conditions would be different than existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

The No Action Alternative is expected to result in potential changes in terrestrial biological resources and critical habitat at reservoirs that store CVP water, tributaries, and the Delta. These changes were described and considered in the 2020 Record of Decision.

Alternatives 2B and 4B are expected to be within the range of effects for Terrestrial Biological Resources described below for Alternatives 2 and 4, respectively.

13.2.1 Potential changes to terrestrial resources from seasonal operations

For the purposes of the wildlife and plant species analyses, *flow changes* constitute the expected effects of implementing the action alternatives in comparison with the No Action Alternative. Differences in flow management between the action alternatives and the No Action Alternative would have the potential to affect a special-status wildlife or plant species if flow changes were to directly harm the species, directly alter habitat availability or quality, or result in vegetation changes that would alter habitat availability or quality. Implementation of the action alternatives would generally result in minor potential changes relative to the No Action Alternative, and these changes are small relative to normal month-to-month and year-to-year variability in the system. Potential changes to terrestrial resources from seasonal operations as a result of the action alternatives are fully described in Appendix P, *Terrestrial Biological Resources Technical Appendix*.

13.2.1.1 Trinity River

Flow changes in the Trinity River under all alternatives are the same as the No Action Alternative. The simulated CalSim3 results are attributed to modeling assumptions for Alternative 1 described in Appendix F. Furthermore, as explained in the Summary Chapter, Section 0.1.7.2, *Trinity River Division*, changes or impacts described for resources associated with the Trinity Reservoir levels and Trinity River flows have been previously analyzed.

Northwestern pond turtle

Flow changes in the Trinity River under all alternatives are the same as the No Action Alternative, therefore, there are no anticipated negative impacts to northwestern pond turtle.

Foothill Yellow-Legged Frog (North Coast DPS)

Flow changes in the Trinity River under all alternatives are the same as the No Action Alternative, therefore, there are no anticipated negative impacts to foothill yellow-legged frog.

13.2.1.2 Sacramento River

Northwestern Pond Turtle

Compared to the No Action Alternative, flow changes in the upper Sacramento River downstream of Shasta Dam and through Keswick Reservoir under all action alternatives would result in relatively minor increases to much higher flows (up to 2,400 cfs higher) during at least some months of the water year which may cause some inundation of upland nesting, basking, overwintering, aestivation, and movement habitat, and may increase water depth to the extent that some aquatic breeding and basking habitat becomes unsuitable. If higher flows result in increased velocity and water levels, this may directly kill eggs if nests are inundated and/or kill hatchlings and make hatchlings more vulnerable to predation by causing shallower areas to become more accessible to aquatic predators. Increased flows relative to the No Action Alternative may also result in lower water temperatures, which can slow growth rates of developing juveniles.

Lower flows resulting from the action alternatives could negatively impact the availability of aquatic breeding and aquatic basking habitat for northwestern pond turtle. Decreased flows under these alternatives may also increase distances juveniles would need to traverse between areas of aquatic and upland habitat, making them more vulnerable to predation. Lower flows relative to the No Action Alternative may also cause aquatic habitat to become unsuitable for hatchlings and force them to move into deeper areas that are more accessible to aquatic predators. Potential reductions in water deliveries to CVPIA wildlife refuges in the Sacramento River watershed under the alternatives could also have impacts on the availability of aquatic habitat, however, Reclamation does not control the distribution of water to CVPIA wildlife refuges beyond initial water year allocations. Therefore, the changes or impacts described for terrestrial resources associated with CVPIA refuges are outside the scope of this alternatives analysis..

Foothill Yellow-Legged Frog (North Coast DPS)

Proposed flow changes in the upper Sacramento River downstream of Shasta Dam and through Keswick Reservoir under all action alternatives (between -1,733 cfs lower and up to 2,400 cfs higher) during at least some months of the water year could result in negative impacts to aquatic habitat for the North Coast DPS of the foothill yellow-legged frog. Changes in flows, may dislodge, isolate, or kill egg masses, and strand and/or kill tadpoles and metamorphs. Higher flows and resulting increases in velocity and water levels may kill adults feeding or residing (e.g., for breeding or overwintering) in the Sacramento River, and may lead to sedimentation of cobbled substrates. Cobbled substrates are used for oviposition and tadpole and metamorph development; thus, sedimentation would decrease the suitability and availability of habitat for these three life stages. High flows in the summer will decrease water temperatures, which can preclude breeding, slow development of eggs, tadpoles, and metamorphs and make these life stages more vulnerable to predation and changing habitat conditions and may make tadpoles and metamorphs more susceptible to pathogens (USFWS 2023b). Seasonal operations under all action alternatives may reduce natural variability in water releases, beyond major flood events, which will create more stable conditions (i.e., more stable flow levels that are less likely to flush and/or kill eggs, tadpoles, metamorphs, and adults, and increase sedimentation) and provide some potential benefits for foothill yellow-legged frogs.

Giant Garter Snake

Sacramento Valley populations of giant garter snake depend on rice fields and associated irrigation and drainage channels, leaving them vulnerable to wide-scale habitat loss in the event of changes in agricultural management such as changes in crops or fallowing large areas of rice fields (Paquin et al. 2006). Long-term fallowing of rice fields can reduce or eliminate habitat and individual giant garter snakes could be subjected to a greater risk of predation while seeking new habitat (USFWS 2020). When rice fields are left out of production there is a reduction or elimination in the use of the surrounding and nearby water conveyance structures by snakes where water supply is dependent upon surface or ground water from non-adjacent or on-site sources (USFWS 2012). The giant garter snake active season extends approximately April through September and giant garter snake requires aquatic habitat during this phase.

Alternative 1 does not propose decreasing water diversions to SRS Contractors in agricultural areas. Therefore, temporary loss of habitat for giant garter snake as a result of cropland idling/shifting actions would not occur. Alternatives 2, 3, and 4 propose reductions in total water diversions to SRS Contractors that is anticipated to result in fallowed rice lands during dry and critical years. As described in Table E.5.10 (Appendix E, *Draft Alternatives*), SRS Contractors will fallow 25,000 acres of rice which is credited with 110 TAF. Maximum fallowing as a result of Alternatives 2, 3, and 4 would be approximately 5.3% of the annual rice acreage grown in the Sacramento Valley in 2023 (U.S. Department of Agriculture, National Agricultural Statistics Service 2024). The new flow contributions from the Sacramento River Basin under Alternatives 2, 3, and 4 are not intended to result in idling more than 35,000 acres of rice land in the Sacramento River Basin. Cropland idling/shifting would reduce the availability of aquatic habitat and increase the risk of predation on individual giant garter snakes.

Giant garter snakes in the action area are within an active rice growing region that experiences variability in rice production and farming activities, therefore they are already subject to these risks relative to the No Action Alternative. Under the four phases of Alternative 2, and Alternatives 3 and 4, CalSim 3 model results indicate that total SRS Contractor diversions would remain the same or decrease relative to the No Action Alternative. In dry and critical water year types, SRS Contactor agricultural diversions are reduced by 34% from 100 TAF to 66 TAF in April and approximately 11% during the remaining months of the active season for giant garter snake under Alternative 3. Some of the largest reductions in average SRS Contactor agricultural diversions would be by 11-13% during some months of the active season for giant garter snake under Alternative 2 Without TUCP Without Delta VA and Alternative 4. Proposed decreases in water diversions to SRS Contractors in agricultural areas during dry and critical water year types under these alternatives could result in temporary loss of aquatic habitat for giant garter snake through the conversion of rice to dryland farming or fallowed lands. Additionally, potential reductions in water deliveries to CVPIA wildlife refuges in the Sacramento River watershed under Alternatives 2 through 4 could have impacts on the availability of aquatic habitat, however, Reclamation does not control the distribution of water to CVPIA wildlife refuges beyond initial water year allocations. Therefore, the changes or impacts to giant garter snake associated with CVPIA refuges are outside the scope of this alternatives analysis.

Bank Swallow

Flow change could potentially affect nesting habitat for bank swallows on the Sacramento River. Due to limited available habitat and the reduction of natural river processes, the species is highly sensitive to reductions in winter flows necessary to erode banks for habitat creation, and high flows during the breeding season (generally April 1–August 31) resulting in flooding of active burrows and destruction of colonies from increased bank sloughing. Bank swallows arrive in California and begin to excavate their burrows in March, and peak egg-laying occurs between April and May (Bank Swallow Technical Advisory Committee 2013). Therefore, high-flow events on the Sacramento River that occur after March when the swallows have nested and laid eggs in the burrows could negatively impact bank swallows and result in the loss of nests. On the Sacramento River, breeding season flows between 14,000 and 30,000 cubic feet per second (cfs) have been associated with localized bank collapses that resulted in partial or complete colony failure (Stillwater Sciences 2007). Additionally, flows above 50,000 cfs on the Sacramento River could lead to multiple bank swallow colony failures during the breeding season, but they may be beneficial during the non-breeding season because erosion can create new breeding habitat in the form of cut banks (Stillwater Sciences 2007).

CalSim 3 model results illustrate that, relative to the No Action Alternative, flows on the Sacramento River would be higher under Alternative 1 (up to 1,522 cfs higher in an above normal year) and Alternative 2 without TUCP without VA (up to 973 cfs higher in a critically dry year) for the majority of bank swallow breeding season (April through June). Flows would be lower under Alternative 1 (up to 1,277 cfs lower in an above normal year) and under Alternative 2 without TUCP without VA (up to 632 cfs lower in a critically dry year) than the No Action Alternative towards the end of the breeding season (July to August). Flows would generally be higher under Alternative 2 without TUCP With Delta VA (+1,127 cfs in a critically dry year), Alternative 2 without TUCP With All VA (+1,267 cfs in a critically dry year), and under Alternative 4 (+163 cfs in a critically dry year) during the early part of the bank swallow breeding season in April. Flows on the Sacramento River under Alternative 4 would generally be lower for the remainder of the breeding season (May to August) in all water years. Flows under Alternative 3 would be up to 1,990 cfs higher than the No Action Alternative in May in above normal and wet years and up to 1,913 cfs higher in August in dry years during bank swallow breeding season. Flows under Alternative 3 would be up to 954 cfs lower from April to June in below normal, dry, and critically dry years, and up to 2,218 cfs lower in July of above normal years. Projected flows would be between 2 cfs and 1,518 cfs higher under Alternative 1, Alternative 2 without TUCP With Delta VA, Alternative 2 without TUCP With All VA, and Alternatives 3 and 4 during part of the non-breeding season, where higher flows would occur from October to March. The increased flows in the Sacramento River during a majority of the non-breeding season could provide the necessary bank erosion functions needed for new bank swallow breeding habitat and therefore could result in a beneficial effect on bank swallow.

Flows greater than 14,000 cfs are anticipated under all action alternatives at some point during the breeding season on the Sacramento River at locations such as at Verona. Flows at this location could exceed 20,233 cfs under Alternative 2 without TUCP With All VA, an approximate increase of 1,270 cfs compared to the No Action Alternative. Flows over 20,500 cfs in April under Alternative 3 would be more than 1,600 cfs above the No Action Alternative. These increases in flow could result in localized bank collapses that result in partial or complete colony failure during the breeding season. Under Alternatives 1 and 4, flow increases are expected to be minor during the bank swallow breeding compared to the No Action Alternative, with approximate increases of 181 cfs and 50 cfs, respectively. Therefore, habitat conditions are expected to be similar to habitat conditions experienced by bank swallow under the No Action Alternative. Effects on bank swallow nesting habitat are anticipated based on these modelling results; however, the degree of impacts are dependent upon the relative increase in flows and the timing of flow changes. Downstream of the Sacramento River at Verona, the river becomes channelized by levee banks which do not provide suitable bank habitat for nesting, therefore there is no potential for the alternatives to impact bank swallow downstream of the confluence of the Sacramento and Feather Rivers.

Western Yellow-Billed Cuckoo

Seasonal operations will on average maintain current vegetation for western yellow-billed cuckoo, with limited floodplain activation to stimulate regeneration. Seasonal operations under all action alternatives may reduce natural variability beyond major flood events and will likely contribute to the further reduction of natural successional processes that result in non-climax stage riparian woodlands and loss of suitable western yellow-billed cuckoo habitat over time. However, habitat conditions with implementation of the action alternatives are expected to be similar to habitat conditions experienced by western yellow-billed cuckoo under the No Action Alternative.

Least Bell's Vireo

Least Bell's vireo does not currently occupy breeding habitat in the upper Sacramento River, however, changes in flow and operations could negatively impact least Bell's vireo through changes in riparian habitats if the species recolonizes the Sacramento River Valley during the timeframe of all action alternatives. The proposed changes, however, are unlikely to produce a measurable change in quantity or quality of least Bell's vireo habitat in the upper Sacramento watershed due to the minimal change in hydrological conditions associated with the action alternatives, and there is no apparent mechanism by which these changes could result in harm to individual least Bell's vireos. In addition, the action alternatives may provide benefits to the species through high fall flows, avoiding drought stress in riparian or wetland vegetation, and by keeping more constant spring flows and avoiding erosion at restoration sites.

13.2.1.3 Clear Creek

Northwestern Pond Turtle

Compared to the No Action Alternative, the four phases under Alternative 2 would result in variable increases and decreases in flow depending on the time of year and Alternatives 3 and 4 would result in relatively minor increased flows (up to 86 cfs higher) which may contribute to similar negative impacts to northwestern pond turtle as described above for the Sacramento River. Alternative 1 would result in decreased flows up to 181 cfs which could negatively impact availability of aquatic breeding and aquatic basking habitat and may increase distances juveniles would need to traverse between areas of aquatic and upland habitat, making them more vulnerable to predation. Generally higher flows may contribute to similar negative impacts to northwestern pond turtle as described. Lower flows resulting from Alternative 1, the four phases of Alternative 2, and Alternatives 3 and 4 may also cause similar negative impacts to aquatic habitat.

Foothill Yellow-Legged Frog (North Coast DPS)

Proposed flow changes in Clear Creek under all action alternatives may also cause negative impacts to aquatic habitat for the North Coast DPS of the foothill yellow-legged frog as described above.

13.2.1.4 Lower American River

Northwestern Pond Turtle

Compared to the No Action Alternative, Alternative 1 and 3 would result in flows up to 870 cfs higher which may contribute to similar negative impacts to northwestern pond turtle as described above for the Sacramento River. Lower flows up to 773 cfs lower than the No Action Alternative resulting from Alternatives 1 and 3 may also cause similar negative effects to aquatic habitat. CalSim 3 model results illustrate that average flows under the four phases of Alternative 2 and under Alternative 4 will be similar to the No Action Alternative, therefore there are no anticipated negative impacts to northwestern pond turtle.

Foothill Yellow-Legged Frog (South Sierra DPS)

There would be no actions under all the alternatives that affect suitable habitat for the South Sierra DPS of foothill yellow-legged frog in the lower American River.

Western Yellow-Billed Cuckoo and Least Bell's Vireo

Similar to Section 13.2.1.2, *Sacramento River*, seasonal operations will on average maintain current vegetation for western yellow-billed cuckoo, with limited floodplain activation to stimulate regeneration. Seasonal operations under all action alternatives may reduce natural variability beyond major flood events. Seasonal operations will likely contribute to the further reduction of natural successional processes that result in non-climax stage riparian woodlands and loss of suitable western yellow-billed cuckoo habitat over time. However, habitat conditions with implementation of the action alternatives are expected to be similar to habitat conditions experienced by western yellow-billed cuckoo under the No Action Alternative.

13.2.1.5 Stanislaus River

Northwestern Pond Turtle

Compared to the No Action Alternative, the action alternatives would result in incremental increases in flows which may contribute to but is not likely to cause negative impacts to northwestern pond turtle as described above for the Sacramento River. Incremental increases in flows could increase velocity and water levels, which may negatively impact eggs if nests are inundated and/or kill hatchlings, and make hatchlings more vulnerable to predation by causing shallower areas to become more accessible to aquatic predators. Lower flows between 96 cfs and 205 cfs resulting from Alternatives 1, 3, and 4 may also cause similar negative impacts to aquatic habitat.

Foothill Yellow-Legged Frog (South Sierra DPS)

Under all the alternatives, flows would not affect the South Sierra DPS of foothill yellow-legged frog upstream of New Melones Reservoir, as there would be no actions that affect suitable habitat in that area. While there are no currently documented South Sierra DPS foothill yellow-legged frog populations below New Melones Reservoir, suitable breeding habitat potentially exists along the river, and the absence of foothill yellow-legged frog cannot be confirmed as survey data is lacking in this area for the species. Hayes et al. (2016) reports that breeding can take place on the Stanislaus River below New Melones Reservoir as late as July, indicating presence of the species, but does not go into further detail about the current population. Given the best available data, Reclamation is assuming presence of this species for all relevant life stages in the action area but the species presence has not been definitively proven in the action area.

Under all action alternatives, proposed flow changes in the lower Stanislaus River downstream of New Melones Reservoir could negatively impact aquatic habitat for the South Sierra DPS of foothill yellow-legged frog. Compared to the No Action Alternative, the action alternatives would result in relatively minor increased flows which may contribute to similar negative impacts to foothill yellow-legged frog as described above for the Sacramento River. Lower flows are also anticipated as a result of the action alternatives, which may also cause similar negative impacts to aquatic habitat. Seasonal operations under the action alternatives may also reduce natural variability in water releases, beyond major flood events, which would create more stable conditions (i.e., more stable flow levels that are less likely to flush and/or kill eggs, tadpoles, metamorphs, and adults, and increase sedimentation) and provide some potential benefits for foothill yellow-legged frogs. Ultimately the limited discretion on flow releases from New

Melones Reservoir into the Stanislaus River will result in limited impacts. These limited impacts could include possible dislodging, isolation, or mortality of egg masses, and possibly strand and/or kill tadpoles and metamorphs. Incrementally higher flows and water levels could impact adults' ability to feed or reside in the Stanislaus River and may lead to sedimentation of cobbled substrates. These impacts could negatively alter the applicable life stages for the foothill yellow legged frog associated with lower water temperatures in the summer, higher flow water releases during developmental periods, and a minor increase in sedimentation of cobbled substrates.

Western Yellow-Billed Cuckoo and Least Bell's Vireo

The seasonal operations under the alternatives and spring pulse flows under the four phases of Alternative 2 in the Stanislaus River and generally higher flows will have a negligible impact on the existing riparian vegetation. Elevated water flows are not anticipated to rise to the level that would cause impacts to nesting western yellow-billed cuckoos or least Bell's vireo.

13.2.1.6 San Joaquin River

Under Alternative 1, the four phases of Alternative 2, and Alternative 4, there would be no changes in average flows that would affect suitable habitat of the northwestern pond turtle or the South Sierra DPS of foothill yellow-legged frog in the San Joaquin River watershed. Under Alternative 3, average flows are expected to be lower across all water years than the No Action Alternative in the San Joaquin River watershed, with decreases between 30 cfs and 123 cfs. Lower flows may cause similar negative impacts to aquatic habitat for northwestern pond turtle as described above in Section 13.2.1.2. The last remaining reproductive population of the giant garter snake in the San Joaquin Valley exists in CVPIA refuges. Reduced water deliveries to CVPIA wildlife refuges in the San Joaquin River under Alternative 3 would have impacts on the availability of aquatic habitat for giant garter snake and northwestern pond turtle.

13.2.1.7 Bay-Delta

Reclamation would continue to operate Delta facilities by season with the same primary purposes as described in the Common Components in Appendix E, Section E.2.4, *Delta*. The Suisun Marsh Salinity Control Gates (SMSCG) are the only component in the Bay-Delta where proposed flow changes were found to have the potential to impact terrestrial resources based on flow modeling, therefore, the terrestrial analysis is centered around SMSCG reoperations.

Northwestern Pond Turtle

The SMSCG reoperations proposed under Alternative 1 would not include Delta smelt summer and fall habitat actions to improve Delta smelt food supply and habitat. This could incrementally increase marsh salinities in the summer and fall compared to the No Action Alternative. Northwestern pond turtles are a primarily freshwater species, and higher basking activity has been observed in Suisun Marsh in areas with low salinity, indicating an increase in habitat suitability when salinity is decreased and vice versa. Northwestern pond turtles were also found to have higher abundance, survival, and growth rates in areas with reduced salinities (Agha et al. 2020; USFWS 2023a). Thus, a seasonal increase in salinity in summer and fall may result in decreased habitat suitability and contribute to negative impacts on Northwestern pond turtle under Alternative 1. The SMSCG are being proposed to direct more fresh water into the Suisun Marsh to improve habitat conditions for Delta smelt in the region under the four phases of

Alternative 2, and under Alternatives 3 and 4. Therefore, these alternatives will likely have a beneficial impact on northwestern pond turtle.

Soft bird's beak and Suisun thistle

SMSCG reoperations under Alternative 1 could incrementally increase marsh salinities in the summer and fall, creating a vegetation shift in Suisun Marsh. However, salinity levels of the habitat in which soft bird's-beak or Suisun thistle are found would not be substantially increased, thus, the proposed operation of the SMSCG associated with Alternative 1 would result in a negligible effect to either soft bird's beak or Suisun thistle. SMSCG reoperations under the four phases of Alternative 2 and Alternatives 3 and 4 are expected to lower marsh salinities. Because salinity levels of the habitat in which soft bird's-beak or Suisun thistle are found would not be substantially altered, the proposed operation of the SMSCG associated with the four phases of Alternative 2 and Alternatives 3 and 4 would likely be negligible to either soft bird's beak or Suisun thistle.

13.2.2 Potential changes to Critical Habitat from seasonal operations

Proposed flow changes are included under all alternatives in the Sacramento River within western yellow-billed cuckoo critical habitat. The proposed changes are unlikely to produce measurable change in quantity or quality of western yellow billed cuckoo habitat, including riparian vegetation, in the upper Sacramento watershed.

Critical habitat for valley elderberry longhorn beetle is present along the lower American River. However, under the alternatives, proposed flow changes are unlikely to produce measurable changes in quantity or quality of valley elderberry longhorn beetle critical habitat in the lower American River watershed, as the riparian vegetation of the surrounding habitat would not be measurably altered.

Critical habitat for soft bird's-beak and Suisun thistle is present in the Delta region. SMSCG reoperations under Alternative 1 could incrementally increase marsh salinities in the summer and fall. However, salinity levels of the habitat in which soft bird's-beak or Suisun thistle are found would not be substantially increased, thus the proposed operation of the SMSCG associated with Alternative 1 would likely result in a negligible effect to both soft bird's beak and Suisun thistle critical habitat. SMSCG reoperations under the four phases of Alternative 2 and Alternatives 3 and 4 are expected to lower marsh salinities. These slightly lower salinity levels in the surrounding habitat would not be result in measurable effects on the primary constituent elements for soft birds beak and Suisun thistle critical habitat due to the variability of existing salinities as well as the variability created between years under these alternatives.

13.3 Mitigation Measures

Appendix D includes a detailed description of mitigation measures identified for terrestrial resources per alternative. These mitigation measures include avoidance and minimization measures that are part of each alternative and, where appropriate, additional mitigation to lessen impacts of the alternatives. Additional mitigation measures for terrestrial resources are identified: Mitigation Measures BIO-1: Flow criteria and real-time group considerations for Bank Swallow, BIO-2: Real-time group considerations for Foothill Yellow-Legged Frog, and BIO-3: Real-time group considerations for Northwestern Pond Turtle.

13.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and may result in potential changes in terrestrial biological resources and critical habitat from seasonal operations at reservoirs that store CVP water, tributaries and the Delta, and agricultural lands. The action alternatives will result in changes to terrestrial biological resources and critical habitat from seasonal operations at reservoirs that store CVP water, tributaries and the Delta, and agricultural lands. The magnitude of the changes is dependent on alternative and water year type. Therefore, the No Action Alternative and action alternatives may contribute to cumulative changes to terrestrial biological resources as described in Appendix P, *Terrestrial Biological Resources* and Appendix Y, *Cumulative Impacts Technical Appendix*.

Chapter 14 Regional Economics

This chapter is based on the background information and technical analysis documented in Appendix Q, *Regional Economics Technical Appendix*, which includes additional information on regional economic conditions and technical analysis of the effects of each alternative.

14.1 Affected Environment

Regional economics includes conditions and economic information relevant to the specific industries in which potential economic effects could occur, such as municipal and industrial (M&I) water uses, agriculture, fisheries, recreation, and hydropower. Presented below are descriptions of the affected environment specific to regional economics including agricultural economics and commercial and recreational fisheries economics. Descriptions of the affected environment for recreation resources are detailed in Chapter 18. The affected environment for power resources are detailed in Chapter 18.

Regional economic data is presented at a county level, with data compiled using Impact Planning and Analysis (IMPLAN) data files for 2021 (the most recent complete data set available) from a variety of sources, including, but not limited to, the United States Bureau of Economic Analysis, the United States Bureau of Labor, and the U.S. Census Bureau. This section presents IMPLAN data and results for economic output, employment, and labor income. Output is the dollar value of industry production. Employment is measured as the number of jobs. Labor income is the dollar value of total payroll (including benefits) for each industry plus income received by self-employed individuals.

According to the US Census Bureau, California's median, mean, and per capita household income for 2017 through 2021 was $84,097, $119,149, and $41,276, respectively. All counties except Placer and El Dorado within the Sacramento Valley Region have lower median household, mean household, and per capita incomes than the state average. All counties in the San Joaquin Valley Region have median household, mean household, and per capita incomes lower than the state average. The mean and median household incomes for all counties in the San Francisco Bay Area Region are higher than the state average. In the Central Coast Region, San Luis Obispo has a lower than state average median household income and Santa Barbara has a higher than state average median household income. All counties in the South Coast Region except Ventura, Orange and San Diego have lower median household income than the state average.

14.1.1 Agricultural Economics

California is the highest producer (by value) of agricultural commodities in the United States. California accounted for over 11.8% of the nation’s total agricultural value (cash farm receipts) in 2021 (California Department of Food and Agriculture 2022). According to the California Department of Food and Agriculture's *2021-2022 Agricultural Statistics Review* (2022), in 2021 the San Joaquin Valley Region counties accounted for approximately 59% ($36.1 million) of the agricultural produce (by value) in California. Sacramento Valley counties accounted for approximately 13% ($7.9 million). Southern California counties accounted for approximately 10% ($5.9 million) followed by Delta, Central Coast, and San Francisco Bay counties at 8% ($4.7 million), 5% ($3.0 million) and 2% ($1.5 million).

14.1.2 Commercial and Recreational Fisheries Economics

The commercial and recreational ocean salmon fisheries along the Southern Oregon/Northern California Coast are affected by the population of salmon that rely upon the Northern California rivers, including the Sacramento and San Joaquin Rivers. Changes in CVP and SWP water operations would affect the flow patterns and water quality of the Sacramento and San Joaquin rivers and the survivability of the salmon that use those rivers for habitat

Management of the California ocean salmon fishery is a combined effort of the California Department of Fish and Wildlife (CDFW) and the Pacific Fishery Management Council (PFMC), a regional council of the National Oceanic and Atmospheric Administration. CDFW manages salmon harvest from the shoreline to three nautical miles off the California coast. From three nautical miles to 200 nautical miles offshore is managed by PFMC. PFMC is responsible for developing the Pacific Coast Salmon Fishery Management Plan that guides management of the ocean commercial and recreational fishery in California, Oregon, and Washington (Pacific Fishery Management Council 2022). The annual ocean salmon fishery regulations promote the maximum amount of harvest while ensuring that suitable population levels are maintained (National Oceanic and Atmospheric Administration Fisheries 2023).

14.2 Effects of the Alternatives

The impact analysis considers changes in regional economic conditions related to changes in CVP and SWP operation under the alternatives as compared with the No Action Alternative.

The No Action Alternative is based on 2040 conditions. The changes to regional economic resources that are assumed to occur by 2040 under the No Action Alternative conditions would be different than existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

In the long term, it is anticipated that climate change, and development throughout California, could affect water supply deliveries.

Under the No Action Alternative, Reclamation would continue with the current operation of the CVP, as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the SWP represent current management direction or intensity pursuant to 43 CFR Section 46.30.

Although the No Action Alternative included habitat restoration projects at a programmatic level, the 2020 ROD did not provide environmental coverage for these projects, and all of the habitat projects considered under the No Action required or will require additional environmental documentation. Thus, ground disturbance for habitat restoration projects did not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

It is anticipated that climate change would result in more short-duration high-rainfall events and less snowpack in the winter and early spring months. This could result in decreasing CVP/SWP water supplies, recreation and hydropower generation. Additionally, land uses in 2040 would occur in accordance with adopted general plans and could convert natural or rural areas to developed areas, resulting in increased water supply demand and increased power use to supply water. These increases in demand could result in development of alternate supplies. It is assumed that costs associated with development of alternate supplies would be passed on the end users which could result decreases in discretionary income and could result in less discretionary spending in the regional economy.

The No Action Alternative, thus, is expected to result in potential changes in regional economic resources for M&I water uses, agricultural water uses, fisheries, recreation, and hydropower. These changes were described and considered in the 2020 Record of Decision.

For the purposes of this analysis, the changes in operations and flows are linked to changes in regional economic resources because they are related to water supply and hydropower generation. The evaluation of economic conditions is based on IMPLAN data and results for economic output, employment, and labor income.

Alternative 4B is expected to be within the range of effects for economics described below for Alternative 4.

14.2.1 Potential M&I water supply-related changes to the regional economies

Most water agencies conduct long-term resource planning every five years to ensure adequate water supplies are available to meet existing and future demands. If a substantial deficit is estimated during these planning exercises, water agencies may decide to secure alternate water supplies such as desalination and new groundwater development (considered new supply sources), water conservation projects, or water transfers/imported water. All or a portion of increased water costs to secure these alternate water supplies are passed on to the retail agencies and water customers through increased water rates, subject to prevailing legislation and regulatory framework regarding changes in water rates. An increase in water rates would reduce disposable income and could result in less spending in the regional economy. The No Action Alternative analysis includes CVP and SWP water supplies under existing conditions and future water demands (2040 water demands). M&I water supply costs under the No Action Alternative are expected to be higher in comparison to existing conditions since demands are expected to increase due to population growth under the No Action Alternative with no change to supplies. Consequently, M&I contractors would need to invest in alternate water supplies to meet increases in demand. Typically, increased water supply cost associated with development of alternate water supplies are passed on to water customers through water rate increases. This could result in a decrease in disposable income and could result in less spending in the regional economy under No Action Alternative. This analysis used outputs from the California Water Economics Spreadsheet Tool (CWEST) model to identify changes in the composition of water supplies and resulting changes in water rates.

Alternatives 1 and all phases of Alternative 2 would increase water supply deliveries to North of Delta and South of Delta M&I contractors in comparison to No Action Alternative and consequently reduce water supply costs to contractors (see Table 14–1). Alternative 3 would decrease water supply deliveries and result in an increase to water supply costs to contractors (see Table 14–1). Alternative 4 would mostly result in an increase in deliveries and decrease in water supply costs to M&I contractors (see Table 14–1).

Alternative 1, Alternative 2 phases, and Alternative 4 would mostly result in an increase in M&I water supply deliveries while Alternative 3 would decrease water supply deliveries. The No Action Alternative would require the development of alternate supplies to meet water demands, but increased CVP and SWP deliveries under Alternatives 1, Alternative 2 phases, and Alternative 4 would reduce water supply costs as alternate water supply projects would not need to be implemented. Additionally, there would be reductions in lost water sales revenues, transfer costs, groundwater pumping savings, and/or excess water savings. Typically, water supply cost increases are passed on to water customers through water rate increases.

As summarized in Table 14–1, water supply costs under Alternative 1, Alternative 2 phases, and Alternative 4 would decrease in comparison to the No Action Alternative. Consequently, water rates under Alternatives 1, Alternatives 2 phases, and Alternative 4 could be lower than the No Action Alternative. Water rates under Alternative 3 could be higher than the No Action Alternative. This could result in an increase in disposable income and could result in more spending in the regional economy under Alternative 1, Alternative 2 phases, and Alternative 4.

Table 14–2 summarizes the regional economic effects on employment, labor income, and revenue from decreased water supply costs to CVP and SWP M&I contractors. Most of the economic developments under Alternative 1, Alternative 2 phases, and Alternative 4 would occur in the Southern California region (Ventura, Los Angeles, Orange, Imperial, San Diego, Riverside, and San Bernardino Counties) since approximately 85% of the increased M&I deliveries would be in this region.

Under Alternative 3, decreased CVP and SWP deliveries would increase water costs due to increased alternate water supply costs. This increase in water supply costs could be passed on to the water customer through water rate increases. Increase in water rates could result in a decrease in disposable income and could result in less spending in the regional economy. Table 14–2 summarizes the regional economic effects on employment, labor income, and revenue from increased water supply costs under Alternative 3.

Table 14–1. Annual Changes to M&I Water Supply Costs under the Action Alternatives Compared to the No Action Alternative (in thousand dollars)

	Sacramento River Region	San Joaquin River Region	San Francisco Bay Region	Central Coast Region	South Coast Region
Alternative 1	($115)	($12,533)	($34,100)	($2,198)	($274,279)
Alternative 2 With TUCP Without VA	($1,107)	($3,697)	($5,214)	($316)	($487)
Alternative 2 Without TUCP Without VA	($146)	($2,303)	$2,039	($360)	($52,143)
Alternative 2 Without TUCP With Delta VA	($4,349)	($3,431)	($5,491)	($311)	($5,243)
Alternative 2 Without TUCP With Systemwide VA	($2,055)	($3,451)	($6,062)	($294)	($8,444)
Alternative 3	$7,070	$17,319	$26,534	$4,286	$1,112,874
Alternative 4	$274	($2,567)	$1,912	($370)	($63,806)

All costs in 2023 dollars. Numbers in parentheses are negative values.
Values presented in the table refer to cost savings from contract water not used to meet demand or reduce groundwater pumping and reflect aggregate impacts across contractors. Negative refers to savings and positive refers to costs.

Table 14–2. M&I Water Supply Costs Related to Regional Economic Effects under the Action Alternatives Compared to the No Action Alternative

	Sacramento River Region	San Joaquin River Region	San Francisco Bay Region	Central Coast Region	South Coast Region
EMPLOYMENT (NUMBER OF JOBS [a])					
Alternative 1	0.4	41.1	104.7	9.0	1352.5
Alternative 2	0.6 - 16.4	7.5 - 12.1	-6.3 - 18.6	1.2 - 1.5	2.4 - 257.1
Alternative 3	-26.7	-56.7	-81.5	-17.5	-5487.6
Alternative 4	-1.0	8.4	-5.9	1.5	314.6
LABOR INCOME (IN MILLION DOLLARS)					
Alternative 1	$0.02	$1.91	$7.41	$0.44	$75.87
Alternative 2	$0.03-$0.90	$0.35-$0.56	($0.44)-$1.32	$0.06-$0.07	$0.13-$14.42
Alternative 3	($1.47)	($2.64)	($5.77)	($0.85)	($307.84)
Alternative 4	($0.06)	$0.39	($0.42)	$0.07	$17.65
OUTPUT (IN MILLION DOLLARS)					
Alternative 1	$0.08	$7.17	$24.54	$1.65	$266.07

	Sacramento River Region	San Joaquin River Region	San Francisco Bay Region	Central Coast Region	South Coast Region
Alternative 2	$0.10-$3.10	$1.32-$2.12	($1.47)-$4.36	$0.22-$0.27	$0.47-$50.58
Alternative 3	($5.04)	($9.91)	($19.10)	($3.21)	($1,079.57)
Alternative 4	($0.20)	$1.47	($1.38)	$0.07	$61.90

All costs in 2024 dollars. Numbers in parentheses are negative values.
[a] Jobs include full-time, part-time and temporary jobs created or lost.

14.2.2 Potential agriculture-related changes to the regional economy

During past water supply shortages, agricultural contractors have typically increased groundwater pumping to substitute for reduced water supplies. If groundwater is not available, growers would idle field crops and use available surface water to irrigate permanent crops. Implementation of the Sustainable Groundwater Management Act (SGMA) could constrain the ability to increase or maintain groundwater pumping to fully offset reductions in surface water deliveries. This analysis used outputs from the SWAP model to identify the effect of changes in the availability of agricultural water supplies to growing practices in the Sacramento and San Joaquin River Regions. Groundwater pumping and SGMA implementation is represented in the SWAP model to govern whether and to what amount project water users can utilize groundwater to offset reductions in surface water deliveries. The SWAP model constrains groundwater pumping to maximum sustainable yield in the modeled area. SWAP model results are estimated for both below normal (used as a proxy for overall average) and dry conditions, defined according to the yearly Sacramento River Index values associated with the water deliveries from the CalSim 3 operations model. As summarized in Table 14–3 and Table 14–4, changes in annual agricultural water supplies would result in changes to total irrigated acreage and gross revenue generated in both regions.

Table 14–5 and Table 14–6 summarize the annual regional economic effects resulting from changes in agricultural water supplies delivered under the alternatives when compared to the No Action Alternative. Changes to irrigated acreage and agricultural revenue would affect businesses and individuals who support farming activities, such as farm workers, fertilizer and chemical dealers, wholesale and agricultural service providers, truck transport, and others involved in crop production and processing. The changes in agricultural revenue results presented in Table 14–3 include price adjustments for crops that reflect both demand shifts from current conditions to 2040 (fixed price revenue) and price changes caused by alternative-driven changes in crop production/ supply shifts (price effect revenue). Since IMPLAN assumes fixed prices, regional economic effects were estimated using the fixed price agricultural revenue results. Price effect revenue results would primarily result in changes to proprietor income and are not expected to result in substantial impacts on the regional economy.

Table 14–3. Agricultural Water Supply Costs under the Action Alternatives Compared to the No Action Alternative for Sacramento River Region

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
AVERAGE CONDITIONS [a]				
Average Annual CVP/SWP Deliveries (AF)	4,501	-102,891 – -2,472	-79,652	7,342
Irrigated Acreage (acres)	955	-7,038 – -650	-22,818	1,316
Total Agricultural Revenue (million dollars)	($29.47)	($6.27) – $9.09	$42.88	($2.63)
Fixed Price Agricultural Revenue (million dollars) [b]	($5.27)	($8.63) – $6.95	($25.89)	$10.50
Price Effects Agricultural Revenue (million dollars) [c]	($24.20)	($9.79) – $14.12	$68.77	($13.14)
DRY CONDITIONS [d]				
Average Annual CVP/SWP Deliveries (AF)	13,632	-75,255 – -13,157	-86,124	-2,785
Irrigated Acreage (acres)	4,379	-5,589 – -4,320	-21,123	-814
Total Agricultural Revenue (dollars)	($26.51)	($1.06) – $17.41	($29.49)	$4.19
Fixed Price Agricultural Revenue (million dollars) [b]	$6.22	($6.87) – ($0.93)	($54.86)	$7.13
Price Effects Agricultural Revenue (dollars) [c]	($32.73)	$2.97 - $18.34	$25.37	($2.94)

All costs in 2024 dollars. Numbers in parentheses represent negative values. Values are an annual average change between the No Action Alternative and the alternatives under 2040 conditions.
AF = acre-feet; CVP = Central Valley Project; SWP = State Water Project
[a] Average Conditions refers to an average of all year types in the CalSIM simulation period.
[b] Agricultural Revenue based on fixed prices for agricultural products, current price used in the analysis.
[c] Agricultural Revenue based on projected price effect for agricultural products based on changes to irrigated acreage in the Central Valley and other global effects on crop prices.
[d] Dry Conditions refer to an average of dry years only, using Sacramento River Index.

Table 14–4. Agricultural Water Supply Costs Related to Regional Economic Effects under the Action Alternatives in Comparison to the No Action Alternative for Sacramento River Region

	Employment (number of jobs)[a]	Labor Income (million dollars)	Revenue (million dollars)
AVERAGE CONDITIONS			
Alternative 1	-86.9	($1.98)	($7.18)
Alternative 2	-128 - 40.9	($3.045) - $1.85	($12.72) - $10.92
Alternative 3	-603.3	($12.07)	($41.29)
Alternative 4	147.1	$3.82	$16.53
DRY CONDITIONS			
Alternative 1	61.5	$1.90	$9.78
Alternative 2	-94.8 - -17.7	($2.35) - ($0.28)	($9.95) - ($1.23)
Alternative 3	-784.5	($19.53)	($80.34)
Alternative 4	57.7	$2.09	$11.05

All costs in 2024 dollars; Labor income and output in parentheses represent negative values.
[a] Jobs include full-time, part-time and temporary jobs created or lost.

Table 14–5. Agricultural Water Supply Costs under the Action Alternatives Compared to the No Action Alternative for the San Joaquin River Regions

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
AVERAGE CONDITIONS [a]				
Average Annual CVP/SWP Deliveries (AF)	466,371	-147,690 - 25,174	-1,146,414	53,305
Irrigated Acreage (acres)	91,372	-47,769 - 4,701	-303,764	14,094
Total Agricultural Revenue (million dollars)	$337.02	($235.05) - $10.54	($1,589.89)	$51.03
Fixed Price Agricultural Revenue (million dollars) [b]	$340.90	($260.78) - $10.21	($1,549.45)	$55.59
Price Effects Agricultural Revenue (million dollars) [c]	($3.89)	$0.33 - $30.66	($40.44)	($4.56)
DRY CONDITIONS [d]				
Average Annual CVP/SWP Deliveries (AF)	318,194	-143,168 – -65,257	-821,700	-27,470
Irrigated Acreage (acres)	87,164	-47,500 – -22,585	-210,633	-10,343

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Total Agricultural Revenue (dollars)	$411.95	($278.06) - ($136.47)	($1,178.88)	($67.11)
Fixed Price Agricultural Revenue (million dollars) [b]	$403.61	($285.56) - ($132.02)	($1,261.01)	($61.07)
Price Effects Agricultural Revenue (dollars) [c]	$8.34	($4.46) - $7.50	$82.14	($6.04)

All costs in 2024 dollars. Numbers in parentheses represent negative values. Values are an annual change between the No Action Alternative and the alternatives under 2040 conditions.
AF = acre-feet; CVP = Central Valley Project; SWP = State Water Project
[a] Average Conditions refers to an average of all year types in the CalSIM simulation period.
[b] Agricultural Revenue based on fixed prices for agricultural products, current price used in the analysis.
[c] Agricultural Revenue based on projected price effect for agricultural products based on changes to irrigated acreage in the Central Valley and other global effects on crop prices.
[d] Dry Conditions refer to an average of dry years only, using Sacramento River Index.

Table 14–6. Agricultural Water Supply Costs Related to Regional Economic Effects under the Action Alternatives in Comparison to the No Action Alternative for San Joaquin River Region

	Employment (number of jobs)[a]	Labor Income (million dollars)	Revenue (million dollars)
AVERAGE CONDITIONS			
Alternative 1	3951.7	$116.72	$504.08
Alternative 2	-2094.4 - 208.1	($75.32) - $4.79	($383.60) - $14.94
Alternative 3	-14404.2	($480.77)	($2,304.27)
Alternative 4	593.7	$17.65	$80.06
DRY CONDITIONS			
Alternative 1	3722.3	$123.89	$596.32
Alternative 2	-2125.9 - -963.9	($79.99) - ($36.96)	($421.32) - ($195.89)
Alternative 3	-10672.5	($375.31)	($1,873.80)
Alternative 4	-389.8	($14.99)	($86.68)

All costs in 2024 dollars; Labor income and output in parentheses represent negative values.
[a] Jobs include full-time, part-time and temporary jobs created or lost.

14.2.3 Potential fisheries-related changes to the regional economy

The commercial and recreational (ocean sports) ocean salmon fishery along the SONCC are affected by the population of salmon that rely upon the Northern California rivers, including the Sacramento and San Joaquin rivers. As described in detail in Chapter 12, Fish and Aquatic Resources, annual average Central Valley Chinook salmon abundance (includes Spring, Winter, Fall and late-Fall runs) in the Bay under all alternatives would be negligeable in comparison to the No Action Alternative. There would be minimal impacts to commercial and recreational ocean salmon harvest under Alternative 1 compared to the No Action Alternative. Consequently, revenues received by fisherman from changes to ocean salmon harvest would be minimal. Ocean fisheries support industries such as fish processors, boat manufacturers, repair and maintenance would see no changes in revenue. Overall fisheries related changes to the regional economy under Alternative 1 would be minimal.

Coho salmon, fall-run and spring-run Chinook salmon impacts under all the alternatives would be minor in comparison to the No Action Alternative. These salmon populations are extremely important to the Yurok Tribe and Hoopa Valley Tribe as part of their lives, cultural traditions, ceremonies, and community health (Bureau of Reclamation 2012). Salmon populations in the Trinity River would not be adversely affected under the alternatives, therefore, there would be no fisheries-related adverse effects to revenue and disposable incomes in the Trinity River Region. Consequently, there would be no adverse effects to the Tribe's economy.

14.2.4 Potential impacts to regional recreational economics

Changes in reservoir levels under the alternatives could impact recreational use and spending in the region. Recreation (leisure and hospitality sector) is in the top three industries in terms of employment in Trinity, El Dorado and Napa counties that fall within the study area. The alternatives are not expected to impact reservoir levels and recreational use and spending in Napa County or Lake Tahoe in El Dorado County. This analysis only considers potential recreational use and spending effects on regional economics in Trinity County forecast from changes to Trinity Reservoir levels under the alternatives. Average water elevations in Trinity Reservoir under Alternative 1 and Alternative 3 would remain the same or be slightly higher when compared to the No Action Alternative. Therefore, camping, day use opportunities at the campgrounds surrounding Trinity Reservoir, and recreational fishing access are expected to be similar under Alternative 1 and 3 in comparison to the No Action Alternative.

Under the Alternative 2 phases, average elevation of Trinity Reservoir would be lower compared to the No Action Alternative by one to three feet between October through June. From July through September, average water elevation under the Alternative 2 phases in comparison to No Action Alternative would be between two to five feet lower. Seasonal fluctuations in water levels would also remain the same throughout the year under all phases. The minimum elevations of Trinity Reservoir, under all phases of Alternative 2 would remain the same as the No Action Alternative from January through March. From April through October, all phases of Alternative 2 would have a higher minimum elevation compared to the No Action Alternative except for the without TUCP and with Delta Voluntary Agreements phase. From October through December, all three Alternative 2 without TUCP phases would have lower minimum elevation compared to the No Action Alternative. Under Alternative 2 without TUCP and with Delta Voluntary Agreements, the minimum December water elevation in Trinity Reservoir may be less than 2,170 feet, making the Minersville boat ramp unusable. When Trinity Reservoir levels fall below 2,170 feet and all the boat ramps on the lake are unusable, recreational visitation could substantially decrease and cause adverse regional economic impacts to Trinity County. However, the lowering of reservoir levels is expected to occur in the off season (December) when recreational visitation to the reservoir are expected to be low. Given the limited changes in Trinity Reservoir levels forecast under Alternative 2 in comparison to the No Action Alternative and reservoir levels remaining above 2,170 feet with the exception of December in the off season when visitation is low, limited impacts are forecast on camping, day use opportunities at the campgrounds surrounding Trinity Reservoir, and recreational fishing access. Consequently, Alternative 2 is not expected to have a substantial impact to recreational visitation, recreational revenue and recreational regional economics in Trinity County.

Under Alternative 4, average water elevations in Trinity Reservoir would be slightly lower, by up to one to three feet between January through June. From July through December, average water elevation under Alternative 4 in comparison to No Action Alternative would be between three to five feet lower. However, seasonal fluctuations would remain approximately the same under Alternative 4 in comparison to No Action Alternative. The minimum elevations of Trinity Reservoir, under Alternative 4 are similar to or higher than elevations under the No Action Alternative in all months except between November through January. From November through January, minimum elevations of Trinity Reservoir could be lower by up to eight feet in comparison to No Action Alternative. Trinity Reservoir levels are never lower than 2,170 feet under Alternative 4. Given the limited changes in Trinity Reservoir levels forecast under Alternative 4 in comparison to the No Action Alternative and reservoir levels remaining above 2,170 feet, limited impacts are forecast on camping, day use opportunities at the campgrounds surrounding Trinity Reservoir, and recreational fishing access.

Consequently, there would be no adverse effects on recreational visitation, recreational revenue, and the recreational regional economy in Trinity County under all four action alternatives.

14.2.5 Potential impacts to regional economics from changes to hydropower

As described in detail in *Chapter 18, Power,* the CVP net hydropower generation would be slightly lower over the long-term and over dry and critically dry years under Alternative 1 compared to the No Action Alternative. Under the Alternative 2 phases, Alternative 3 and Alternative 4, the CVP net hydropower generation would be similar or slightly higher over the long-term and over dry and critically dry years compared to the No Action Alternative. The hydropower generated by the CVP is marketed and transmitted by the Western Area Power Administration (WAPA) Sierra Nevada Region. As CVP annual and plant-in-service power costs increase (including Central Valley Project Improvement Act Environmental Restoration Funds), and available energy for sale decreases, the net unit cost of CVP power may decrease. Typically, increases or decreases in power costs would be passed on to customers through rate increases or decreases, respectively. Alternative 1 would result in a decrease in disposable income and could result in less discretionary spending in the regional economy. Alternative 2, Alternative 3 and Alternative 4, would result in an increase in disposable income and could result in more discretionary spending in the regional economy.

Under Alternative 1, Alternative 2 and Alternative 4, SWP net generation over the long-term would be lower for both long-term average and in dry and critically dry years in comparison to the No Action Alternative. Under Alternative 3 compared to the No Action Alternative, SWP annual energy generation would be lower for both the long-term average and for dry and critically dry years , but the energy required by the SWP to move the water would also be lower for both the long-term average and for dry and critically dry years resulting in an increase in SWP net generation over the long-term for both long-term average and in dry and critically dry years. Power generated by the SWP is transmitted by PG&E, Southern California Edison, and California ISO through other facilities (California Department of Water Resources 2022). The SWP also markets energy in excess of the SWP demands to a utility and members of the WSPP, formerly known as the Western Systems Power Pool. A decrease in SWP net generation under Alternatives 1, 2 and 4 would increase the need for the development of other alternative supplies which could result in an overall increase in power cost. Typically, increase in power costs would be passed on to customers through rate increases. This would result in a decrease in disposable income and could result in less discretionary spending in the regional economy. Alternative 3 would result in an increase in disposable income and could result in more discretionary spending in the regional economy.

14.2.5.1 Alternative 2B

Analysis of Alternative 2B, although qualitative, builds on the quantitative analysis provided for Alternative 2. Only components under Alternative 2B that are expected to result in economic resources impacts compared to Alternative 2 are discussed.

Alternative 2b is anticipated to be more restrictive on Delta exports than Alternative 2 and the No Action Alternative. Please see *Chapter 5 Water Supply* for a description of the restrictions associated with the QWEST criteria under Alternative 2B. These restriction in exports may result in a reduction in surface water supply and, thus, potentially increase land that is taken out of agricultural production. Taking land out of agricultural production may result in loss of agricultural jobs. Also, a decrease in surface water supply may result in the need for development of new water projects to replace the lost surface water supply. Usually, the investment and costs in new projects are passed to customer in the form of increased water rates. This increase in rates may result in a reduction in personal disposable income. Conversely, restriction in exports and the associated decrease in surface water supply may result in a net gain in power generation. Usually, this surplus of power generation is translated as a decrease in power rates for customers. This decrease in rates may result in an increase in personal disposable income. However, if groundwater pumping is increased to supplant the lost surface water supply, then the net gain in power generation may not materialize, and the associated expected decrease in rates for power customers may not occur. Alternative 2B is not expected to result in meaningful changes to commercially important fisheries, when compared to Alternative 2.

In addition to the more restrictive QWEST criteria, Alternative 2B includes an extension of the CCF operation period to December 1 through March 31 from mid-December through mid-March, effectively increasing the operation of the SWP by one month. This extended operation would result in an increase of surface water supply, which may translate into a decrease in rates for water customers. This decrease in water rates may result in an increase in personal disposable income for water customer. On the other hand, this extended operation of CCF would result in an increase of power consumption from this SWP facility and the need to purchase additional power. Purchasing additional power may translate into increased rates for power customers, thereby resulting in a decrease in personal disposable income.

Another scenario that may manifest with the extension in the operation of the CCF is more frequently exceeding seasonal and weekly salvage thresholds that may not have otherwise been exceeded. Exceeding these thresholds would result in additional export restrictions. In this case, effects would be similar to those adverse and beneficial impacts described above for export restrictions under Alternative 2B QWEST criteria.

14.3 Mitigation Measures

No avoidance and minimization measures or additional mitigation measures have been identified for Regional Economics.

14.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and may result in changes to the regional economy in the Sacramento River, San Joaquin River, San Francisco Bay, Central Coast, and South Coast regions. The action alternatives would have varying effects on economic output, employment, and labor income. The magnitude of the changes is dependent on alternative and water year type. Given the changes in regional economic conditions, the No Action Alternative and action alternatives may contribute to cumulative changes to Regional Economic resources as described in Appendix Q, *Regional Economics* and Appendix Y, *Cumulative Impacts*.

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Chapter 15 Land Use and Agricultural Resources

This chapter is based on the background information and technical analysis documented in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, which includes additional information on land use and agricultural resource conditions and technical analysis of the effects of each alternative.

15.1 Affected Environment

The description of the affected environment is presented at the county-level for agricultural and municipal and industrial (M&I) land uses. In addition, an overview of agricultural resources is provided.

15.1.1 Land Use

An extensive range of land uses are within this study area. These include forestry, agriculture, water, urban (including industrial, commercial, and residential), rural residential, parks and recreation, and public open spaces.

15.1.1.1 Agricultural Resources

Crop production practices vary by crop and locational differences such as soil, slope, local climate, and water source and reliability. Production practices discussed in this subsection include:

- Crop rotation and fallowing
- Crop water use
- Crop irrigation methods
- Crop responses to water quality
- Crop drainage methods
- Crop adaptation to changes in water supply availability

15.2 Effects of the Alternatives

The impact analysis considers changes in land use and agriculture related to changes in CVP and SWP operation under the alternatives as compared with the No Action Alternative.

The No Action Alternative is based on 2040 conditions. Changes that would occur over that time frame without implementation of the action alternatives are not analyzed in this chapter. However, the changes to land use and agriculture that are assumed to occur by 2040 under the No Action Alternative are summarized in this section.

Conditions in 2040 would be different than existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

In the long term, it is anticipated that climate change, and development throughout California, could affect water supply deliveries.

Under the No Action Alternative, Reclamation would continue with the current operation of the Central Valley Project (CVP), as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the State Water Project (SWP) represent current management direction or intensity pursuant to 43 CFR Section 46.30.

Although the No Action Alternative included habitat restoration projects at a programmatic level, the 2020 ROD did not provide environmental coverage for these projects, and all of the habitat projects considered under the No Action required or will require additional environmental documentation. Thus, ground disturbance for habitat restoration projects did not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

The No Action Alternative, thus, is expected to result in potential changes in land use. These changes were described and considered in the 2020 Record of Decision.

Action alternatives could change the extent of irrigated acreage and total production value over the long-term average condition and in dry and critical dry years compared to the No Action Alternative. The impact analysis compares the typical changes that would occur between alternatives by 2040.

Both the land use and agricultural resources analyses rely in part on modeling of water deliveries as projected by CalSim 3. CalSim 3 is the model used to simulate CVP and SWP operations and much of the water resources infrastructure in the Central Valley and the Delta region (California Department of Water Resources 2023). CalSim 3 model output includes minor fluctuations of up to 5% due to model assumptions and approaches. Therefore, if quantitative changes between a specific alternative and the No Action Alternative are less than 5%, conditions under the specific alternative would be considered to be “similar” to conditions under the No Action Alternative.

The California Water Economics Spreadsheet Tool (CWEST) model was used to evaluate M&I water demands of CVP and SWP water users in the Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions.

For impacts within the area modeled, agricultural impacts were evaluated using both CalSim 3 and a regional agricultural production model developed for large-scale analysis of irrigation water supply and cost changes. The Statewide Agricultural Production (SWAP) model is a regional model of irrigated agricultural production and economics that simulates the decisions of producers (farmers) in 27 agricultural subregions in the Central Valley, as described in Appendix Q, Attachment 3, *Statewide Agricultural Production (SWAP) Model Documentation*.

15.2.1 Potential Changes in Land Use

As shown in Table 15-1, M&I water deliveries would increase for the Sacramento River region under Alternative 2 Without TUCP Delta VA and Alternative 2 Without TUCP Systemwide VA, and the Central Coast and Southern California regions would increase compared to the No Action Alternative under Alternative 1, Alternative 2 With TUCP Without VA, and Alternative 4. M&I water deliveries in the San Joaquin River region and the San Francisco Bay Area region would increase under Alternative 1. Alternative 3 would result in decreases in M&I water deliveries in the San Joaquin River, San Francisco Bay Area, Central Coast, and Southern California regions. As shown in Table 15-2, M&I deliveries would be like those under the long-term average condition, with the exception of Alternative 2 which would see slight increases or no changes in deliveries across different regions.

Under the alternatives that would see increases or no change in M&I deliveries compared to the No Action Alternative, local jurisdictions would have adequate water supply available to implement their general plans, and there would be no changes in land use. Table 15-3, shows the average annual CVP and SWP deliveries for each region and the associated average annual cost in thousands of dollars.

Table 15-1. Change in CalSim 3 Water Deliveries by Region and Type, Long-Term Average [a,b]

Regions Modeled	Water Delivery Type	Percent Change [c]						
		Alternative 1	Alt2woTUCP DeltaVA	Alt2woTUCP woVA	Alt2woTUCP AllVA	Alt2wTUCP woVA	Alternative 3	Alternative 4
Sacramento River	M&I	1%	**7%**	0%	**5%**	0%	-4%	0%
	Agriculture	2%	-4%	-4%	-4%	-3%	**-12%**	-1%
San Joaquin River [d]	M&I	**31%**	1%	2%	1%	2%	**-50%**	4%
	Agriculture	**21%**	**-6%**	-1%	-6%	-1%	**-63%**	1%
San Francisco Bay Area	M&I	**10%**	1%	2%	2%	1%	**-25%**	1%
	Agriculture	**12%**	**-7%**	**-5%**	**-5%**	**-5%**	**-72%**	-2%
Central Coast	M&I	**28%**	3%	3%	3%	**6%**	**-53%**	**6%**
	Agriculture	-	-	-	-	-	-	-
Southern California	M&I	**37%**	3%	4%	3%	**5%**	**-54%**	**5%**
	Agriculture	**43%**	0%	0%	0%	0%	**-57%**	0%

[a] The totals do not include deliveries for CVP Settlement/Exchange or SWP Feather River Service Area
[b] Long Term is the average quantity for the period of Oct 1921 - Sep 2021; simulated at 2022 Median climate.
[c] CalSim 3 model output includes minor fluctuations of up to 5% due to model assumptions and approaches. Changes less than 5% are considered “similar” to conditions under the No Action Alternative.
[d] Does not include Friant-Kern Canal or Madera Canal water users.
Alt2woTUCPDeltaVA= Alternative 2 Without TUCP Delta VA
Alt2woTUCPwoVA= Alternative 2 Without TUCP Without VA
Alt2woTUCPAllVA= Alternative 2 Without TUCP Systemwide VA
Alt2wTUCPwoVA= Alternative 2 With TUCP Without VA
M&I= Municipal and Industrial

Table 15-2. Change in CalSim 3 Water Deliveries by Region and Type, Dry and Critical Average [a,b]

Regions Modeled	Water Delivery Type	Percent Change [c]						
		Alternative 1	Alt2woTUCP DeltaVA	Alt2woTUCP woVA	Alt2woTUCP AllVA	Alt2wTUCP woVA	Alternative 3	Alternative 4
Sacramento River	M&I	0%	**6%**	0%	0%	-1%	**-6%**	-1%
	Agriculture	**6%**	**-11%**	**-12%**	**-11%**	**-11%**	**-30%**	**-6%**
San Joaquin River [d]	M&I	**38%**	-2%	0%	-2%	0%	**-51%**	2%
	Agriculture	**38%**	**-12%**	**-6%**	**-11%**	**-9%**	**-65%**	-3%
San Francisco Bay Area	M&I	**10%**	2%	2%	3%	0%	**-20%**	1%
	Agriculture	**41%**	**-12%**	**-12%**	**-12%**	**-18%**	**-82%**	**-12%**
Central Coast	M&I	**45%**	**5%**	**5%**	**5%**	**5%**	**-55%**	**5%**
	Agriculture	-	-	-	-	-	-	-
Southern California	M&I	**46%**	2%	1%	2%	**3%**	**-55%**	**6%**
	Agriculture	**67%**	0%	0%	0%	0%	**-33%**	0%

[a] The totals do not include deliveries for CVP Settlement/Exchange or SWP Feather River Service Area

[b] Dry and Critical Years Average is the average quantity for the combination of the SWRCB D-1641 40-30-30 Dry and Critical Dry years for the period of Oct 1921 - Sep 2021; simulated at 2022 Median climate.

[c] CalSim 3 model output includes minor fluctuations of up to 5% due to model assumptions and approaches. Changes less than 5% are considered “similar” to conditions under the No Action Alternative.

[d] Does not include Friant-Kern Canal or Madera Canal water users.

Alt2woTUCPDeltaVA= Alternative 2 Without TUCP Delta VA
Alt2woTUCPwoVA= Alternative 2 Without TUCP Without VA
Alt2woTUCPAllVA= Alternative 2 Without TUCP Systemwide VA
Alt2wTUCPwoVA= Alternative 2 With TUCP Without VA
M&I= Municipal and Industrial

Table 15-3. Differences in Water Supply and Costs Between the No Action Alternative and All Alternatives

Regions Modeled	Alternative 1		Alt2woTUCPDeltaVA		Alt2woTUCPwoVA		Alt2woTUCPAllVA	
	Average Annual CVP/SWP Deliveries (TAF)	**Average Annual Cost ($1,000) [a]**	**Average Annual CVP/SWP Deliveries (TAF)**	**Average Annual Cost ($1,000) [a]**	**Average Annual CVP/SWP Deliveries (TAF)**	**Average Annual Cost ($1,000) [a]**	**Average Annual CVP/SWP Deliveries (TAF)**	**Average Annual Cost ($1,000) [a]**
Sacramento Valley	0.1	578	9.8	-4,184	0	-873	6.2	-1,520
San Joaquin	27.6	-11,596	1.2	-3,493	2.4	-3,807	1.4	-3,540
San Francisco Bay Area	43.3	-35,280	6.1	-8,160	5.9	-7,807	7.1	-9,131
Central Coast	9.6	-2,198	1.4	-311	1.4	-316	1.3	-294
Southern California	467.8	-336,646	43.7	-1,955	53.1	33,190	43.4	-747
Total	**548.3**	**-355,865**	**62.2**	**-18,103**	**62.8**	**20,387**	**59.5**	**-15,232**

[a] Benefits are shown as negative costs.
Alt2woTUCPDeltaVA= Alternative 2 Without TUCP Delta VA
Alt2woTUCPwoVA= Alternative 2 Without TUCP Without VA
Alt2woTUCPAllVA= Alternative 2 Without TUCP Systemwide VA
CVP= Central Valley Project
SWP= State Water Project
TAF= Thousand-acre feet

Table 15-4. Differences in Water Supply and Costs Between the No Action Alternative and All Alternatives (continued)

Regions Modeled	Alt2wTUCPwoVA		Alternative 3		Alternative 4	
	Average Annual CVP/SWP Deliveries (TAF)	Average Annual Cost ($1,000) [a]	Average Annual CVP/SWP Deliveries (TAF)	Average Annual Cost ($1,000) [a]	Average Annual CVP/SWP Deliveries (TAF)	Average Annual Cost ($1,000) [a]
Sacramento Valley	-0.3	-309	-15.6	7,903	-0.4	67
San Joaquin	2.7	-2,460	-54.2	16,108	3.3	-2,615
San Francisco Bay Area	3.1	3,074	-115.4	35,548	4	2,925
Central Coast	1.6	-360	-18.9	4,286	1.6	-370
Southern California	64.3	-19,106	-736.1	1,098,094	66.6	-50,233
Total	**71.5**	**-19,161**	**-940.1**	**1,161,939**	**75.2**	**-50,227**

[a] Benefits are shown as negative costs.
Alt2wTUCPwoVA= Alternative 2 With TUCP Without VA
CVP= Central Valley Project
SWP= State Water Project
TAF= Thousand-acre feet

As shown in Table 15-3, annual average deliveries would increase across Alternatives 2 and 4 and more significantly under Alternative 1 compared to the No Action Alternative, which would correspond to reduced average annual costs. Alternative 3 would see a reduction in deliveries compared to the No Action Alternative and an increase in average annual costs. Regions that experience increases in deliveries and reductions in annual costs would be expected to have adequate water supply available to implement their general plans, and there would be no changes in land use. Regions that experience an increase in average annual costs may have a difficult time affording alternative water sources to supplement reduced deliveries. Under Alternative 3, local jurisdictions may be unable to implement their general plans which could result in changes to land use. Implementation of Mitigation Measure AG-1 described in Section 15.3, Mitigation Measures, could reduce effects by encouraging water agencies to diversify their water portfolios, thus increasing likelihood that water users would have adequate water and land use and development in the regions would continue as projected by general plans.

15.2.2 Potential Changes in Irrigated Agricultural Acreage

As shown in Table 15-1 and Table 15-2, agricultural water deliveries would increase under Alternative 1, resulting in no conversion of agricultural land to non-agricultural use. Alternative 2 would result in slight decreases in agricultural water deliveries in the San Francisco Bay Area region compared to the No Action Alternative. Agricultural water deliveries under Alternative 3 would significantly decrease across all regions compared to the No Action Alternative, which could result in the conversion of agricultural land to non-agricultural use. Implementation of Mitigation Measure AG-1 could reduce some of the anticipated conversion of agricultural land.

Figure 15-1 and Figure 15-2 present the long-term average annual change in irrigated acreage for each action alternative compared to the No Action Alternative. These figures also depict the dry water year condition, respectively, under Year 2040 conditions. Irrigated crop acreage as modeled by SWAP would increase under Alternative 1 in the Sacramento River and San Joaquin River regions under the long-term average and dry water year conditions. Therefore, there would be no conversion of agricultural land to nonagricultural use. Alternative 4 would see an increase in irrigated acres in the two regions under the long-term average condition but would decrease under dry water year condition. Under Alternatives 2 and 3, there would be decreases in irrigated acres in both regions under both the long-term average and dry conditions compared to the No Action Alternative. These decreases would result in the conversion of agricultural land to nonagricultural uses. The conversion of land could be reduced by implementing Mitigation Measure AG-1.

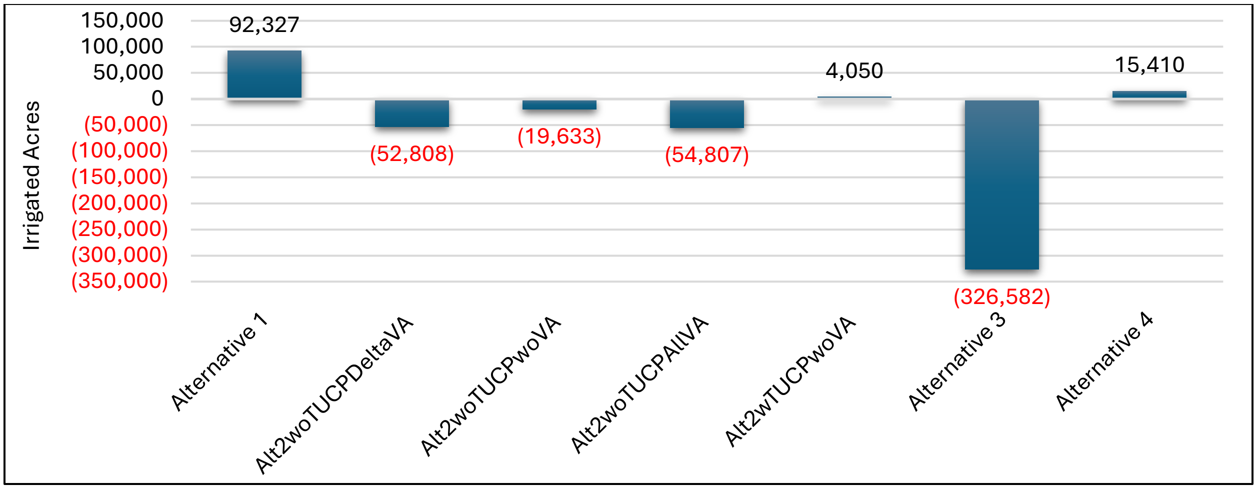

Figure 15-1. Annual Change in Irrigated Acres from No Action Alternative - Long-Term Average Water Year Condition

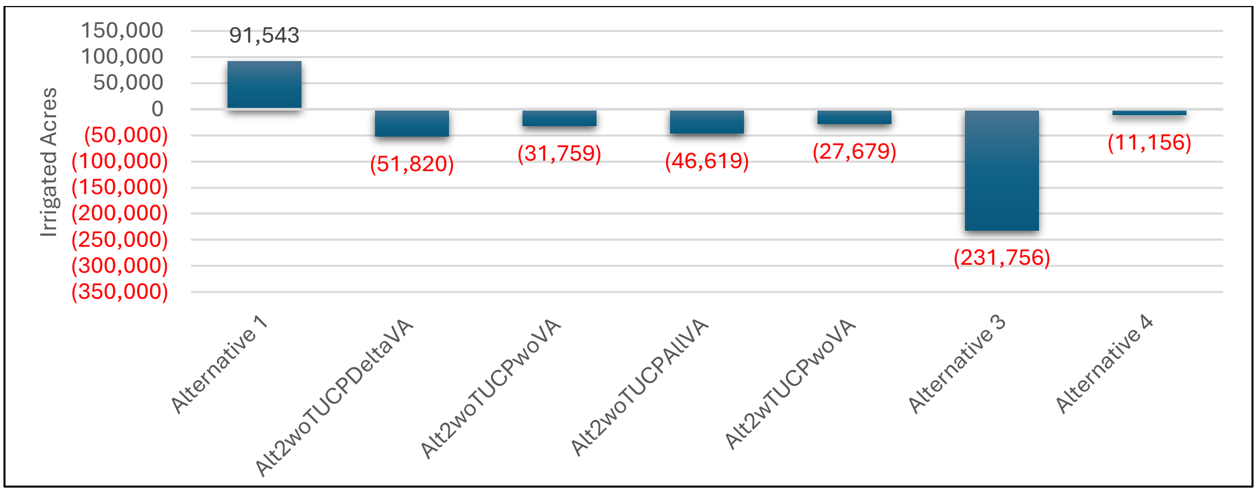

Figure 15-2. Annual Change in Irrigated Acres from No Action Alternative - Dry Water Year Condition

15.2.2.1 Alternative 2B

Analysis of Alternative 2B, although qualitative, builds on the quantitative analysis provided for Alternative 2. Only components under Alternative 2B that are expected to result in land use concerns compared to Alternative 2 are discussed.

Alternative 2b is anticipated to be more restrictive on Delta exports than Alternative 2 and the No Action Alternative. Please see *Chapter 5 Water Supply* for a description of the restrictions associated with the QWEST criteria under Alternative 2B. These restriction in exports may result in a reduction in water supply and, thus, potentially increase land that is taken out of agricultural production. Although, taking agricultural land out of production during a specific year may not necessarily mean that the land use will permanently shift from agricultural uses to other uses, it does increase the potential that eventually that land will be converted to other uses. This impact may be decreased if other sources of water, including groundwater, are used to make up for the decrease in surface water supply.

In addition to the more restrictive QWEST criteria, Alternative 2B includes an extension of the CCF operation period to December 1 through March 31 from mid-December through mid-March, effectively increasing the operation of the SWP by one month. This extended operation may increase water supply, potentially reducing the potential of agricultural land taken out of production for the SWP. Conversely, this extension in the operation of the CCF may result in more frequently exceeding seasonal and weekly salvage thresholds that may not have otherwise been exceeded. Exceeding these thresholds would result in additional export restrictions, that may be translated into a reduction in water supply, potentially increasing land that is taken out of agricultural production for the CVP as well as the SWP. This impact may be decreased if other sources of water, including groundwater, are used to make up for the decrease in surface water supply.

15.2.2.2 Alternative 4B

Alternative 4B is expected to be within the range of effects for land use and agriculture described for Alternatives 4.

15.3 Mitigation Measures

Appendix D includes a detailed description of mitigation measures identified for land use and agricultural resources per alternative. These mitigation measures include avoidance and minimization measures that are part of each alternative and, where appropriate, additional mitigation to lessen impacts of the alternatives. For land use and agricultural resources, no avoidance and minimization measures have been identified. Additional mitigation measures have been identified for land use and agricultural resources.

15.3.1 Avoidance and Minimization Measures

15.3.1.1 Alternatives 1-4

No avoidance and minimization measures have been identified.

15.3.2 Additional Mitigation

15.3.2.1 Alternatives 1-4

Alternatives 1 through 4 could reduce agricultural land. The mitigation measure below relies on entities other than Reclamation to implement the measures. Because Reclamation does not have authority to implement this measure, Reclamation cannot ensure that it will be implemented.

- *Mitigation Measure AG-1: Diversify Water Portfolios* – could be implemented to reduce impacts on agricultural land

15.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and may result in potential changes in land use and irrigated agricultural acreage. The action alternatives may result in changes to land use and irrigated agricultural acreage. The magnitude of the changes is dependent on alternative and water year type. Therefore, the No Action Alternative and action alternatives may contribute to cumulative changes to land use resources as described in Appendix R, *Land Use,* and Appendix Y, *Cumulative Impacts.*

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Chapter 16 Recreation

This chapter is based on the background information and technical analysis documented in Appendix S, *Recreation Technical Appendix*, which includes additional information on recreation conditions and technical analysis of the effects of each alternative.

16.1 Affected Environment

16.1.1 Trinity River

The Trinity River Region includes Trinity Reservoir, the Lewiston Reservoir, and the area along the Trinity River connecting the two. Many recreational opportunities occur in the Trinity River Region, including motorized and non-motorized boating, camping, and day use activities such as wildlife viewing, hiking, swimming, picnicking, and fishing.

16.1.2 Sacramento River

Recreational opportunities in the Sacramento Valley upstream of the Sacramento-San Joaquin Delta (Delta) that are influenced by the long-term operation of CVP and SWP occur at Shasta Reservoir; Keswick Reservoir; Whiskeytown Reservoir; Sacramento River, between Keswick Dam and the Delta; Folsom Reservoir and Lake Natoma; American River, between Nimbus Dam and the Sacramento River; and wildlife refuges that use CVP water supplies. Boating, waterskiing, other water sports, and fishing occur, as well as camping, hiking and wildlife viewing some locations.

16.1.3 Clear Creek

The initial reaches of Clear Creek downstream of Whiskeytown Dam are located within the Whiskeytown-Shasta-Trinity NRA. The remaining portions of Clear Creek flow to the Sacramento River through lands owned by BLM and private owners. All these reaches are located within Shasta County and the easternmost reaches are within Redding. Hiking, picnicking, kayaking, swimming, fishing, and gold panning occur along lower Clear Creek (Sacramento River Watershed Project 2023a). The Clear Creek Greenway includes 10 trails and eight picnic areas (Bureau of Land Management n.d.). Hunting is allowed in the Swasey and Muletown Road areas of the Clear Creek Greenway. Fishing opportunities include steelhead, Chinook salmon, carp, suckers, bluegill, bass, and Sacramento pikeminnow (Sacramento River Watershed Project 2023b).

16.1.4 Stanislaus River

New Melones Reservoir and Tulloch Reservoir on the Stanislaus River and the lower Stanislaus River are located within areas in the Stanislaus River watershed that could be affected by changes in CVP operations. Water-related recreational activities include boating, waterskiing, camping, picnicking, wildlife viewing, spelunking, rock climbing, gold panning, and fishing (Bureau of Reclamation 2010a).

16.1.5 San Joaquin River

Recreational opportunities along the San Joaquin River are located at Millerton Reservoir, which include boating, sailing, waterskiing, jet skiing, swimming, tournament and recreational fishing, camping, and picnicking. Along portions of the San Joaquin River from Friant Dam to the Delta, water-related recreational activities include boating, canoeing, kayaking, whitewater rafting, and fishing (Bureau of Reclamation and California Department of Water Resources 2011). Camping, picnicking, and hunting are also available. Access and facilities for these activities are available at several locations along and adjacent to the San Joaquin River. Between Friant Dam and the confluence with the Merced River, beginner-level whitewater rafting occurs between Friant Dam and Skaggs Bridge Park at State Route 145 (American Whitewater 2023). Refuges in the San Joaquin Valley that rely on CVP water supplies offer activities including wildlife viewing and hunting. Hunting opportunities include waterfowl and pheasant. Wildlife viewing opportunities include waterfowl, shorebirds, upland birds and songbirds, birds of prey, and aquatic and terrestrial mammals (Bureau of Reclamation and California Department of Water Resources 2011).

16.1.6 Bay-Delta Operations

The Delta is located at the terminus of the Sacramento River and the San Joaquin River. The primary recreational activities in the Delta are related to boating, wildlife viewing, hunting, and fishing. Recreational opportunities in the Bay-Delta region vary depending on CVP and SWP water facility operations (Delta Protection Commission 2012a). Public recreation facilities are limited within the Delta. Most recreational opportunities are provided by private enterprises, including marinas, restaurants, hunting venues, and wineries and farm visits.

16.1.7 Nearshore Pacific Ocean on the California Coast

Recreational fishing along California's coast is included in the analysis because changes in CVP and SWP operations could affect fish populations. Chinook salmon, coho salmon (*Oncorhynchus kisutch*), and steelhead are the primary recreational fish species found along the Pacific Coast of Northern California that could be affected by changes in CVP and SWP operations. Pacific salmon fisheries are managed by the Pacific Fishery Management Council (PFMC) from 3 to 200 nautical miles offshore (Pacific Fishery Management Council 2019). Along the California coast, salmon fisheries are managed by the CDFW from 0 to 3 nautical miles offshore with regulations that are generally similar to those applied by the PFMC. The PFMC analyzes the status of the fisheries each year and defines the length of the fishing season and minimum fish sizes allowed to be caught for commercial, recreational, and tribal salmon fishing activities.

16.2 Effects of the Alternatives

The impact analysis considers changes in recreation related to changes in CVP and SWP operation under the alternatives as compared with the No Action Alternative.

The No Action Alternative is based on 2040 conditions. The changes to recreational resources that are assumed to occur by 2040 under the No Action Alternative conditions would be different than existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

Under the No Action Alternative, Reclamation would continue with the current operation of the Central Valley Project (CVP), as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the State Water Project represent current management direction or intensity pursuant to 43 Code of Federal Regulations Section 46.30.

Although the No Action Alternative included habitat restoration projects at a programmatic level, the 2020 ROD did not provide environmental coverage for these projects, and all of the habitat projects considered under the No Action required or will require additional environmental documentation. Thus, ground disturbance for habitat restoration projects did not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

Under the No Action Alternative, land uses in 2040 would occur in accordance with adopted general plans, which could also result in impacts on water quality. In terms of CVP operations, under the No Action Alternative, by the end of September, the surface water elevations at CVP reservoirs generally decline, which could reduce recreation opportunities. It is anticipated that climate change would result in more short-duration high-rainfall events and less snowpack in the winter and early spring months. As water is released in the spring, there would be less snowpack to refill the reservoirs. This condition would reduce flow within streams, potentially resulting in less recreation opportunities.

The No Action Alternative, thus, is expected to result in potential changes to recreational resources caused by changes in average water elevations, river flows, and seasonal fluctuations. These changes were described and considered in the 2020 Record of Decision.

Alternatives 2B and 4B are expected to be within the range of effects for recreation resources described below for Alternatives 2 and 4, respectively.

16.2.1 Potential changes in recreational resources

For the purposes of this analysis, the changes in operations and flows are linked to changes in recreational resources. The evaluation of impacts on recreational activities (boating, camping, day use, and fishing access and opportunities) caused by changes in average water elevations, river flows, and seasonal fluctuations is based on the potential for each alternative to affect recreational resources.

The action alternatives would change river flows and reservoir levels. If river flows have substantive declines or increases in areas with recreational opportunities, those changes could limit available opportunities (including potential impacts on boating, camping, and day use activities). For example, higher flows could inundate beach areas or lower flows could reduce boating or rafting opportunities. Additionally, lower reservoir levels during the summer recreation season could reduce boating opportunities because boat ramps may no longer be inundated and the areas for recreation would be smaller. This in turn could reduce desirability of other associated recreational opportunities, such as use of camping sites and day use areas. Changes in water deliveries to wildlife refuges could impact the availability of wildlife viewing and hunting, including the duration when public access is allowed, and the scale of public access.

Currently, seasonal low water levels affect campgrounds located near shorelines by increasing the distance between the shoreline and the campsites. Whitewater rafting on the Sacramento, Stanislaus, San Joaquin Rivers would continue to be affected by seasonal fluctuations caused by current CVP and SWP operations.

Alternatives 1 through 4 are anticipated to change the water levels in reservoirs. Figure 16-1, *Shasta Reservoir Long-Term Average Water Level Elevation* shows changes in Shasta Reservoir water elevations as an example; other reservoirs show similar patterns of elevations compared to the No Action Alternative. In most cases, reservoirs have only small changes and alternatives would not substantively affect recreation in these facilities. River flows would generally have only small changes during the recreation season (for example, see Figure 16-2, Sacramento Long-Term Average Flow Downstream of Keswick Reservoir). The flow changes are relatively small during each year type and would not result in substantive changes to the available recreational opportunities.

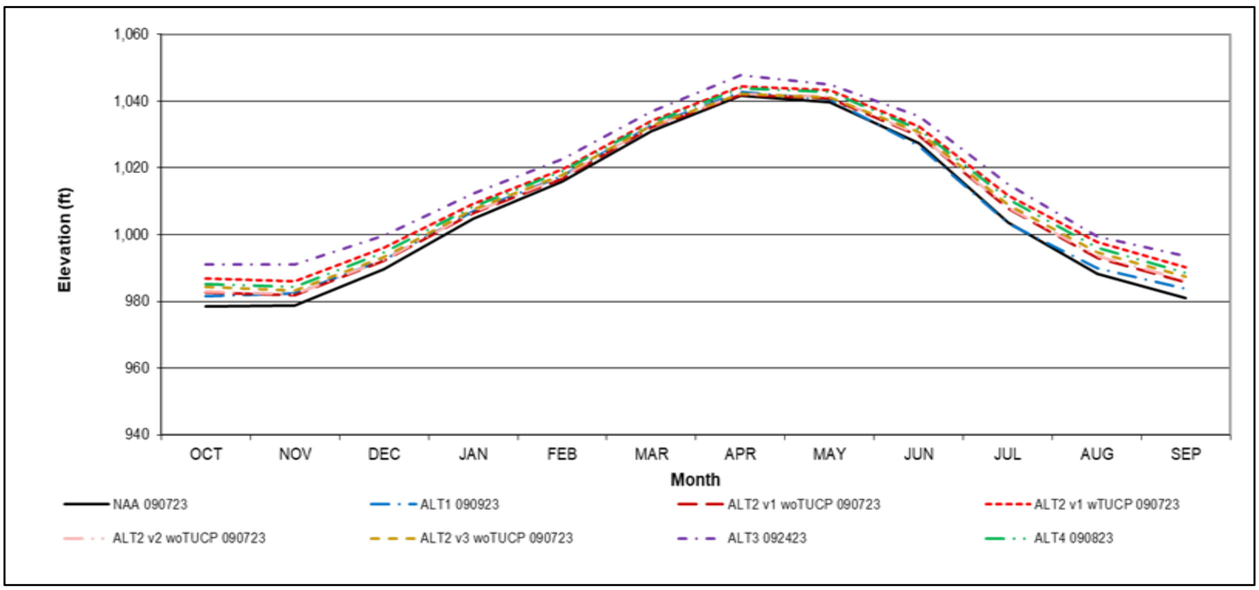

Figure 16-1. Shasta Reservoir Long-Term Average Water Level Elevation

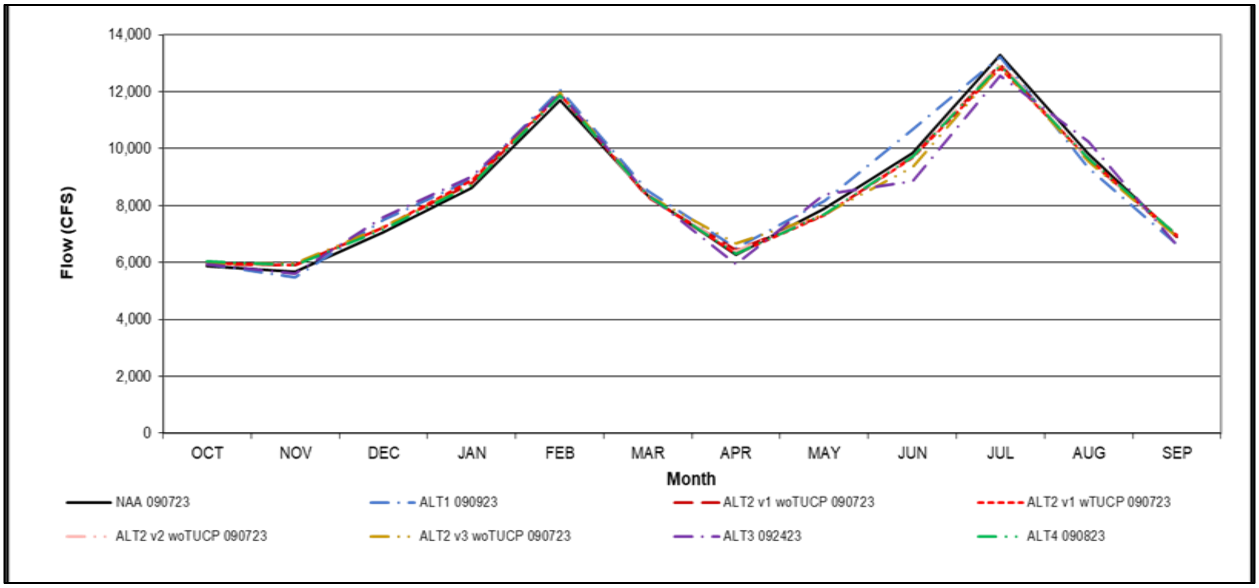

Figure 16-2. Sacramento River Long-Term Average Flow Downstream of Keswick Reservoir

Each alternative has the potential to cause effects on boating, camping, day use, and/or fishing on several recreational locations within the CVP and SWP project areas when compared to the No Action Alternative. The effects can be beneficial or adverse, depending on the time of year and water year type. There may be several locations where there is no effect from the alternatives.

Under Alternative 1 potential benefits on boating, camping, day use, and/or fishing could occur at Sacramento River (in the spring and summer), Folsom Reservoir, the American River Parkway (in the spring and summer, particularly for water activities), Stanislaus River (in the spring, for fishing), San Luis Reservoir, and recreational fishing in the Nearshore Pacific Ocean on the California Coast. Under Alternative 1 potential minor adverse impacts on boating, camping, day use, and/or fishing could occur at the Sacramento River (in the fall), Clear Creek (year-round), and Lake Del Valle (November).

Under Alternative 2 potential benefits on boating, camping, day use, and/or fishing could occur at Shasta Reservoir, Clear Creek (winter through spring), Lake Natoma, the Bay-Delta Area, and San Luis Reservoir. Under Alternative 2 potential minor adverse impacts on boating, camping, day use, and/or fishing could occur at Clear Creek (spring through fall), and the lower Stanislaus River (spring). None of the Alternative 2 phases differ greatly from the No Action Alternative but the Alternative 2 without TUCP with systemwide VAs is the only alternative that is modeled to increase Chinook salmon, potentially benefiting recreational fisheries, of all the Alternative 2 phases. The other three phases decrease salmon abundance available relative to the No Action Alternative, but the decrease is likely negligible.

Under Alternative 3 potential minor benefits to boating, camping, day use, and/or fishing would occur at Shasta Reservoir, Clear Creek (winter through spring), American River (spring), and the Bay-Delta Area. Alternative 3 would benefit recreational fishing in the Nearshore Pacific Ocean on the California Coast. Under Alternative 3 potential minor, adverse impacts boating, camping, day use, and/or fishing would occur at Sacramento River; Clear Creek (summer through fall); Folsom Reservoir, Lake Natoma and the American River Parkway (summer); and San Luis Reservoir.

Under Alternative 4 potential minor benefits to boating, camping, day use, and/or fishing would occur at Shasta Reservoir, Clear Creek (winter through spring), and San Luis Reservoir. There would be negligible change to recreational fishing in the Nearshore Pacific Ocean on the California Coast. Under Alternative 4 potential minor adverse effects on boating, camping, day use, and/or fishing would occur at Clear Creek (summer through fall), and lower Stanislaus River (spring).

16.3 Mitigation Measures

Appendix D includes a detailed description of mitigation measures identified for recreation resources per alternative. These mitigation measures include avoidance and minimization measures that are part of each alternative and, where appropriate, additional mitigation to lessen impacts of the alternatives. For recreation resources, no avoidance and minimization measures have been identified. Additional mitigation measures have been identified for recreation resources.

16.3.1 Avoidance and Minimization Measures

16.3.1.1 Alternatives 1-4

No avoidance and minimization measures have been identified.

16.3.2 Additional Mitigation

16.3.2.1 Alternatives 1-4

Alternatives 1 through 4 could affect recreational opportunities compared with the No Action Alternative

- *Mitigation Measure REC-1: Update Public Information on Changing Recreation Conditions* – could be implemented to reduce impacts

16.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and may result in potential changes in recreational opportunities at reservoirs that store CVP water and fluctuating flows in rivers and tributaries in the action area. The action alternatives will result in changes to recreational opportunities at reservoirs that store CVP water and fluctuating river and tributary flows. The magnitude of the changes is dependent on alternative and water year type. Therefore, the No Action Alternative and action alternatives may potentially contribute to cumulative changes to recreational resources as described in Appendix S, *Recreation* and Appendix Y, *Cumulative Impacts Technical Appendix*.

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Chapter 17 Environmental Justice

This chapter is based on the background information and technical analysis documented in Appendix T, *Environmental Justice Technical Appendix*, which includes additional information on environmental justice conditions and technical analysis of the effects of each alternative.

17.1 Affected Environment

In most portions of the study area, the availability of Central Valley Project (CVP) and State Water Project (SWP) water supplies directly or indirectly affects most of the population within a county. Therefore, the entire population of each county within the study area is considered to determine whether minority or low-income areas could be affected by the implementation of the alternatives.

The availability of CVP and SWP water supplies also affects agricultural productivity and employment. The majority of crop workers in California are Spanish-speaking (approximately 92%) and are immigrants (approximately 90%) (Cha and Collins 2022).

17.1.1 Trinity River

The Trinity River Region includes Del Norte, Humboldt, and Trinity counties.

17.1.1.1 Minority Populations

As recorded in the U.S. Census Bureau 2017–2021 American Community Survey (ACS) five-year population estimate, the Trinity River Region had a total population of 180,487 (U.S. Census Bureau 2023a). About 29% of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race. Minority populations accounted for less than 50% of each county's total population, and of the total Trinity River Region population; thus, these counties do not meet the criteria for minority populations under CEQ guidance.

17.1.1.2 Poverty Levels

According to the U.S. Census Bureau, 20.0% of the population in the Trinity River region was below the poverty level (2023b). The U.S. Census Bureau defines geographical areas with more than 20% of the population below the poverty level as "poverty areas"; thus, Humboldt and Trinity counties are defined as "poverty areas" and are subject to environmental justice evaluations.

17.1.2 Sacramento Valley Region

The Sacramento Valley Region includes Butte, Colusa, El Dorado, Glenn, Nevada, Placer, Plumas, Sacramento, Shasta, Sutter, Tehama, Yolo, and Yuba Counties. Solano County is also located within the Sacramento Valley; however, Solano County is discussed below as part of the San Francisco Bay Area Region.

17.1.2.1 Minority Populations

According to the 2021 ACS five-year dataset, the Sacramento Valley Region had a total population of 3,196,192 in 2021 (U.S. Census Bureau 2023a). Approximately 45% of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race. Although the minority population in the region as a whole accounted for less than 50% of the total region population, minority populations accounted for 50% or more of the total county population in Colusa, Sacramento, Sutter, and Yolo counties. Thus, these counties are further evaluated for environmental justice impacts.

17.1.2.2 Poverty Levels

According to the U.S. Census Bureau, 12.9% of the population in the Sacramento Valley Region was below the poverty level (2023b). Neither the region as a whole nor any of the counties within it are considered "poverty areas."

17.1.3 San Joaquin Valley Region

The San Joaquin Valley Region includes Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare Counties.

17.1.3.1 Minority Populations

The San Joaquin Valley Region had a total population of 4,289,382 in 2021 (U.S. Census Bureau 2023a). About 69% of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race. Minority populations accounted for 50% or more of the total county populations in all San Joaquin Valley Region counties. Thus, all counties in this region are further evaluated for environmental justice impacts.

17.1.3.2 Poverty Levels

According to the U.S. Census Bureau, 17.7% of the San Joaquin Valley Region population was below the poverty level (2023b). Because the population below the poverty level in Fresno County exceeds 20% of the total population, Fresno County is considered a "poverty area" and is further evaluated for environmental justice impacts.

17.1.4 San Francisco Bay Area Region

The San Francisco Bay Area Region includes Alameda, Contra Costa, Napa, San Benito, Santa Clara, and Solano counties that are within the CVP and SWP service areas.

17.1.4.1 Minority Populations

The San Francisco Bay Area Region had a total population of 5,420,354 in 2021 (U.S. Census Bureau 2023a). About 67% of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race. Minority populations accounted for 50% or more of the total populations in Alameda, Contra Costa, San Benito, Santa Clara, and Solano counties. Thus, these counties are further evaluated for environmental justice impacts.

17.1.4.2 Poverty Levels

According to the U.S. Census Bureau, 7.9% of the San Francisco Bay Area Region population was below the poverty level (2023b). None of the counties in the San Francisco Bay Area Region are defined as "poverty areas."

17.1.5 Central Coast Region

The Central Coast Region includes San Luis Obispo and Santa Barbara Counties, portions of which are served by the SWP.

17.1.5.1 Minority Populations

The Central Coast Region had a total population of 730,422 in 2021 (U.S. Census Bureau 2023a). 47.6% of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race. Minority populations accounted for 50% or more of the total population of Santa Barbara County; thus, Santa Barbara County is further evaluated for environmental justice impacts.

17.1.5.2 Poverty Levels

According to the U.S. Census Bureau, 12.9% of the Central Coast Region population was below the poverty level (2023b). None of the counties in the Central Coast Region are considered "poverty areas."

17.1.6 South Coast Region

The South Coast Region includes Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura Counties, portions of which are served by the SWP.

17.1.6.1 Minority Populations

The South Coast Region had a total population of 21,924,532 in 2021 (U.S. Census Bureau 2023a). About 68% of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race. Minority populations accounted for 50% or more of the total county populations in all six counties of this region. Thus, all counties within the South Coast Region are further evaluated for environmental justice impacts.

17.1.6.2 Poverty Levels

According to the U.S. Census Bureau, 12.5% of the South Coast Region population was below the poverty level (2023b). None of the counties in the South Coast Region are considered "poverty areas."

17.2 Effects of the Alternatives

The impact analysis considers changes in environmental justice related to changes in CVP and SWP operation under the alternatives as compared with the No Action Alternative.

For the purposes of this analysis, the changes in operations and flows are linked to changes in environmental justice conditions because they are related to water supply which directly or indirectly affects most of the population within a county. Changes in water supply under the No Action Alternative could affect the availability of jobs associated with agriculture and M&I water supplies and groundwater resources. The analysis is focused on the alternatives' potential for causing disproportionately high and adverse effects on minority and/or low-income populations.

The No Action Alternative is based on 2040 conditions. Changes that would occur over that time frame without implementation of the action alternatives are not analyzed in this chapter. However, the changes to environmental justice that are assumed to occur by 2040 under the No Action Alternative are summarized in this section.

Conditions in 2040 would be different than existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

In the long term, it is anticipated that climate change, and development throughout California, could affect water supply deliveries.

Under the No Action Alternative, Reclamation would continue with the current operation of the CVP, as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the SWP represent current management direction or intensity pursuant to 43 CFR Section 46.30. The 2020 Record of Decision did not identify environmental justice impacts.

Although the No Action Alternative included habitat restoration projects at a programmatic level, the 2020 ROD did not provide environmental coverage for these projects, and all of the habitat projects considered under the No Action required or will require additional environmental documentation. Thus, ground disturbance for habitat restoration projects did not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

By the end of September, the surface water elevations at CVP reservoirs generally decline. It is anticipated that climate change would result in more short-duration high-rainfall events and less snowpack in the winter and early spring months. The reservoirs would be full more frequently by the end of April or May by 2040 than in recent historical conditions. However, as the water is released in the spring, there would be less snowpack to refill the reservoirs. This condition would reduce reservoir storage, which may result in reduced water availability and subsequent impacts on the industries and minority and/or low-income populations that rely on the water.

Under the No Action Alternative, land uses in 2040 would occur in accordance with adopted general plans, which could also result in impacts on minority and/or low-income communities. Development under the general plans could affect the availability of jobs associated with agriculture and M&I water uses and groundwater resources, depending on the type and location of development.

17.2.1 Potential Disproportionate Economic Effects on Minority or Low-Income Populations

Economic impacts could occur if changes in CVP and SWP operations under the action alternatives were to result in changes to M&I water supply deliveries and associated water costs, agricultural water supply deliveries, or recreation (only relevant in Trinity County) that would subsequently affect labor income and/or job availability within the regions. Minority and/or low-income populations could be disproportionately affected by changes in labor income and/or job availability if those changes were to occur in sectors of the labor force that predominantly employ minority and/or low-income individuals, such as the agriculture sector, more significantly than other sectors. Economic impacts could also occur if groundwater levels decreased below the maximum operable depth of existing private wells, or if reduced groundwater levels resulted in increased subsidence. This reduction could limit well owners' access to water and generate new economic burdens from procuring alternate supplies or potentially modifying their existing well(s) to access groundwater at lower levels.

Potential changes in M&I water supply deliveries resulting from the implementation of the action alternatives are expected to affect job availability and labor income primarily within the services sector. Jobs within the services sector are not predominantly held by minority and/or low-income populations. Although changes in M&I water supply may result in effects on job availability and/or labor income within other sectors (agriculture, mining, construction, transportation, information, power and utilities, trade, service, and government), effects within these sectors are expected to be much smaller than effects within the services sector. Therefore, although impacts on job availability and/or labor income resulting from changes in M&I water supply may result in negligible to minor effects on minority and/or low-income populations, the effects are not expected to be disproportionately high or adverse on minority and/or low-income populations.

Changes in agricultural water availability resulting in changes to irrigated acreage and gross revenue in the agriculture sector have the potential to disproportionately affect minority and/or low-income populations since agricultural jobs are disproportionately held by minority and low-income individuals (Cha and Collins 2022). Generally, increases or decreases in job availability resulting from the implementation of the action alternatives would be minor, representing less than 5% of the total farm worker labor force in the region; however, Alternative 3 has the potential to cause more significant changes to agricultural revenue and job availability. Alternative 3 could result in decreases of up to 14.0% in the farm worker labor force in the Sacramento Valley Region (during dry conditions) and up to 16.2% in the farm worker labor force in the San Joaquin Valley Region (during average conditions).

There is potential for Alternative 2 without TUCP and with Delta VA to result in the drawdown of reservoir elevations under certain conditions that make the boat ramps unusable[3,4]. In periods when the boat ramps is non-operational, recreational visitation is expected to decrease by up to

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[3] Potential changes to water levels in Trinity Lake are evaluated in Chapter 5 and Appendix H, *Water Supply Technical Appendix*.

[4] Potential changes to river flow in the Trinity River downstream of Trinity Lake are evaluated in Chapter 4 and Appendix G, *Water Quality Technical Appendix*.

27%, which could affect the revenue of local businesses that rely on visitors (e.g., Shasta-Trinity National Forest, retail stores, hotels). Because Trinity County is considered a "poverty area," a reduction in jobs and/or labor income within the tourism industry in the county could have disproportionately high and adverse effects on low-income populations.

Alternative 3 is expected to result in the largest impacts to groundwater elevations, especially in the San Joaquin Valley Region. Reduced groundwater elevations could result in reduced water accessibility through existing private wells, although the depths and locations of existing private wells are not known. Should reduced groundwater elevations result in reduced water accessibility for residents within the San Joaquin Valley Region, which contains both minority and low-income populations, well owners may be forced to take on additional economic burdens to modify their existing wells or pay for water from a different source. Therefore, decreases in groundwater elevations could have disproportionately high and adverse effects on minority and/or low-income populations. Additionally, these reductions in groundwater elevations are expected to occur in areas susceptible to land subsidence. Should subsidence occur on properties owned by minority and/or low-income individuals, an additional financial burden may be imparted onto these homeowners to pay for repairs to their homes or other infrastructure damaged by subsidence. Because the exact location and severity of subsidence is impossible to predict, it is not possible to quantify this impact.

17.2.2 Potential Disproportionate Effects on Health of Minority or Low-Income Populations

Construction or operation and maintenance of any planned or underway CVP or SWP projects or any ongoing operations and maintenance activities requiring heavy equipment (e.g., front loaders, dump trucks, excavators, cranes) that use hazardous materials (e.g., fuels, lubricants, solvents) could create a hazard to the public and environment through the accidental release of those hazardous materials. However, these projects are expected to be the same as those occurring under the No Action Alternative; no construction work is required under Alternatives 1 through 4. Thus, no adverse effects related to human health, including minority and low-income populations, would result from operations expected to occur under Alternatives 1 through 4.

As described in Appendix V, *Hazards and Hazardous Materials Technical Appendix,* Alternatives 1 through 4 would require chemical weed control and algae treatments involving the use of toxic herbicides at Clifton Court Forebay. However, these weed control and algae treatments would comply with relevant conditions required in the General Pesticide Permit issued for the work, and the same activities would be implemented under the No Action Alternative. Thus, no adverse effects related to human health, including minority and low-income populations, would result from these treatments under Alternatives 1 through 4.

Alternatives 1 through 4 are not expected to substantially reduce reservoir levels in the study area and as such would not adversely affect recreation opportunities occurring at these reservoirs. Alternatives 1 through 4 are not expected to impair firefighting abilities in the study area; therefore, there would be no adverse effects on the population, including minority and low-income populations, within the study area.

17.2.3 Consideration of Potential Effects on Minority or Low-Income Populations Resulting from Greenhouse Gas Emissions

California is home to significant numbers of emission producing power plants, despite its status as a world leader in renewable and emission free energy development and goals. These emissions include, but are not limited to Carbon Dioxide, Methane, NOx, and fine particulate matter such as PM 2.5, along with other point source pollutants. Emission producing power plants tend to disproportionally affect minority and low-income populations because of their proximity to these populations. As described in Appendix M, *Greenhouse Gas Emissions*, under Alternatives 1, 2 (all four phases), and 4, net energy from hydropower would decrease compared to the No Action Alternative. Other sources of energy that are less clean would need to be used and as a result GHG emissions would increase. The increases in emissions would be largest with Alternative 1, less with Alternative 2 (all four phases), and least with Alternative 4. With Alternative 3 net energy generation would increase compared to the No Action Alternative, and as a result GHG emissions would decrease. The relatively low magnitudes of changes in emissions suggest that potential disproportionate effect on minority or low-income populations would be minimal.

17.2.3.1 Alternative 2B

Analysis of Alternative 2B, although qualitative, builds on the quantitative analysis provided for Alternative 2. Only components under Alternative 2B that are expected to result in environmental justice concerns compared to Alternative 2 are discussed.

Alternative 2b is anticipated to be more restrictive on Delta exports than Alternative 2 and the No Action Alternative. Please see *Chapter 5 Water Supply* for a description of the restrictions associated with the QWEST criteria under Alternative 2B. These restriction in exports may result in a reduction in water supply and, thus, potentially increase land that is taken out of agricultural production. Taking land out of agricultural production may result in loss of agricultural jobs, which are traditionally held in great proportion by disadvantage communities, creating a concern for environmental justice. Additionally, taking land out of agricultural production, depending on the magnitude, may increase the potential for hay fever in areas where disadvantage communities live.

Reductions on exports associated with QWEST may result in less consumption in power from the CVP and SWP Delta export facilities that could result in a surplus of hydropower and, thus, less need for fossil fuels power sources purchased from the grid. This surplus of hydropower may result in a net decrease of harmful GHG and other air quality emissions. If these reduction in harmful emissions are localized in places where disadvantage communities live and work, it may promote environmental justice. Conversely, there may be an increase in groundwater pumping to meet water supply demands. An increase in groundwater pumping would result in an increase of power consumption, and a potential increase for fossil-fuel power sources that may increase harmful GHG emissions. If these increases in harmful emissions are concentrated in areas where disadvantage communities work and live, it creates a concern for environmental justice.

In addition to the more restrictive QWEST criteria, Alternative 2B includes an extension of the CCF operation period to December 1 through March 31 from mid-December through mid-March, effectively increasing the operation of the SWP by one month. This extended operation would result in an increase of power consumption from this SWP facility and the need to purchase additional power from fossil fuel sources. The increase in consumption of power from less clean sources may increase harmful air quality emissions. If these increases in harmful emissions are concentrated in areas where disadvantage communities work and live, it creates a concern for environmental justice. This potentially negative impact on associated with increased GHG and air quality emissions may be ameliorated if less groundwater pumping results from this increase in surface water supply from the extended operation of the CCF.

Conversely, this extension in the operation of the CCF may result in more frequently exceeding seasonal and weekly salvage thresholds that may not have otherwise been exceeded. Exceeding these thresholds would result in additional export restrictions and less consumption in less clean power under Alternative 2B, potentially resulting in a decrease of harmful air quality emissions. This potential beneficial effect may be lessened if the additional export restrictions encourage more groundwater pumping under Alternative 2B. In this case, more fossil-fueled power sources may be necessary thereby increasing harmful air quality emissions. If these increases in harmful emissions are concentrated in areas where disadvantage communities work and live, it creates a concern for environmental justice. Additionally, export restrictions may result in a reduction in water supply and thus potentially increase land that is taken out of agricultural production. Taking land out of agricultural production may result in loss of agricultural jobs, which are traditionally held in great proportion by disadvantage communities, creating a concern for environmental justice.

17.2.3.2 Alternative 4B

Alternative 4B is expected to be within the range of effects for environmental justice described for Alternative 4.

17.3 Mitigation Measures

Appendix D includes a detailed description of mitigation measures identified for environmental justice resources per alternative. These mitigation measures include avoidance and minimization measures that are part of each alternative and, where appropriate, additional mitigation to lessen impacts of the alternatives. For environmental justice resources, no avoidance and minimization measures have been identified. Additional mitigation measures have been identified for environmental justice resources.

17.3.1 Avoidance and Minimization Measures

17.3.1.1 Alternatives 1-4

No avoidance and minimization measures have been identified.

17.3.2 Additional Mitigation

17.3.2.1 Alternatives 1-4

The following mitigation measures have been identified for Environmental Justice:

- *Mitigation Measure EJ-1: Increase Participation with Tribal, Minority, and Low-Income Populations* – would require that Reclamation identify opportunities to gather Tribal Indigenous Knowledge for consideration in future Reclamation projectsand to include tribal interests and low-income/minority advocacy groups in affected communities to review and provide input on compliance documentation.
- *Mitigation Measure EJ-2: Reduce Effects of Employment Loss* – would require assisting in offsetting agricultural sector job losses.

17.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and, as described in the 2020 Record of Decision, would not result in potential changes to disproportionate economic and health effects on minority or low-income populations. The action alternatives will result in changes of disproportionate economic and health effects on minority or low-income populations and greenhouse gas emissions. The magnitude of the changes is dependent on alternative and water year type. Given these changes, the action alternatives may contribute to cumulative changes to environmental justice conditions as described in Appendix T, *Environmental Justice* and Appendix Y, *Cumulative Impacts Technical Appendix*.

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Chapter 18 Power

This chapter is based on the background information and technical analysis documented in Appendix U, *Power Technical Appendix*, which includes additional information on power conditions and technical analysis of the effects of each alternative.

18.1 Affected Environment

Most of the Central Valley Project (CVP) and State Water Project (SWP) dams have associated hydroelectric facilities. As water is released from the CVP and SWP reservoirs, the generation facilities produce power that is used by the CVP and SWP pumping plants, respectively, and by other users. The study focuses on CVP and SWP hydroelectric generation facilities at CVP and SWP reservoirs, CVP and SWP energy use to move water, and transmission activities of the net generated electricity for other users throughout California. These CVP/SWP energy generation facilities are in the Trinity River and Central Valley regions. The movement of water with CVP and SWP energy primarily occurs in the Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions, as defined in Appendix U.

18.1.1 Central Valley Project Power and Energy Resources

Power generated by the CVP is marketed and transmitted by the Western Area Power Administration (WAPA) Sierra Nevada Region. CVP facilities generally use around 25% to 30% of the power generated by the CVP. WAPA markets the remaining power under existing laws including the Reclamation Project Act, Hoover Power Plant Act, Energy Policy Act, and reporting policies under WAPA/Power Marketing Department Order, Department of Energy (DOE) Order RA6120-2. WAPA under the 2025 Power Marketing Program for the Sierra Nevada provides allocations to wholesale customers in northern and central California and portions of Nevada (Western Area Power Administration 2023). Five customers are listed as first preference in the Fiscal Year 2024 Rates. First preference power customers are Calaveras Public Power Agency, Chicken Rancheria, California Department of Corrections Sierra Conservation Center, Trinity Public Utilities District, and Tuolumne Public Power Agency (Western Area Power Administration 2024). Additional customers include Native American tribes, Bureau of Reclamation (Reclamation) customers, military agencies, cities, Bay Area Rapid Transit District (BART), rural electric cooperatives, public utilities and irrigation districts, and federal and state agencies (Western Area Power Administration 2020).

The CVP power facilities include 11 hydroelectric powerplants and have a total maximum generating capacity of 2,103 megawatts (MW), as shown in Table 18-1. Water releases as part of water operations determine the amount of power that will be produced at an individual plant. Hydrology can vary substantially from year to year, which then affects the hydropower production. The season of the release and the time of day affect the value of the power production. Typically, in an average water year, approximately 4,500 gigawatt-hours (GWh) of energy is produced (Bureau of Reclamation 2021). During power emergencies water may be released to provide power generation for a specific purpose. The power generated from CVP powerplants is prioritized to: (1) meet project use loads; (2) first preference power customers; (3) sub balancing authority requirements; (4) ancillary services; and (5) base resource energy which is marketed to other preference customers.

Table 18-1. Central Valley Project Hydroelectric Powerplants

Facility	Installed Capacity (MW)
Trinity Powerplant	140
Lewiston Powerplant	0.3
Judge Francis Carr Powerplant	154
Shasta Powerplant	714
Spring Creek Powerplant	180
Keswick Powerplant	117
Folsom Powerplant	207
Nimbus Powerplant	13
New Melones Powerplant	380
O'Neill Pump-Generating Plant	14.4
San Luis Powerplant (CVP portion of the San Luis (William R. Gianelli) Pump-Generating Plant)	202
Total	**2,121.7**

Source: *Bureau of Reclamation 2021.*
MW = megawatt
CVP = Central Valley Project

WAPA Sierra Nevada together with the Balancing Area of Northern California joined California Independent System Operator's (CAISO) Western Energy Imbalance Market in March of 2021 (Western Area Power Administration 2021). Participants in the Western Energy Imbalance Market are able to purchase and sell power at a reduced cost in real-time and improve balancing supply and demand. The benefits to the CVP power facilities and other Western Energy Imbalance Market participants include the following (Western Energy Imbalance Market 2024).

- Costs are reduced with more efficient transmission through the regional transmission system and the need to carry reserve utilities is reduced
- Carbon emissions are reduced with more efficient use and integration of renewable energy
- Increased operational visibility among other electricity grids enhances reliability and improves transmission line congestion management

18.1.2 State Water Project Power and Energy Resources

The SWP also generates hydroelectricity along the California Aqueduct at energy recovery plants (California Department of Water Resources 2022). Power generated by the SWP is transmitted by PG&E, Southern California Edison, and CAISO through other facilities (California Department of Water Resources 2022). The SWP also markets energy in excess of the SWP demands to a utility and members of the WSPP, formerly known as the Western Systems Power Pool.

The SWP power facilities are operated primarily to provide power for the SWP facilities (California Department of Water Resources 2022). Table 18-2 summarizes the SWP power facilities and capacities. The SWP has power contracts with electric utilities and the CAISO that function as exchange agreements with utility companies for transmission and power sales and purchases. Each year, the SWP must purchase additional power to meet pumping requirements.

Table 18-2. State Water Project Hydroelectric Powerplants

Facility	Installed Capacity (MW)
Hyatt Pumping-Generating Plant (Oroville)	645
Thermalito Diversion Dam Powerplant (Oroville)	3
Thermalito Pumping-Generating Plant (Oroville)	114
San Luis (William R. Gianelli) Pumping-Generating Plant (SWP share)	225
Alamo Powerplant	17
Mojave Siphon Powerplant	30
Devil Canyon Powerplant	276
Warne Powerplant	74
Total	**1,384**

Source: *California Department of Water Resources 2017*.
MW = megawatt
SWP = State Water Project

18.1.3 Other Hydroelectric Generation Facilities

Hydroelectric facilities in addition to CVP and SWP hydroelectric facilities in the study area are owned by investor-owned utility companies, such as PG&E and Southern California Edison; municipal agencies, such as the Sacramento Municipal Utility District; and by local and regional water agencies. Some of the larger facilities outside the CVP and SWP systems and within or adjacent to the study area are included in the subsequent list (California Energy Commission 2023).

- PG&E
    - Helms Pumped Storage (1,212 MW capacity) in Fresno County
    - Pit System (579 MW) in Shasta County

- Upper North Fork Feather River System (351 MW) in Plumas County

- Sacramento Municipal Utility District American River Project System (708 MW) in El Dorado County
- City and County of San Francisco Hetch Hetchy Power System (286 MW) in Tuolumne County
- Southern California Edison
  - Big Creek System and Eastwood Pump Storage (590 MW) in Fresno and Madera counties
  - Mammoth Pool Project (187 MW) in Fresno and Madera counties
- Turlock Irrigation District and Modesto Irrigation District Don Pedro Project (203 MW) in Tuolumne County
- Yuba Water Agency Yuba River Development Project (364 MW) in Yuba County

18.2 Effects of the Alternatives

The impact analysis considers changes in surface power generation related to changes in CVP and SWP operation under the alternatives as compared with the No Action Alternative.

The No Action Alternative is based on 2040 conditions. Changes that would occur over that time frame without implementation of the action alternatives are not analyzed in this chapter. However, the changes to power generation that are assumed to occur by 2040 under the No Action Alternative are summarized in this section.

The No Action Alternative is based on 2040 conditions. The changes to power that are assumed to occur by 2040 under the No Action Alternative conditions would be different than existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

Under the No Action Alternative, Reclamation would continue with the current operation of the Central Valley Project (CVP), as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the State Water Project represent current management direction or intensity pursuant to 43 Code of Federal Regulations Section 46.30.

Although the No Action Alternative included habitat restoration projects at a programmatic level, the 2020 ROD did not provide environmental coverage for these projects, and all of the habitat projects considered under the No Action required or will require additional environmental documentation. Thus, ground disturbance for habitat restoration projects did not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

The No Action Alternative is expected to result in potential changes to power generation at CVP and SWP facilities and energy used to pump water resulting in changes to net generation of CVP and SWP power. These changes were described and considered in the 2020 Record of Decision.

18.2.1 Potential Changes in Central Valley Project Net Generation

Each of the action alternatives would result in a change in annual average net power generation. Alternative 1 would increase the annual energy use of the CVP 12% for the long-term average and 15% for dry and critically dry years. Alternative 2 would slightly decrease (up to 3%) annual long-term average energy use or have no change to annual long-term average energy use; and slightly decrease annual average energy use (2% to 4%) for dry and critically dry years. Alternative 1 would increase the annual energy use of the SWP 25% for the long-term average and 47% for dry and critically dry years compared with the No Action Alternative. Alternative 2 phases would slightly increase (2% to 3%) annual long-term average energy use; and slightly increase annual energy use (1% to 3%) or have no change in dry and critically dry years. Under Alternative 3 there would be decreases (47% long-term average, 49% dry and critically dry years) in annual average energy use compared with the No Action Alternative. Alternative 4 would slightly increase average energy use for the annual long-term average (4%), and for dry and critically dry years (6%).

The CalSim 3 modeling output indicates that each of the action alternatives would slightly increase annual generation of CVP power. The increase in energy generation is due to increases in reservoir storage and elevation resulting in higher generation for each unit of water released. The changes in energy use are due to changes in the volume of exports through CVP pumping facilities. The increase in annual generation (1% long-term average, 3% dry and critically dry years) would be much less than increases of annual energy use (12% long-term average, 15% dry and critically dry years) under Alternative 1, resulting in slight reductions in annual net generation (4% long-term average, 2% dry and critically dry years). Under the Alternative 2, there would be slight increases in annual generation (up to 1%) or there would be no change in annual generation for both the long-term average and dry and critically dry years, resulting in slight increases (1% to 3%) or no change in annual net generation for all phases of Alternative 2 compared with the No Action Alternative. Under Alternative 3, there would be no change in annual long-term generation and a slight increase (2%) in annual generation for dry and critically dry years, resulting in substantial increases (21% long-term average, 16% dry and critically dry years) in annual net generation because of the greater decreases in annual energy use. Under Alternative 4, there would be slight increases (1%) in annual generation, resulting in no change in annual net generation for the long-term average and a slight increase (2%) in net generation for dry and critically dry years.

Figure 18-1 shows the comparison of long-term average annual CVP energy use, generation, and net generation for the No Action Alternative and the action alternatives.

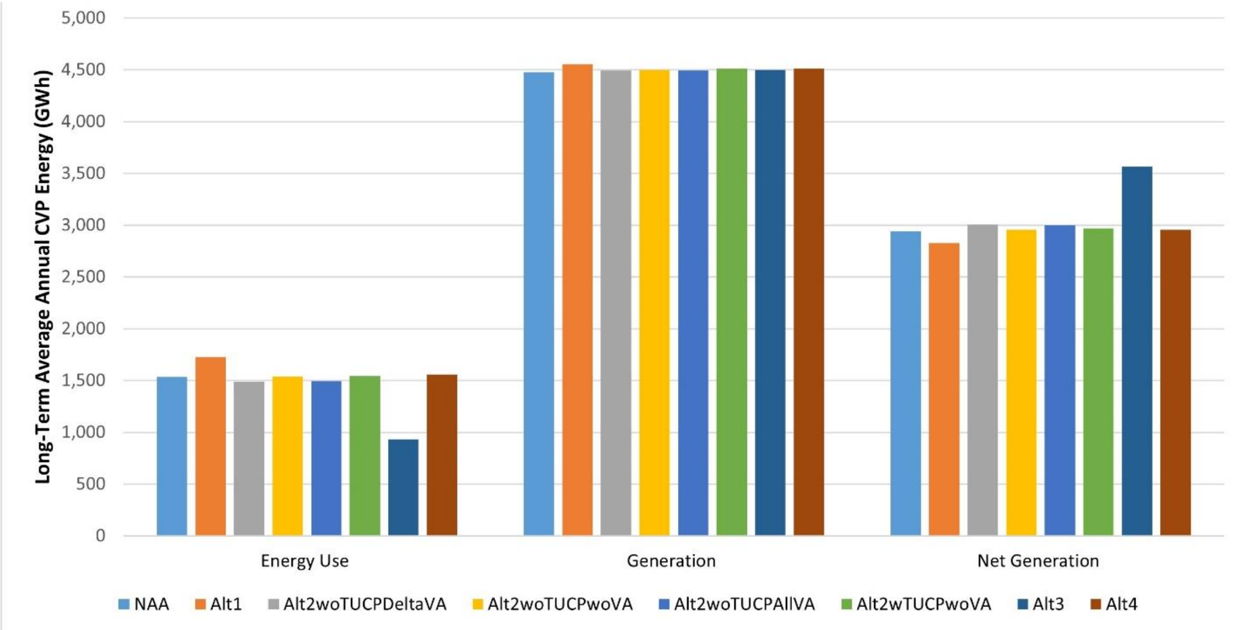

Figure 18-1. Comparison of Simulated Long-Term Average Annual CVP Energy Use, Generation and Net Generation

Each of the action alternatives would result in a change in long-term average CVP net generation on a monthly basis. Reductions in monthly net generation would not require the procurement of additional generation energy because generation would be positive in all months under all of the alternatives. Monthly reductions (greater than 5%) in long-term average net generation for the action alternatives compared with the No Action Alternative would be greatest in January through March and September through October under Alternative 1. Alternatives 2 through 4 would not have reductions in long-term average net generation greater than 5%, with several months having an increase in net generation. Figure 18-2 shows a comparison of long-term monthly average net generation for the No Action Alternative and the action alternatives, as well as changes between the action alternatives and the No Action Alternative.

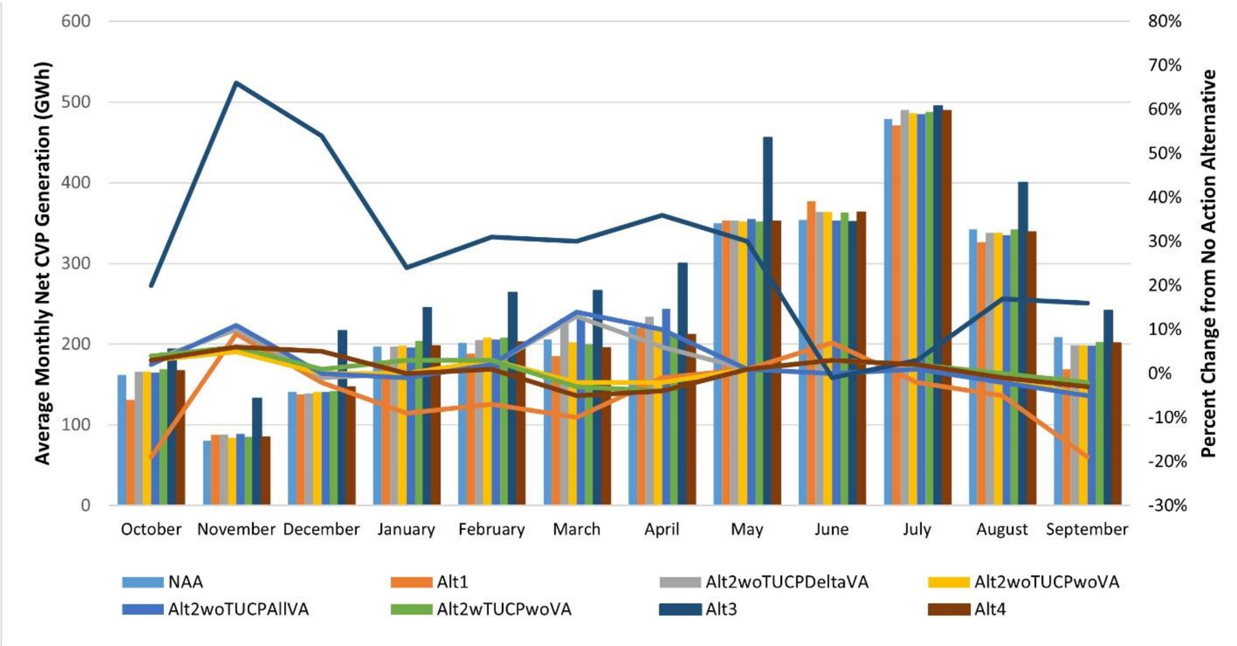

Figure 18-2. Comparison of Stimulated Long-Term Monthly CVP Net Generation and Percent Change in Net Generation from the No Action Alternative

Due to the limitations and uncertainty in the CalSim 3 monthly model and other analytical tools, monthly incremental differences of less than 5% between action alternatives and the No Action Alternative are considered to be similar.

There may be inherent overestimation bias for monthly power generation release in the CalSim modeling output. As the monthly power generation releases are different across the alternatives, there may be differences in overestimation bias between the alternatives. In CalSim, the power generation releases are assumed constant through each month. However, there can be significant releases during flood and temperature control operations within the month. The assumption of monthly averaged releases in CalSim may result in unaccounted for power bypass from flood and temperature control in the model which in turn may result in bias in power generation release outputs.

Due to the comparative manner that the output data is used, the overestimation bias may be considered to not be a concern. However, to evaluate the alternatives, the gross differences in outputs between the alternatives may not be able to be used on their own because there are differences in bias of CalSim modeled power generation release between alternatives. These differences could be attributed to differences in elevations of the CVP reservoirs between alternatives (along with other criteria), which in turn could lead to varying amounts of bypass from flood and water temperature control being unaccounted for in each of the alternatives, and therefore could result in varying amounts of bias between the alternatives with respect to generation.

18.2.2 Potential Changes in State Water Project Net Generation

Alternative 1 would increase the annual energy use of the SWP 25% for the long-term average and 47% for dry and critically dry years compared with the No Action Alternative. Alternative 2 phases would slightly increase (2% to 3%) annual long-term average energy use; and slightly increase annual energy use (1% to 3%) or have no change in dry and critically dry years. Under Alternative 3 there would be substantial decreases (47% long-term average, 49% dry and critically dry years) in annual average energy use compared with the No Action Alternative. Alternative 4 would slightly increase average energy use for the annual long-term average (4%), and for dry and critically dry years (6%).

Each of the action alternatives would increase or decrease annual generation of SWP power. Under Alternative 1 for the long-term average and dry and critically dry years, the increase in annual generation (10% and 43%, respectively) would be less than increases of annual energy use (25% and 47%, respectively), resulting in reductions in annual net generation (42% long-term average, 72% dry and critically dry years). Under Alternative 2, phases there would be slight increases or decreases in annual generation (<1% to 1%) or there would be no change for both year types, resulting in slight decreases (4% to 6%) in annual net generation for Alternative 2 phases compared with the No Action Alternative. Under Alternative 3, there would be a decrease (19%) for annual long-term average generation, and a decrease (12%) in annual generation for dry and critically dry years, resulting in substantial increases (77% long-term average, 88% dry and critically dry years) in annual net generation compared with the No Action Alternative because of the greater decreases in annual energy use. Under Alternative 4, there would be slight increases (1% long-term average, 2% dry and critically dry years) in annual generation, resulting in a decrease (7%) in annual net generation for the long-term average and a decrease (10%) in net generation for dry and critically dry years. Figure 18-3 shows long-term average annual SWP energy use, generation, and net generation for the No Action Alternative and the action alternatives.

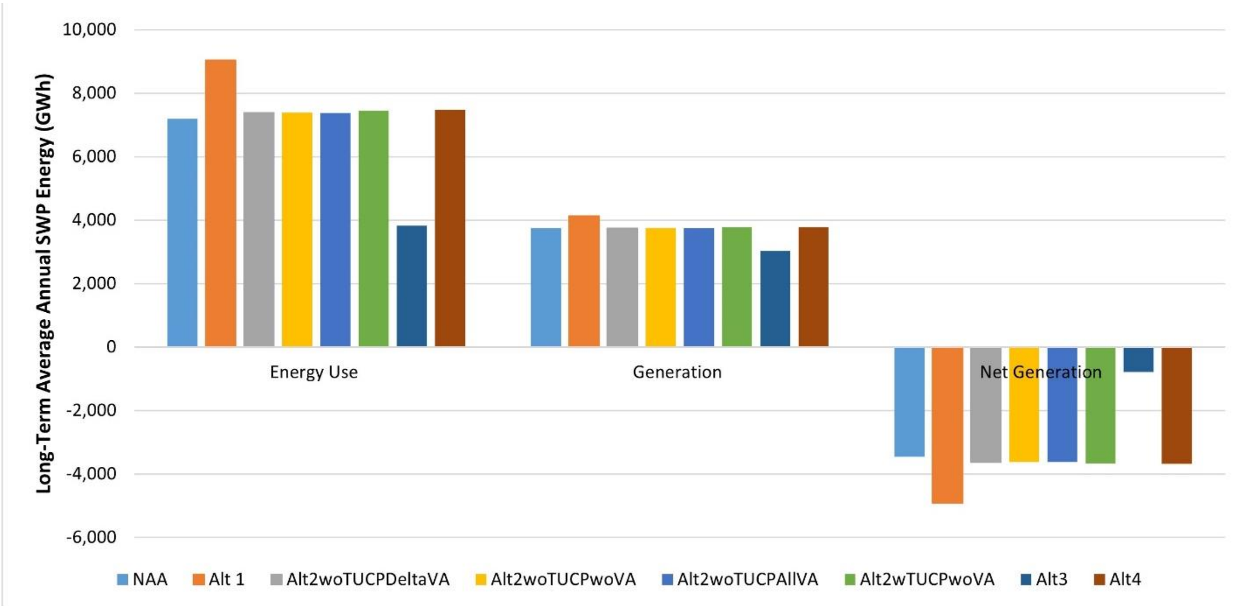

Figure 18-3. Comparison of Stimulated Long-Term Average Annual SWP Energy Use, Generation, and Net Generation

Each of the action alternatives would result in a change in long-term average SWP net generation on a monthly basis. All alternatives would have negative net generation in all months except for Alternative 3 where January through May would have positive net generation. Negative net generation would require the procurement of additional generation elsewhere within the California energy system. Monthly reductions (greater than 5%) in long-term average net generation for the action alternatives compared with the No Action Alternative would occur in all months and be greatest in January through March and July (over a 50% reduction) under Alternative 1. Alternative 2 phases would vary in the months with the greatest reduction in annual long-term net generation. However, June, September, and November would not have reductions greater than 5% in those months. Under Alternative 3, monthly long-term net generation would increase in all months compared with the No Action Alternative. Under Alternative 4, the greatest decreases in monthly long-term net generation would occur in February, April, and May compared with the No Action Alternative. Figure 18-4 shows long-term average monthly net generation for the No Action Alternative and the action alternatives, as well as changes between the action alternatives and the No Action Alternative.

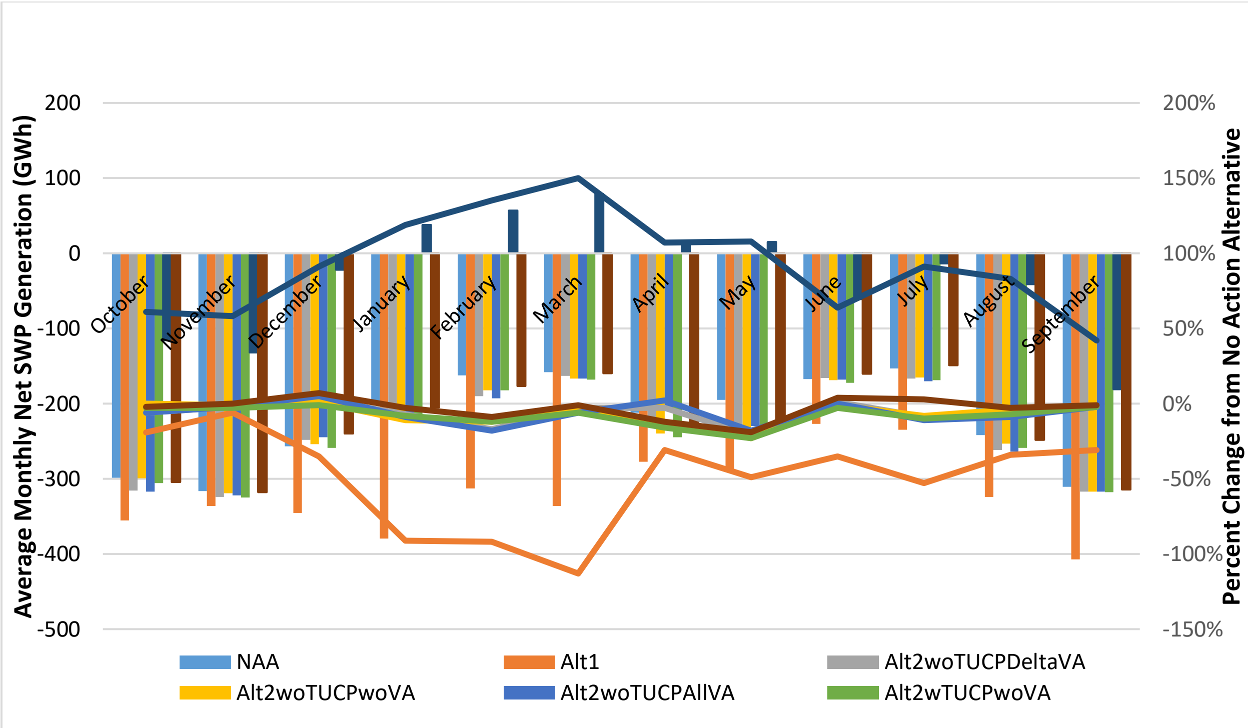

Figure 18-4. Comparison of Stimulated Long-Term Monthly SWP Net Generation and Percent Change in Net Generation from the No Action Alternative

18.2.2.1 Alternative 2B

Analysis of Alternative 2B, although qualitative, builds on the quantitative analysis provided for Alternative 2. Only components under Alternative 2B that are expected to result in changes to power resources compared with Alternative 2 are discussed.

Alternative 2B is anticipated to be more restrictive on Delta exports than Alternative 2 and the No Action Alternative. Please see *Chapter 5, Water Supply,* for a description of the restrictions associated with the QWEST criteria (the average daily flow traveling past Jersey Point, which represents the net flow in the lower San Joaquin River) under Alternative 2B. These restriction on exports may result in less consumption in power from the CVP and SWP Delta export facilities that could result in a surplus of power, and a potentially beneficial impact on power resources. Conversely, these export restrictions would result in a decrease of water supply. There may be an increase in groundwater pumping to meet water supply demands. An increase in groundwater pumping would result in an increase of power consumption and a potentially negative impact on power resources.

In addition to the more restrictive QWEST criteria, Alternative 2B includes an extension of the Clifton Court Forebay (CCF) operation period to December 1 through March 31 from mid-December through mid-March, effectively increasing the operation of the SWP by one month. This extended operation would result in an increase of power consumption from this SWP facility and a potentially negative impact on power resources. This potentially negative impact on power resources may be ameliorated if less groundwater pumping results from this increase in surface water supply from the extended operation of the CCF.

On the other hand, this extension in the operation of the CCF may result in more frequently exceeding seasonal and weekly salvage thresholds that may not have otherwise been exceeded. Exceeding these thresholds would result in additional export restrictions and less consumption in power under Alternative 2B, potentially resulting on a beneficial effect on power resources. This potential beneficial effect on power resources may not materialize if thresholds are not exceeded during the extended CCF operation under Alternative 2B, resulting in more exports by virtue of the increased operation window. In this case, more power would be required, resulting in a potentially negative impact on power resources.

18.2.2.2 Alternative 4B

Alternative 4B is expected to be within the range of effects for power described for Alternative 4.

18.3 Mitigation Measures

No avoidance and minimization measures or mitigation measures have been identified for power.

18.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and may result in changes to Central Valley Project and State Water Project net generation. The action alternatives will result in changes in long-term average CVP and SWP net generation rates. The magnitude of the changes is dependent on alternative and water year type. Given the changes in long-term average CVP and SWP net generation rates, the No Action Alternative and action alternatives may contribute to cumulative impacts for power resources as described in Appendix U and Appendix Y, *Cumulative Impacts Technical Appendix*.

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Chapter 19 Hazards and Hazardous Materials

This chapter is based on the background information and technical analysis documented in Appendix V, *Hazards and Hazardous Materials Technical Appendix*, which includes additional information on hazards and hazardous materials conditions and technical analysis of the effects of each alternative.

19.1 Affected Environment

The Central Valley Project (CVP) and State Water Project (SWP) reservoirs are managed to store water supplies for local and regional uses as well as export. Stored water in water supply reservoirs, including water stored in CVP and SWP reservoirs, may be used for fighting wildfires in the California foothills and mountains. Firefighting actions in wildland areas frequently involve collection and transport of water from reservoirs located close to wildfires, including CVP and SWP reservoirs. Other ongoing activities in the study area introduce hazardous materials (e.g., pesticides, fertilizers, industrial waste) and potential hazards (e.g., creating conditions for the spread of vector-borne diseases from mosquitos such as seasonal wetlands). Some surface water bodies within the study area (e.g., lakes and reservoirs) have the potential to grow cyanobacteria harmful algal blooms (CHABs) at certain times of year.

19.2 Effects of the Alternatives

The impact analysis considers changes in hazards related to changes in CVP and SWP operation under the alternatives as compared with the No Action Alternative.

The No Action Alternative is based on 2040 conditions. The changes to hazards and hazardous materials that are assumed to occur by 2040 under the No Action Alternative conditions would be different than existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

Under the No Action Alternative, Reclamation would continue with the current operation of the Central Valley Project (CVP), as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the State Water Project (SWP) represent current management direction or intensity pursuant to 43 CFR Section 46.30.

Although the No Action Alternative included habitat restoration projects at a programmatic level, the 2020 ROD did not provide environmental coverage for these projects, and all of the habitat projects considered under the No Action required or will require additional environmental documentation. Thus, ground disturbance for habitat restoration projects did not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

The No Action Alternative is expected to result in potential changes to hazards. These changes were described and considered in the 2020 LTO Record of Decision and associated documents.

Alternatives 2b and 4b are expected to be within the range of effects for the analysis on Hhazards and hazardous materials described below for Alternatives 2 and 4, respectively.

19.2.1 Expose People or Structures to a Substantial Risk of Loss, Injury, or Death Involving Wildfires

Under the No Action Alternative, construction activities could involve the use of heavy equipment and entail activities that have the potential to ignite wildfires (e.g., use of flammable and combustible materials). Increase in human presence in a wildland urban interface also has the potential to increase fire risks (e.g., smoking, handling of combustible chemicals). Climate change would likely increase the potential for wildfires. The potential for adverse effects related to wildfires due to operations of the CVP and SWP would likely be similar as under existing conditions because projects would generally occur in the same geographic area and present a similar risk. Additionlly, projects would be required to comply with all pertinent fire prevention laws and regulations and best practices, including those taking effect in the futurethat are refined for climate change conditions.

Under the No Action Alternative, water elevations in reservoirs would maintain their current patterns of seasonal variation and availability of water. Lower reservoir storage would not entirely prevent access to reservoir water for fighting wildfires, and there are multiple methods used to suppress wildfires. Therefore, implementation of the No Action Alternative would not substantially impair the ability to fight wildfires relative to existing conditions, and people or structures would not be exposed to a substantial risk of loss, injury, or death involving wildfires.

As discussed in Appendix S, *Recreation Technical Appendix*, reservoir levels in the study area under the Alternatives 1 through 4 would not be substantially different from the No Action Alternative. None of the alternatives would change the availability of water stored in reservoirs for firefighting purposes; therefore, implementation of Alternatives 1 through 4 would not substantially impair the ability to fight wildfires, and there would be no adverse effect. Most of the Sacramento and San Joaquin Valleys are outside of an area designated as a Very High or High Fire Hazard Severity Zone. There are multiple methods that are used in suppressing wildfires aside from drawing water from reservoirs.

19.2.2 Increase the Potential for Creating a Public or Environmental Hazard through the Use or Accidental Release of Hazardous Materials

Under the No Action Alternative, programmatic construction and specified maintenance planned or currently under way may require the use of hazardous materials, which could create a hazard to the public and environment through the accidental release of those hazardous materials or by disruption of existing oil or gas pipelines where deep excavation may be required. As such, relative to existing conditions, the No Action Alternative would not result in adverse effects related to the use or accidental release of hazardous materials.

There would not be new construction under Alternatives 1 through 4 that would use hazardous materials. Mechanical and chemical aquatic weed removal and algae treatments would be implemented on an as-needed basis at Clifton Court Forebay as part of Alternatives 1 through 4 as well as the No Action Alternative. The use of herbicides and algaecides would be done pursuant to applicable regulatory requirements. Therefore, Alternatives 1 through 4 would not result in an adverse effect.

19.3 Mitigation Measures

No avoidance and minimization measures or mitigation measures have been identified for hazards and hazardous materials.

19.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and would not be expected to result in potential changes in exposure of people or structures to substantial risk of loss, injury, or death involving wildfires and use and accidental release of hazardous materials. The action alternatives will not result in changes in exposure of people or structures to substantial risk of loss, injury, or death involving wildfires and use and accidental release of hazardous materials Therefore, the No Action Alternative and action alternatives are not expected to contribute to cumulative changes to hazards and hazardous materials as described in Appendix V, *Hazards and Hazardous Materials* and *Appendix Y*, *Cumulative Impacts Technical Appendix*.

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Chapter 20 Geology and Soils

This chapter is based on the background information and technical analysis documented in Appendix W, *Geology and Soils Technical Appendix*, which includes additional information on geology and soil quality conditions and technical analysis of the effects of each alternative.

20.1 Affected Environment

20.1.1 Trinity River

Soils in the southern region of the Klamath Mountain Geomorphic Province, including the Trinity River watershed are generally composed of gravelly loam with some alluvial areas with dredge tailings, river wash, and xerofluvents, which is a gravelly soil. Soils along the lower Klamath River are generally composed of gravelly clay loam and gravelly sandy loam with sand and gravels within the alluvial deposits. Throughout the Trinity River and lower Klamath River watersheds, large, dormant, deep-seated landslides occur where low shear strength soils are located. In most cases, slope movement occurs in geologic units known as mélanges found in the Franciscan Complex.

20.1.2 Central Valley

The Sacramento River flows from Shasta Reservoir to the Sacramento–San Joaquin Delta (Delta). The area along the Sacramento River from Shasta Reservoir to downstream of Red Bluff is characterized by loosely consolidated deposits of sandstone, shale, and gravel. Downstream of Red Bluff to the Delta, the river flows through Quaternary-age alluvium, lake, playa, and terrace deposits that are unconsolidated or poorly consolidated. The active river channel maintains roughly constant dimensions as it migrates across the floodplain within the limits of the meander belt. The area along the American River downstream of Folsom Reservoir and Nimbus Dam is in the Great Valley Geomorphic Province. The alluvial plains in the American River watershed include older Quaternary deposits. River flood plains and channel deposits lay along the American River.

The Stanislaus River downstream of New Melones Reservoir flows through the Great Valley Geomorphic Province. Tertiary sedimentary formations were deposited along the Stanislaus River from an area east of Knights Ferry to Oakdale. The lower San Joaquin River is a low-gradient, single-channel, generally sand-bedded, meandering river downstream of Millerton Reservoir. There are large sections of the riverbanks that have been armored with large rocks to reduce bank erosion and channel migration. Land subsidence throughout the Central Valley occurs to varying degrees primarily due to aquifer-system compaction as groundwater elevations decline because of groundwater overdraft (i.e., groundwater withdrawals at rates greater than groundwater recharge rates) typically used for irrigation. Throughout the Central Valley, agricultural lands are subject to erosional processes when land cover is reduced or lost.

20.1.3 Bay-Delta

The San Francisco Bay/Sacramento–San Joaquin Delta Estuary (Bay-Delta) Region is a northwest-trending structural basin, separating the primarily granitic rock of the Sierra Nevada from the primarily Franciscan Formation rock of the California Coast Ranges. The historical delta at the confluence of the Sacramento River and San Joaquin River is referred to as the Sacramento–San Joaquin Delta, or Delta. The soils of this region are as diverse as the landscapes but typically are fine textured with locally high organic content (e.g., peat). The flatter landscapes of this region are not conducive for mass wasting processes, and surficial erosion is typically localized in response to storm runoff events and tidal influences. Subsidence in the region is associated with groundwater overdraft in the southern Santa Clara Valley. Land subsidence on some islands in the central and western Delta and Suisun Marsh may be a function of changes in tidal influence on these island landscapes because of levee construction and subsequent development.

20.1.4 Additional Central Valley Project and State Water Project Service Areas

In San Luis Obispo County, Morro Bay, Pismo Beach, and Oceano along the coast have soils that range from sands and loamy sands in areas near the shoreline to shaley loams, clay loams, and clays in the terraces and foothills located along the eastern boundaries of these communities. In Santa Barbara County, the Santa Maria, Vandenberg Air Force Base, Santa Ynez, Goleta, Santa Barbara, and Carpinteria areas are in alluvial plains, along stream channels with alluvium deposits, along the shoreline, or along marine terrace deposits above the Pacific Ocean.

20.2 Effects of the Alternatives

The impact analysis considers changes in geological and soils conditions related to changes in CVP and SWP operation under the alternatives as compared with the No Action Alternative.

Changes in releases to prioritize deliveries or storage may result in changes in reservoir water surface elevations that could influence shoreline erosion rates throughout the extent of the reservoir as water surface elevations fluctuate on an annual and interannual basis. For discussion purposes, the term *drawdown* is used to describe these changes in water surface elevations.[5] While shoreline rock content and slope directly influence shoreline erodibility, the extent of time and surface area exposed to wave and surficial erosion are also key factors in the loss of soil resources along reservoir shorelines. Changes in surface water deliveries could also result in modification of flow regimes that could affect stream channel erosion. Changes in water deliveries and the extent of irrigated acreage have the potential to result in soil erosion on crop-idled lands over the long-term average condition and in dry and critically dry years. Changes in water delivery amounts may also result in increased use of groundwater resources to maintain crops, which could affect land subsidence.

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[5] In surface water hydrology and civil engineering, *drawdown* refers to the lowering of the surface elevation of a body of water where the shoreline is exposed to the atmosphere due to water-level fluctuations.

The No Action Alternative is based on 2040 conditions. The changes to geology and soil resources that are assumed to occur by 2040 under the No Action Alternative conditions would be different than existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

Under the No Action Alternative, Reclamation would continue with the current operation of the Central Valley Project (CVP), as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the State Water Project (SWP) represent current management direction or intensity pursuant to 43 CFR Section 46.30.

Although the No Action Alternative included habitat restoration projects at a programmatic level, the 2020 ROD did not provide environmental coverage for these projects, and all of the habitat projects considered under the No Action required or will require additional environmental documentation. Thus, ground disturbance for habitat restoration projects did not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

Under the No Action Alternative, land uses in 2040 would occur in accordance with adopted general plans, which could also result in impacts on erosion and subsidence due to ground disturbance and increased water use.

The No Action Alternative is expected to result in potential changes in soil erosion and rate of land subsidence for geology and soils resources at reservoirs that store CVP water, tributaries, and agricultural land. These changes were described and considered in the 2020 LTO Record of Decision and associated documents.

Alternatives 2b and 4b are expected to be within the range of effects for geology and soils resources described below for Alternatives 2 and 4, respectively.

20.2.1 Potential Changes in Soil Erosion

20.2.1.1 Trinity River

Reservoir Shoreline Erosion

Alternative 1

Changes in shoreline erosion associated with operation of Trinity Reservoir under Alternative 1 are negligible.

Alternative 2

During dry and wet periods, for all phases of Alternative 2 at Trinity Reservoir, the drawdown values are negligible.

Alternative 3

During dry periods, Alternative 3 has the largest drawdown for Trinity Reservoir compared with the No Action Alternative; therefore, shoreline erosion would increase relative to the No Action Alternative. During wet periods, the potential for shoreline erosion would be negligible.

Alternative 4

During Alternative 4, dry and wet periods in Trinity Reservoir would have negligible changes in drawdown relative to the No Action Alternative.

Riverine Erosion

Alternative 1

Erosion associated with high flows are not expected in the Trinity River below Lewiston under Alternative 1 because the drawdown values are negligible.[6,7,8]

Alternative 2

Changes in high flows during wet periods are negligible in the Trinity River below Lewiston Dam under all phases of Alternative 2. During dry periods, as all phases of Alternative 2 in the Trinity River are negative (-4 thousand acre-feet [TAF]), indicating less erosion and mass wasting than the No Action Alternative.

Alternative 3

During releases from Trinity Reservoir during dry periods, Alternative 3 would have an increase in flow that would likely result in an increase in erosion of the bed and banks of the Trinity River when compared with the No Action Alternative. During wet periods, Alternative 3 would result in a decreased potential for erosion compared with the No Action Alternative.

Alternative 4

During releases from Trinity Reservoir, Alternative 4 during dry periods is less likely to result in erosion of the bed and banks of the Trinity River when compared with the No Action Alternative. However, during wet periods, Alternative 4 increase is negligible relative to the No Action Alternative.

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[6] High flows are defined as flows from the CalSim3 model that exceed the No Action Alternative and thus cause more impacts than NAA conditions.

[7] For a reservoir, Alternative drawdown values > No Action Alternative drawdown values imply a larger erosional surface exposed for the alternative than the No Action Alternative possibly resulting in surface erosion and mass-wasting. For river releases, Alternative drawdown values > No Action Alternative drawdown values implies more releases into the river and possibly results in flooding with subsequent bank failures.

[8] As defined in Appendix W, negligible drawdown values are those whose changes from the No Action Alternative are between -5% and 5%.

Agricultural Land Erosion

The steep, mountainous terrain associated with much of Trinity River watershed has precluded development of irrigated agriculture; therefore, erosion of irrigable lands is excluded from consideration in this discussion for all action alternatives.

20.2.1.2 Sacramento Valley

Reservoir Mass Wasting

Alternative 1

Shoreline erosion associated with changes in Shasta Reservoir storage is negligible under Alternative 1 compared with the No Action Alternative. Under Alternative 1, Folsom Reservoir drawdowns for dry periods is more (24% change) than the No Action Alternative. Therefore, there is a greater likelihood for shoreline erosion in Folsom Reservoir to occur for Alternative 1 during dry periods relative to the No Action Alternative. Changes in shoreline erosion in Folsom Reservoir would be negligible in wet periods.

Alternative 2

During dry periods in Shasta Reservoir, all phases of Alternative 2 have positive drawdown values (ranging from 11% to 21% change) that indicate the likelihood for shoreline erosion would be greater relative to the No Action Alternative. For wet periods, all phases of Alternative 2 would have negligible drawdown changes relative to No Action Alternative. Changes in shoreline erosion in Folsom Reservoir would be negligible in both dry and wet periods for all phases of Alternative 2.

Alternative 3

During dry periods, Alternative 3 has a positive drawdown value (32% change) for Shasta Reservoir storage. Therefore, there is a greater potential for shoreline erosion relative to the No Action Alternative for Alternative 3. For wet periods, the potential for shoreline erosion would be negligible relative to the No Action Alternative. Changes in shoreline erosion in Folsom Reservoir would be negligible in both dry and wet periods for Alternative 3.

Alternative 4

Under Alternative 4, dry periods in Shasta Reservoir would have an increased potential for shoreline erosion at Shasta Reservoir relative to the No Action Alternative due to the increased drawdown (9% change). For wet periods, the potential for shoreline erosion is negligible relative to the No Action Alternative. Changes in shoreline erosion in Folsom Reservoir would be negligible in both dry and wet periods for Alternative 4.

Riverine Erosion

Alternative 1

Under Alternative 1, flow-related riverine erosion in the Sacramento River for both dry and wet periods is negligible. Alternative 1 would likely result in decreased riverine erosion in the American River relative to the No Action Alternative. During wet periods, conditions are equal to those in the No Action Alternative, and therefore riverine erosion in the American River would be comparable to the No Action Alternative. The potential for riverine erosion through the Yolo Bypass under Alternative 1 is negligible given the low channel gradient, large cross-sectional area for flow, and low flow velocities at the margins of the bypass.

Alternative 2

Under all phases of Alternative 2, the potential for riverine erosion in the Sacramento River for both dry and wet periods would be negligible. All phases of Alternative 2 would release less flow during dry periods to at the American River and would result in decreased riverine erosion in the American River relative to the No Action Alternative. During wet periods, conditions are equal to those in the No Action Alternative. The minor anticipated increase in winter flood flows through the Yolo Bypass under Alternative 2 Without TUCP Without VA and Alternative 2 With TUCP Without VA would result in negligible increases in riverine erosion. However, under Alternative 2 Without TUCP With Delta VA and Alternative 2 Without TUCP All VA, riverine erosion through the Yolo Bypass would be reduced relative to the No Action Alternative.

Alternative 3

Under Alternative 3, the potential for riverine erosion in the Sacramento River for both dry and wet periods is negligible. Under dry periods in the American River, Alternative 3 would result in decreased riverine erosion relative to the No Action Alternative. During wet periods, riverine erosion in the American River would be comparable to the No Action Alternative. Riverine erosion in the Yolo Bypass under Alternative 3 would be negligible.

Alternative 4

Under Alternative 4, releases to the Sacramento River for both dry and wet periods are negligible. Alternative 4 would release less during dry periods at American River and would likely result in decreased riverine erosion in the American River relative to the No Action Alternative. During wet periods, conditions are equal to those in the No Action Alternative, and therefore riverine erosion would be comparable to the No Action Alternative. The minor anticipated increase in riverine erosion through the Yolo Bypass under Alternative 4 would be negligible.

Agricultural Land Erosion

Alternative 1

When compared with the No Action Alternative, Alternative 1 lands subject to fallowing in the Sacramento River Region would be decreased by 0.05% during average years and by an average of 0.22% during critical and dry water year types, reducing the potential for wind erosion.

Alternative 2

When compared with the No Action Alternative, Alternative 2 would increase land subject to fallowing in the Sacramento River Region during average years from 0.03% to 0.34%, increasing the potential for wind erosion. During the average of critical and dry water year types, land subject to fallowing would increase by 0.21% to 0.27%, increasing the potential for wind erosion.

Alternative 3

When compared with the No Action Alternative, Alternative 3 lands subject to fallowing in the Sacramento River Region would be increased during average (1.11%) and the average of critical, and dry water year types (1.03%), increasing the potential for wind erosion.

Alternative 4

When compared with the No Action Alternative, Alternative 4 lands subject to fallowing in the Sacramento River Region would be decreased during average water years (0.06%) and increased during the average critical and dry water year types (0.04%). The potential for erosion would therefore decrease under Alternative 4 during average water year types and would increase during critical and dry water year types.

20.2.1.3 San Joaquin Valley

Reservoir Shoreline Erosion

Alternative 1

Under Alternative 1, changes in shoreline erosion at New Melones Reservoir would be negligible in both dry and wet periods.

Alternative 2

Under all phases of Alternative 2, changes in shoreline erosion at New Melones Reservoir would be negligible in both dry and wet periods.

Alternative 3

Under Alternative 3, changes in shoreline erosion at New Melones Reservoir would be negligible in both dry and wet periods.

Alternative 4

Under Alternative 4, changes in shoreline erosion at New Melones Reservoir would be negligible in both dry and wet periods.

Under Alternatives 1 through 4, there would be no changes in shoreline erosion at Millerton Reservoir under either dry or wet periods. In addition, shoreline erosion at Millerton Reservoir would not be affected by changes elsewhere in the CVP.

Riverine Erosion

Alternative 1

Alternative 1 has larger drawdowns during both dry and wet periods (13% change and 7% change) through releases on the Stanislaus River relative to the No Action Alternative and has a slightly higher potential for riverine erosion during both dry and wet periods relative to the No Action Alternative. This may be caused by noise in the CalSim 3 model and is discussed further in Appendix W.

Alternative 2

Alternative 2 has larger drawdowns during dry periods (6% change) through releases on the Stanislaus River relative to the No Action Alternative. Therefore, under all phases of Alternative 2 during dry periods, the potential for riverine erosion would increase slightly relative to the No Action Alternative. Changes in riverine erosion during wet periods would be negligible relative to the No Action Alternative.

Alternative 3

Alternative 3 has larger drawdowns during wet periods (2% change) through releases on the Stanislaus River relative to the No Action Alternative. Under Alternative 3, riverine erosion would slightly increase in the Stanislaus River during wet periods relative to the No Action Alternative. During dry periods, riverine erosion would be negligible relative to the No Action Alternative.

Alternative 4

Releases to the Stanislaus River would be positive during dry periods (3 TAF, 7% change) and negligible during wet periods (22 TAF, 3% change) under Alternative 4. Under Alternative 4, riverine erosion would therefore slightly increase in the Stanislaus River during dry periods relative to the No Action Alternative. During wet periods, riverine erosion would be negligible relative to the No Action Alternative.

There would be no change in riverine erosion in in the San Joaquin River under any action alternative.

Agricultural Land Erosion

Alternative 1

When compared with the No Action Alternative, lands subject to fallowing in the San Joaquin River Region would be decreased during average years (2.88% change) and during the average of dry and critical water years (3.01%) under Alternative 1, decreasing the potential for erosion of fallowed land.

Alternative 2

When compared with the No Action Alternative, lands subject to fallowing in the San Joaquin River Region would decrease (0.15%) during average water years and would increase (0.25%) during the average of critical and dry water year types under Alternative 2 With TUCP Without VA. Therefore, the potential for erosion of fallowed lands would decrease in average water years and increase in critical and dry water year types.

When compared with the No Action Alternative, lands subject to fallowing in the San Joaquin River Region would increase (0.23%) during average water years and increase (0.82%) during the average of critical dry water years under Alternative 2 Without TUCP Without VA. This would increase the potential for erosion of fallowed lands during all water year types.

When compared with the No Action Alternative, lands subject to fallowing in the San Joaquin River Region would increase (1.50%) during average water years and increase (1.50%) during the average of critical dry water years under Alternative 2 Without TUCP Delta VA. This would increase the potential for erosion of fallowed lands during all water year types.

When compared with the No Action Alternative, lands subject to fallowing in the San Joaquin River Region would increase (1.50%) during average water years and increase (1.43%) during the average of critical dry water years under Alternative 2 Without TUCP Systemwide VA. This would increase the potential for erosion of fallowed lands during all water year types.

Alternative 3

When compared with the No Action Alternative, lands subject to fallowing in the San Joaquin River Region would decrease (9.56%) during average water years and increase (6.63%) during the average of critical dry water years under Alternative 3. Therefore, the potential for erosion would decrease during average water years and increase during critical and dry water year types.

Alternative 4

When compared with the No Action Alternative, lands subject to fallowing in the San Joaquin River Region would decrease (0.06%) during average water years and increase (0.33%) during the average of critical dry water years under Alternative 4. Therefore, the potential for erosion would decrease during average water years and increase during critical and dry water year types.

20.2.1.4 Bay-Delta Operations

Riverine Erosion

Alternative 1

No changes in riverine erosion would occur in the Bay-Delta Region under Alternative 1 relative to the No Action Alternative. No changes in riverine erosion would occur in the Suisun Marsh or the San Francisco Bay under Alternative 1 relative to the No Action Alternative.

Alternative 2

No changes in riverine erosion would occur in the Bay-Delta Region under any phase of Alternative 2 relative to the No Action Alternative. No changes in riverine erosion would occur in the Suisun Marsh or the San Francisco Bay under any phase of Alternative 2 relative to the No Action Alternative.

Alternative 3

As discussed previously, a minor increase in flow under Alternative 3 is expected through the Bay-Delta Region during January; however, this increase is within the range of high flows through the Bay-Delta Region during winter flood events through the Bay-Delta; therefore, riverine erosion is not a substantial concern in this area.

Alternative 4

No changes in flows are expected in the Bay-Delta Region under Alternative 4 compared with the No Action Alternative; therefore, riverine erosion would not occur in this area. No changes in flows are expected in the Suisun Marsh or the San Francisco Bay under Alternative 4; therefore, there is no expected change in riverine erosion.

Agricultural Land Erosion

No conversion of agricultural land or crop idling is anticipated, and erosion of fallowed land would not change compared with the No Action Alternative. Under all phases of Alternative 2 and Alternative 3, agricultural flows to the San Francisco Bay Area would decrease, which could result in erosion of fallowed land. Under Alternative 4, agricultural flows to the San Francisco Bay Area would increase, which could increase erosion of fallowed land.

20.2.1.5 Additional CVP and SWP Service Areas

There are no Reclamation storage reservoirs or affected stream reaches in the CVP and SWP service areas; therefore, erosion of fallowed land would not change relative to the No Action Alternative.

20.2.2 Potential Changes in Rate of Land Subsidence

Land subsidence occurs for different reasons throughout the Central Valley. Land subsidence in the Sacramento and San Joaquin valleys occurs primarily due to aquifer-system compaction as groundwater elevations decline because of groundwater overdraft (i.e., groundwater withdrawals at rates greater than groundwater recharge rates) typically used for irrigation.

20.2.2.1 Trinity River

As described in Appendix I, *Groundwater Technical Appendix*, the area along the Trinity River is not known to be susceptible to subsidence, and groundwater pumping is not expected to increase in this region; therefore, subsidence is not a concern in this area.

20.2.2.2 Central Valley

Land subsidence is caused by the consolidation of certain subsurface soils when the pore pressure in those soils is reduced. In the Sacramento and San Joaquin valleys, that reduction in pore pressure is usually caused by groundwater pumping that causes groundwater levels to fall below historical low levels. The location and amount of subsidence is highly dependent on the local soil conditions and historical low groundwater levels in the area. Given that groundwater levels are generally expected to increase or remain unchanged due to Alternative 1, it is unlikely that Alternative 1 would cause additional subsidence relative to the No Action Alternative.

Average simulated groundwater levels decrease up to approximately 12 feet for Alternative 2 With TUCP Without VA and Alternative 2 Without TUCP Without VA in some water year types relative to the No Action Alternative. Groundwater levels may decrease by as much as 20 feet for Alternative 2 Without TUCP Delta VA and Alternative 2 Without TUCP Systemwide VA relative to the No Action Alternative. The largest decreases in simulated groundwater levels would occur along the western portion of the Central Valley in the Sacramento Valley and in the San Joaquin Valley. Portions of these areas are known to have historic subsidence, and further reductions in groundwater level may cause additional subsidence. All phases of Alternatives 2 result in larger decreases in groundwater levels than the No Action Alternative and, thus, have a higher likelihood of additional subsidence.

Average simulated groundwater levels indicate that Alternative 3 may decrease groundwater levels by as much as 160 feet in some water year types relative to the No Action Alternative. The largest decreases in groundwater levels are simulated to occur along the western portion of the Sacramento and San Joaquin valleys. Additional areas of decreased groundwater levels appear north of Modesto and south of Fresno. Given the relatively large decreases in simulated groundwater elevations and the fact that portions of these areas are known to have historic subsidence, the potential for additional subsidence is high.

In the Sacramento and San Joaquin valleys, average simulated groundwater levels are generally expected to decrease up to 7 feet in certain water year types under Alternative 4 relative to the No Action Alterative. The largest decreases in these simulated groundwater levels occur along the western portion of the Sacramento Valley. The relatively small decreases in groundwater levels are not expected to cause large amounts of additional subsidence.

20.2.2.3 Southern California Region

The Southern California region is not known to be highly susceptible to subsidence, as noted in Appendix I, Section I.2.3.1.4, *Southern California Region*. Groundwater pumping is not expected to increase in this region, suggesting that subsidence will not be a concern in this area.

20.2.3 Mitigation Measures

No avoidance and minimization measures or mitigation measures have been identified for geology and soils.

20.2.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and may result in potential changes in soil erosion and rate of land subsidence at reservoirs that store CVP water, tributaries, and agricultural land. The action alternatives will result in changes to soil erosion and rate of land subsidence at reservoirs that store CVP water, tributaries, and agricultural land. The magnitude of the changes is dependent on alternative and water year type. Therefore, the No Action Alternative and action alternatives may contribute to cumulative changes to geology and soils resources as described in *Appendix W*, *Geology and Soils Resources* and *Appendix Y*, *Cumulative Impacts Technical Appendix*.

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Chapter 21 Public Health and Safety

This chapter is based on the background information and technical analysis documented in Appendix X, *Public Health and Safety Technical Appendix*, which includes additional information on public health and safety conditions and technical analysis of the effects of each alternative.

21.1 Affected Environment

21.1.1 Valley Fever

Coccidioidomycosis (Valley fever) is an illness that is caused by inhaling the spores of a soil-dwelling fungus, *Coccidioides* (Centers for Disease Control and Prevention 2019). This fungus lives in the top layers of some soils within 2 to 12 inches from the ground surface (California Division of Occupational Safety and Health 2017). When the soil is disturbed by digging, vehicles, cultivation, or wind, the fungal spores are dispersed and can be inhaled by people in the area. Irrigated soils are less likely to contain the fungus than dry, previously undisturbed soils.

21.1.2 Bioaccumulation of Methylmercury in Fish

In aquatic environments, sulfate-reducing bacteria, and, to a lesser degree, iron-reducing bacteria, convert inorganic mercury to methylmercury, and this process is enhanced by multiple environmental variables in water and sediment including temperature, pH, oxygen, sulfate and/or iron, and the presence of organic matter (U.S. Geological Survey 2014; State Water Resources Control Board 2017). Conversion of inorganic mercury to methylmercury occurs primarily at the sediment-water interface, but also in anoxic waters, and drying and rewetting of soils and sediment stimulates mercury methylation (State Water Resources Control Board 2017). Methylmercury production is greatest in high marshes that experience wet and dry periods over the highest monthly tidal cycles, and production is lower in low marshes that are always inundated and not subject to dry periods (Alpers et al. 2008). Total mercury concentrations in sediment positively correlate with methylmercury levels in sediment and water (Central Valley Regional Water Quality Control Board 2010). Positive correlations also exist between fish tissue methylmercury concentrations and concentrations of total mercury and methylmercury in water (State Water Resources Control Board 2017). High concentrations of mercury in the form of methylmercury can bioaccumulate in fish and shellfish through food consumption and absorption from water based upon the water quality.

21.1.3 Harmful Algal Blooms

Cyanobacteria harmful algal blooms (CHABs) are overgrowths of cyanobacteria in surface waterbodies that generally occur from spring to fall (May to October) when water temperatures are warmer and are therefore conducive to bloom formation (Central Valley Regional Water Quality Control Board 2019). Cyanobacteria are microscopic, photosynthetic organisms that occur naturally in fresh, marine, and brackish waters (ITRC 2021). Under certain conditions, cyanobacteria can multiply and become very abundant, discoloring the water throughout a water body, accumulating at the surface, and/or attached to surfaces in a water body (e.g., rocks, submerged vegetation). The overgrowth of cyanobacteria in surface waters is referred to as a bloom. Generally, CHABs are dependent on warmer water temperatures; water clarity and irradiance; a calm, stratified water column coupled with long water residence times; and sufficient availability of dissolved nitrogen and phosphorus (U.S. Environmental Protection Agency 2019b; Lehman et al. 2013; Berg and Sutula 2015). Some species of cyanobacteria produce toxins, referred to as cyanotoxins, which can have adverse health effects on humans, domestic animals, fish and other aquatic biota, and other wildlife.

21.2 Effects of Alternatives

The impact analysis considers changes in public health and safety conditions related to changes in CVP and SWP operation under the alternatives as compared with the No Action Alternative.

The No Action Alternative and action alternatives may introduce public health hazards to the study area through the following mechanisms.

- A reduction in surface water supplies could result in an increase in agricultural land fallowing and a consequent increase in dust, which could increase the potential for exposure to Valley fever fungal spores.
- Central Valley Project and State Water Project operations could affect water and fish tissue methylmercury concentrations.
- Increase the potential for public exposure to cyanotoxins due to an increase in CHABs.

Under the No Action Alternative, Reclamation would continue with the current operation of the CVP, as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the SWP represent current management direction or intensity pursuant to 43 CFR Section 46.30.

The No Action Alternative is not expected to result in potential changes to Public Health and Safety resources, such as changes to Valley fever related to changes in irrigated agricultural land. Potential changes are not anticipated in methylmercury production and resultant changes in bioaccumulation in fish for human consumption, nor public exposure to cyanotoxins due to an increase in CHABs. These impacts were described and considered in the LTO 2020 Record of Decision and associated documents.

Alternatives 2b and 4b are expected to be within the range of effects for Public Health and Safety described below for Alternatives 2 and 4, respectively.

21.2.1 Potential changes in the potential for Valley fever related to changes in irrigated agricultural land

Under the No Action Alternative, Reclamation would continue with the current operation of the CVP, as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. CVP and SWP operations under the No Action Alternative are not expected to result in an increase in nonirrigated agricultural land relative to existing conditions and, thus, there would be no increased potential for growth of *Coccidioides* in the study area. Accordingly, adverse effects on public health are not expected related to Valley fever under the No Action Alternative.

Alternative 1 would increase irrigated agricultural acreages in the study area (i.e., the Sacramento River and San Joaquin River regions) over the long-term average condition and in dry and critical dry years relative to the No Action Alternative. Because there would be no reduction of irrigated agricultural land in the study area under Alternative 1, there would be a decrease in the potential for Valley fever due to CVP and SWP operations under this alternative.

There would be a decrease in irrigated agricultural acreages in the study area over the long-term average condition under Alternatives 2 and 3 relative to the No Action Alternative, and an increase in irrigated agricultural acreages in the study area over the long-term average condition under Alternative 4 relative to the No Action Alternative. Under dry and critical conditions, the Sacramento River region and San Joaquin River region would have fewer irrigated acres relative to the No Action Alternative under Alternatives 2, 3, and 4. Although there would be a reduction in irrigated agricultural land in the study area under Alternatives 2, 3, and 4 relative to the No Action Alternative, conversion of this land to non-agricultural use would not necessarily mean that the land would be fallowed or idled; land taken out of production could be converted to a different land use altogether that is not conducive to the growth of *Coccidioides*. Further, implementation of Mitigation Measure AG-1, *Diversify Water Portfolios,* could help reduce the magnitude of irrigated agricultural land conversion by encouraging water users to develop alternative sources of water. Accordingly, an increase in the potential for Valley fever due to CVP and SWP operations under Alternatives 2, 3, and 4 is not expected.

21.2.2 Potential changes in methylmercury production and resultant changes in bioaccumulation in fish for human consumption

Under the No Action Alternative, Reclamation would continue with the current operation of the CVP, as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. Given the lack of changes under the No Action Alternative to CVP and SWP operations, there are no expected additional changes on water quality conditions in the study area associated with methylmercury or increased risks for humans consuming fish in the study area.

Under Alternatives 1, 2 and 4, there would be no adverse effects on public health due to methylmercury exposure related to consumption of fish because modeled changes in water column concentrations of methylmercury would have little to no measurable effect on fish tissue concentrations in the Delta, Suisun Marsh, Suisun Bay or San Francisco Bay relative to the No Action Alternative.

Alternative 3 would not result in increased water column methylmercury concentrations or increased methylmercury bioaccumulation in biota in Suisun Marsh relative to the No Action Alternative. Modeled long-term average water column concentrations of methylmercury in the Delta under Alternative 3 would not differ from those under the No Action Alternative at the modeled Delta assessment locations except for increases of 0.01 ng/L at Victoria Canal, Contra Costa Water District Pumping Plant #1, Banks Pumping Plant, and Jones Pumping Plant. Under Alternative 3, modeled changes in water column concentrations of total methylmercury could have a measurable effect on Delta fish tissue concentrations relative to the No Action Alternative. All modeled fish tissue concentrations exceed the water quality objective of 0.24 milligrams per kilogram (mg/kg) wet weight (ww) [350 mm largemouth bass fillets])[9] under both the No Action Alternative and Alternative 3. Average modeled fish tissue concentrations for all years increased at all modeled Delta locations by 0.01 to 0.08 mg/kg ww relative to the No Action Alternative, which indicates a increase in the potential for methylmercury bioaccumulation in fish tissue. Because Alternative 3 would result in higher Delta outflow in all months except June, relative to the No Action Alternative, methylmercury loads to Suisun Bay and San Francisco Bay could potentially increase, which could result in increased methylmercury bioaccumulation in fish in these areas. OEHHA standards for the consumption of fish in the study area would continue to be implemented and thus would serve to protect people against the overconsumption of fish with increased body burdens of mercury.

21.2.3 Potential changes in the potential for public exposure to cyanotoxins due to an increase in CHABs

Under the No Action Alternative, Reclamation would continue with the current operation of the CVP, as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. There would be no additional changes in CVP or SWP system operations under the No Action Alternative relative to existing conditions. Additionally, it is foreseeable that there would be implementation of water resources management projects to provide water supplies. As a result there would be no change in the limits on water supply deliveries currently in place. Given the lack of changes to CVP and SWP operations under the No Action Alternative, there would be no expected changes associated with the operation of the CVP and SWP on water quality associated with CHABs in the study area.

Because there would not be substantial effects on changes in Delta inflows from the Sacramento and San Joaquin rivers June through November, Alternatives 1, 2, and 4 are expected to have only minor, if any, effect on the environmental variables (i.e., irradiance, nutrients, water column turbulence/mixing, temperature and residence time) correlated with the frequency or magnitude of CHABs, relative to the No Action Alternative. As such, Alternatives 1, 2 and 4 would not increase the potential for public exposure to cyanotoxins in the study area and there would be no associated adverse effects.

Alternative 3 would have similar effects on nutrients and water clarity as Alternatives 1, 2, and 4, which would be minimal changes from the No Action Alternative. However, relative to the No Action Alternative, Alternative 3 would result in substantial reductions in Sacramento River flows at Freeport and San Joaquin River flows at Vernalis entering the Delta during the months June through September, when CHABs are most likely to occur. The substantial flow reductions that would occur under this alternative, relative to the No Action Alternative, in June and July in all but critical water years types; June through August for wet, above normal, and below normal years; and in June and July of dry years would be expected to increase residence time throughout many locations within the study area. Reduced Sacramento River and San Joaquin River inflows to the Delta and increased water residence times within the Delta could cause increased water temperatures at some Delta locations in some months of the June through September period. The substantial reductions in Delta inflows from these rivers may also result in reduced turbulence

[9] The methylmercury objectives protective of human health and wildlife include a goal of not exceeding 0.24 mg/kg wet weight in muscle tissue of trophic level 4 fish (200–500 mm total length) normalized to 350 mm total length.

and mixing of water in the Delta, relative to that for the No Action Alternative. This reduction in turbulence would create a calmer water column favored by cyanobacteria. Alternative 3 could increase the potential for public exposure to cyanotoxins in waterbodies in the Bay-Delta region.

Because Alternative 3 is expected to make CHABs worse in the Delta, greater volumes of cyanobacteria cells would be expected to flow from the Delta into Suisun Marsh, relative to the No Action Alternative. Also, salinity is typically sufficiently low within the eastern portion of the marsh to allow CHABs to form. Consequently, Alternative 3 could increase CHABs in Suisun Marsh. However, because of higher salinity levels in Suisun Bay and San Francisco Bay that typically prevent *Microcystis* and other cyanobacteria common to the Delta from producing problematic blooms in these water bodies, Alternative 3 is not expected to measurably increase CHABs in Suisun Bay or San Francisco Bay.

21.3 Mitigation Measures

21.3.1 Avoidance and Minimization Measures

21.3.1.1 Alternatives 1 – 4

No avoidance and minimization measures have been identified.

21.3.2 Additional Mitigation

21.3.2.1 Alternative 1

No mitigation measures have been identified.

21.3.2.2 Alternatives 2, 3, and 4

Alternatives 2, 3, and 4 would result in fewer irrigated irrigation acres relative to the No Action Alternative. Although there would be a reduction in irrigated agricultural land in the study area under Alternatives 2, 3, and 4 relative to the No Action Alternative, conversion of this land to non-agricultural use would not necessarily mean that the land would be fallowed or idled; land taken out of production could be converted to a different land use altogether that is not conducive to the growth of *Coccidioides*.

- *Mitigation Measure AG-1: Diversify Water Portfolios* - could be implemented to reduce impacts

21.4 Cumulative Impacts

The No Action Alternative would continue with the current operation of the CVP and may contribute to potential changes to Public Health and Safety resources. The action alternatives are anticipated to result in changes in Valley fever related to changes in irrigated agricultural land, methylmercury production and resultant changes in bioaccumulation in fish for human consumption, and public exposure to cyanotoxins due to an increase in CHABs. The magnitude of the changes is dependent on alternative and water year type. Therefore, the No Action

Alternative and the action alternatives may contribute to cumulative changes to Public Health and Safety resources as described in Appendix X, *Public Health and Safety Technical Appendix* and Appendix Y, *Cumulative Impacts Technical Appendix*.

Chapter 22 Resources Not Analyzed in Detail

The following resources were not analyzed in detail in this environmental impact statement (EIS). As described in Code of Federal Regulations title 40, section 15021, an EIS "shall provide full and fair discussion of significant environmental impacts and shall inform decision makers and the public of reasonable alternatives that would avoid or minimize adverse impacts or enhance the quality of the human environment. Agencies shall focus on significant environmental issues and alternatives and shall reduce paperwork and the accumulation of extraneous background data." To meet this purpose, the following resources were not analyzed in detail because there would not be impacts to these resources, as explained below.

22.1 Population and Housing

Typically, impacts on population and housing are the result of actions that would induce population growth either directly or indirectly or actions that would displace large numbers of people and, therefore, necessitate the construction of additional housing in other locations. Direct impacts would include actions that create additional housing. Indirect impacts include actions that create infrastructure that would induce or support population growth beyond current expectations.

The alternatives evaluated in this EIS would not cause impacts on population and housing because they are composed primarily of operational changes that would not directly or indirectly affect housing or residential populations or create new water supplies that are anticipated to accommodate growth. The alternatives would not create additional housing, provide infrastructure to support additional population, or displace existing populations necessitating the creation of housing in another location. Therefore, it is not anticipated that the alternatives would result in either direct or indirect population growth as the result of operations-related activities.

22.2 Traffic and Transportation

Impacts on traffic and transportation are usually the result of actions that would either directly or indirectly increase road congestion, thereby potentially increasing travel times on roads, increasing emergency response times, or conflicting with local traffic or transportation plans. Such impacts are typically the result of the addition of new roads, new infrastructure that could lead to increased traffic or population growth, or construction activities that would generate additional truck traffic.

The alternatives evaluated in this EIS would not cause impacts on traffic and transportation because they are comprised primarily of operational changes that would not directly or indirectly affect traffic. The operational changes would not induce additional traffic or interfere with existing traffic and transportation patterns. Therefore, it is not anticipated that the alternatives would result in impacts on traffic and transportation as the result of operation-related activities.

22.3 Flood Control

Central Valley Project and State Water Project reservoirs provide flood control in addition to their other purposes. Changing the operations of the facilities could have the potential to affect flood management; however, the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR) are not proposing to alter flood control requirements. Each facility has a flood control curve that defines storage throughout the year that must be available to help manage high flows. The action alternatives would not change these flood control curves or operational parameters established in cooperation with the U.S. Army Corps of Engineers to manage flood risk. Reclamation and DWR would continue to operate with the same flood management procedures under the action alternatives; therefore, the alternatives would not affect flood control.

22.4 Noise

Typically, impacts on noise and vibration are the result of construction activities, including construction equipment used for long-term maintenance or operations. Construction noise levels for various elements of the construction process are calculated based on anticipated construction equipment types and methods of operation. The magnitude of construction noise effects on noise-sensitive land uses depends on the type of construction activity, the noise level generated by various pieces of construction equipment, the distance between the activity and noise-sensitive land uses, and whether the ground between the source and the receiver is "acoustically hard" (e.g., pavement, reflective water) or "acoustically soft" (e.g., unpaved soil). The action alternatives would not include construction activities for new infrastructure and, therefore, would not include maintenance activities for newly constructed infrastructure. Therefore, it is not anticipated that the alternatives would result in impacts on noise and vibration.

Chapter 23 Other NEPA Considerations

23.1 Irreversible and Irretrievable Commitment of Resources

The National Environmental Policy Act (NEPA) requires that an environmental impact statement (EIS) include a discussion of the irreversible and irretrievable commitments of resources that may be involved should an action be implemented. An irreversible commitment of resources is the permanent loss of a resource that cannot be replaced (or restored over a long period of time). An irretrievable commitment of resources is a loss of production or use of natural resources. The operational components of some of the action alternatives would result in irretrievable impacts on power resources, as discussed in Section 18.2.1. Alternative 1 would increase the annual energy use of the Central Valley Project (CVP) 12% for the long-term average and 15% for dry and critically dry years. The increase in annual generation (1% long-term average, 3% dry and critically dry years) would be much less than increases of annual energy use (12% long-term average, 15% dry and critically dry years) under Alternative 1, resulting in slight reductions in annual net generation (4% long-term average, 2% dry and critically dry years). These would represent irreversible and irretrievable commitments of power resources for Alternatives 1.

For the State Water Project (SWP), Alternative 1 would increase the annual energy use of the SWP 25% for the long-term average and 47% for dry and critically dry years compared to the No Action Alternative. Under Alternative 1 for the long-term average and dry and critically dry years, the increase in annual generation (10% and 43%, respectively) would be less than increases of annual energy use (25% and 47%, respectively), resulting in reductions in annual net generation (42% long-term average, 72% dry and critically dry years). Alternative 2 phases would slightly increase (2% to 3%) annual long-term average energy use; and slightly increase annual energy use (1% to 3%) or have no change in dry and critically dry years. Under Alternative 2 phases there would be slight increases or decreases in annual generation (<1% to 1%) or there would be no change for both year types, resulting in slight decreases (4% to 6%) in annual net generation for Alternative 2 phases compared to the No Action Alternative. Alternative 4 would slightly increase average energy use for the annual long-term average (4%), and for dry and critically dry years (6%). Under Alternative 4 there would be slight increases (1% long-term average, 2% dry and critically dry years) in annual generation, resulting in a decrease (7%) in annual net generation for the long-term average and a decrease (10%) in net generation for dry and critically dry years. These would represent irreversible and irretrievable commitments of power resources for Alternatives 1, 2, and 4.

The operational components of some of the action alternatives would result in irretrievable impacts on water supply, given changes in releases from reservoirs, as described in greater detail in Appendix W, *Geology and Soils Technical Appendix*, in the context of potential changes in soil erosion (see Tables W-1, W-2, W-3, W-4, and W-5). Table 23-1 presents a summary of changes in reservoir releases.

Table 23-1. Summary of Changes in Reservoir Releases (Dry Period and Wet Period)

Release Location	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Trinity River	-3% to -2%	-9% to 1%	-8% to 6%	-9 to 2%
Sacramento River	-3% to 1%	2% to 5%	3% to 4%	0% to 1%
American River	-43% to 0%	-31% to 0%	-20% to 0%	-14% to -1%
Stanislaus River	7% to 13%	3% to 6%	4% to 10%	3% to 7%
San Joaquin River	-2% to 0%	0%	0% to 5%	0%

23.2 Relationship between Short-Term Uses and Long-Term Productivity

NEPA requires that an EIS consider "the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity." 40 Code of Federal Regulations 1502.16(a)(3).

In the short and long term, the action alternatives are expected to use power resources to operate the CVP and SWP. Power consumption and power generation are considered both short- and long-term. As discussed in Section 23.1, there would be a net loss of power generation for Alternatives 1 and 4 for the CVP. There would be a loss in net generation for the SWP for Alternatives 1, 2, and 4.

The action alternatives will have varying effects on water deliveries, as shown in Table 23-2 and described in more detail in Appendix H, Water Supply. Increases in water supply shown in Table 23-2 could increase economic productivity, and vice versa. Additionally, as described in greater detail in Chapter 12, these changes in operations would also result in impacts to biological resources, ranging from adverse to beneficial depending on alternative, species, and water year type.

Table 23-2. Summary of Changes in Water Deliveries

Region	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Trinity, Sacramento, Clear Creek, American River	• *Reduce:* CVP Refuge Level 2 • *Increase:* Other Contracts	• *Reduce:* CVP Refuge Level 2, CVP Agriculture, CVP Settlement Contractors • *No Change:* CVP M&I, SWP M&I	• *Reduce:* CVP Settlement Contractors, CVP Refuge Level 2, CVP M&I, CVP Agriculture • *No Change:* SWP M&I	• *Reduce:* CVP Settlement Contractors, Agriculture • *No Change:* CVP Refuge Level 2, CVP M&I, SWP M&I

Region	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Stanislaus	• *Increase:* All	• *Reduce:* CVP Agriculture • *Increase:* CVP Exchange Contractors, CVP Refuge Level 2 • *No Change:* CVP M&I, SWP Agriculture	• *Reduce:* CVP Exchange, CVP Refuge Level 2, CVP M&I, CVP Agriculture, SWP Agriculture	• *No Change:* All
San Francisco Bay/Sacramento–San Joaquin Delta Estuary	• *Increase:* All	• *Reduce:* CVP M&I, CVP Agriculture • *Increase:* SWP M&I	• *Reduce:* CVP M&I, CVP Agriculture, SWP M&I	• *No Change:* CVP M&I, CVP Agriculture • *Increase:* SWP M&I
Central Coast	• *Increase:* All	• *Increase:* All	• *Reduce:* All	• *Increase:* All
Tulare Lake	• *No Change:* CVP Refuge Level 2 • *Increase:* Other Contracts	• *No Change:* CVP Refuge Level 2 • *Increase:* All Other Contract Types	• *Reduce:* CVP Refuge Level 2, CVP Agriculture, SWP M&I, SWP Agriculture	• *Reduce:* CVP Agriculture • *No Change:* CVP Refuge Level 2 • *Improve:* SWP M&I, SWP Agriculture
Lahontan	• *Increase:* All	• *Increase:* All	• *Reduce:* All	• *Increase:* All

CVP = Central Valley Project; SWP = State Water Project; M&I = municipal and industrial

23.3 Growth-Inducing Impacts

NEPA requires that an EIS consider indirect effects of a project, which can be the result of growth inducement. This Project would not directly induce growth through the construction of infrastructure, housing, or commercial development.

As indicated in Table 23-1, some alternatives in some regions would increase water supplies, and inadequate water supplies can be a barrier to growth. However, these increased deliveries are to portions of the CVP and SWP where deliveries have been severely constrained in recent years. Therefore, the action alternatives would not increase deliveries above existing contract amounts and are not expected to reasonably and foreseeably indirectly result in growth-inducing impacts.

23.4 Consultation and Coordination

The U.S. Department of the Interior, Bureau of Reclamation (Reclamation) and the Department of Water Resources (DWR) have been coordinating CVP and SWP operations pursuant to the 1986 "Agreement Between the United States and State of California for the Coordinated Operations Agreement of the CVP and SWP," as amended in 2018. DWR is an applicant under the Interagency Cooperation regulations at 50 CFR § 402.02. Reclamation has worked to coordinate with many different parties that may have an interest in the development of this EIS. Reclamation has been meeting with stakeholders and interested parties since consultation was reinitiated on September 30, 2021. (See Attachment 23.1.)

23.4.1 Interested Party Meetings

Reclamation has been conducting monthly interested party meetings to coordinate with water users, Tribes, cooperating agencies, state and local governments, public utilities districts, non-governmental organizations, among others to provide engagement opportunities that include providing information and receiving input on matters relevant to the long-term operation process.

23.4.2 Water Infrastructure Improvements for the Nation Act

Reclamation has been conducting quarterly public meetings consistent with the Water Infrastructure Improvements for the Nation Act, to provide for the conservation and development of water and related resources.

23.4.3 Tribal Consultation

Reclamation continues to coordinate with interested Tribes on CVP operations. Reclamation is separately and concurrently coordinating with the Hoopa Valley Tribe and the Yurok Tribe as joint leads (40 CFR part 1501) on Trinity River-specific considerations to develop potential Trinity River-specific alternatives for an updated operation for releases to the Trinity River and diversions from the Trinity River Basin to the Central Valley.

23.4.4 Resource Agencies

Reclamation has been coordinating regularly with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and California Department of Fish and Wildlife on the information related to biological resources that will be included in the EIS. Moreover, Alternative 2 was developed in coordination with these agencies.

23.4.5 Public Water Agencies

Reclamation has been coordinating with Public Water Agencies and collecting feedback during monthly interested party meetings.