5. Guide to the Resource Analyses

5.1 Introduction

This chapter is included to help readers understand how the impact analyses were conducted and presented for the resource discussions in Chapters 6 through 31. The resource chapters included in this Environmental Impact Report/Environmental Impact Statement (EIR/EIS) were prepared by a multi-discipline team of resource specialists using data from site visits, field surveys, and technical studies conducted for the Project; and information obtained from published environmental and planning documents, books, websites, journal articles, and communications with technical experts.

Chapters 6 through 31 of this EIR/EIS are organized by environmental resource area. Each chapter discusses the Environmental Setting[1]/Affected Environment,[2] and the Environmental Impacts[1]/Environmental Consequences[2] of implementing the five action alternatives (Alternatives A, B, C, C_1 (as appropriate), and D) in comparison to the Existing Conditions/No Project/No Action Condition. Environmental commitments included as part of all of the action alternatives are discussed in Chapter 3 Description of the Sites Reservoir Project Alternatives. Mitigation measures are proposed as applicable for those impacts considered to be potentially significant. Also discussed for each environmental resource area are the assumptions considered and methodologies used, the regulatory setting, and the references that were consulted during the preparation of the resource analyses.

Chapters 6 through 31 are organized into the following resource areas:

- Chapter 6: Surface Water Resources
- Chapter 7: Surface Water Quality
- Chapter 8: Fluvial Geomorphology and Riparian Habitat
- Chapter 9: Flood Control and Management
- Chapter 10: Groundwater Resources
- Chapter 11: Groundwater Quality
- Chapter 12: Aquatic Biological Resources
- Chapter 13: Botanical Resources
- Chapter 14: Terrestrial Biological Resources
- Chapter 15: Wetlands and Other Waters
- Chapter 16: Geology, Minerals, Soils, and Paleontology
- Chapter 17: Faults and Seismicity
- Chapter 18: Cultural/Tribal Cultural Resources
- Chapter 19: Indian Trust Assets
- Chapter 20: Land Use
- Chapter 21: Recreation Resources
- Chapter 22: Socioeconomics
- Chapter 23: Environmental Justice
- Chapter 24: Air Quality
- Chapter 25: Climate Change and Greenhouse Gas Emissions
- Chapter 26: Navigation, Transportation, and Traffic

---

[1] This terminology is applicable to the California Environmental Quality Act (CEQA).

[2] This terminology is applicable to the National Environmental Policy Act (NEPA).

- Chapter 27: Noise
- Chapter 28: Public Health and Environmental Hazards
- Chapter 29: Public Services and Utilities
- Chapter 30: Visual Resources
- Chapter 31: Power Production and Energy

For some of these resource areas, an appendix has been prepared. All appendixes are listed in the EIR/EIS Table of Contents, and are included at the end of this EIR/EIS. It should also be noted that potential impacts associated with Alternative C_1 are limited to (and, as such, are only discussed in) Chapter 24 Air Quality, Chapter 25 Climate Change and Greenhouse Gas Emissions, and Chapter 31 Power Production and Energy, given the alternative would be the same as Alternative C other than electricity would not be generated as part of the implementation of Alternative C_1.

The Sites Project Authority (Authority) and Bureau of Reclamation (Reclamation) prepared this EIR/EIS in accordance with the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) regulations and requirements, respectively. Requirements associated with implementing these laws and requirements is discussed in further detail in Chapter 1 Introduction.

5.2 Establishment of the Base Condition for the Environmental Setting/Affected Environment

In determining the "Environmental Setting/Affected Environment" for environmental analyses in this EIR/EIS, the California Department of Water Resources (DWR) and Reclamation consulted the *CEQA Guidelines* and the CEQ regulations (40 Code of Federal Regulations [CFR] Part 1500).

As described in Section 1.5, CEQA identifies the Existing Conditions as of the publication date for the Notice of Preparation (NOP). Under NEPA, the identification of policies that would be assumed to continue into the future for inclusion in the No Action Alternative is based on current conditions and assumptions related to relevant future actions that are anticipated to occur in the absence of the project.

As described in Chapter 1 Introduction, DWR originally published an NOP for the Project on November 5, 2001. The Authority assumed the role of CEQA lead agency in 2016 and issued a supplemental NOP on February 2, 2017. Reclamation did not issue a revised Notice of Intent (NOI). Existing conditions/affected environment assumptions for this EIR/EIS account for all current applicable regulatory requirements and operational criteria, including the following: 2008 U.S. Fish and Wildlife Service (USFWS) and 2009 National Marine Fisheries Service (NMFS) biological opinions, State Water Resources Control Board Decision 1641, and assumed current municipal, environmental, and agricultural water use and relevant current plans and policies. These assumed conditions are in part the basis against which each alternative is compared to determine the potential for significant impacts as part of the impact analysis.

5.3 Project Facilities Evaluated

Analysis of the action alternatives within each resource area included consideration of each of the following Project facilities that are components of the alternatives:

Sites Reservoir Complex

- Sites Reservoir Inundation Area
- Golden Gate Dam, Sites Dam, Saddle Dams
- Onsite Borrow Areas
- Sites Reservoir Inlet/Outlet Structure and Associated Facilities
- Sites Pumping/Generating Plant and Electrical Substation
- Tunnel from Sites Pumping/Generating Plant to Sites Reservoir Inlet/Outlet Structure
- South Bridge and Roads
- Recreation Areas
- Field Office Maintenance Yard

Holthouse Reservoir Complex

- Holthouse Reservoir
- Holthouse Spillway and Stilling Basin and Spillway Bridge
- Western Area Power Administration Transmission Line Relocation
- Sites Pumping/Generating Plant Approach Channel
- Existing Tehama-Colusa Canal Connection and Diversion
- Tehama-Colusa Canal Construction Bypass Pipeline
- Additional Pumps at the Red Bluff Pumping Plant
- Pipeline from terminal regulating reservoir (TRR) to Modified Funks Reservoir

Terminal Regulating Reservoir Complex

- Terminal Regulating Reservoir
- TRR Pumping/Generating Plant and Electrical Switchyard
- Glenn-Colusa Irrigation District (GCID) Main Canal Connection to TRR
- TRR Pipeline and TRR Pipeline Road
- GCID Main Canal Modifications

Delevan Pipeline Complex

- Delevan Pipeline Intake/Discharge Facilities
- Delevan Pipeline

Overhead Power Lines and Substations

Project Buffer

Combinations of these Project facilities were used to create Alternatives A, B, C, C_1, and D. In the resource chapters, the Authority and Reclamation described the potential impacts associated with the construction, operation, and maintenance of each of the Project facilities listed above for each of the five action alternatives. Some Project features/facilities and operations (e.g., reservoir size, overhead power line alignments, provision of water for local uses) differ by alternative, and are evaluated in detail within each of the resource areas chapters. As such, the Authority has evaluated a broad range of impacts; thus, combining project elements in a variety of ways would not generate impacts that have not already been addressed or would be more severe than those already identified For this reason, the Authority may choose to select or combine individual features as determined necessary.

5.4 Alternatives Analysis

As discussed in Chapter 2 Alternatives Analysis, the range of alternatives for this EIR/EIS was developed through the numerous screening processes and efforts as well as comments received during the scoping process. Key screening criteria included the relative ability to meet the Project objectives and purpose and need as well as avoidance or relative deduction of adverse effects.

CEQA requires an analysis of an alternative in which the Project is not implemented. CEQA calls this scenario the No Project Alternative. The No Project Alternative allows decision makers to use the EIR to compare the impacts of approving the Project with the future conditions of not approving the Project. *CEQA Guidelines* Section 15126.6, subdivision (e)(2), indicates that No Project conditions include reasonably foreseeable changes in Existing Conditions and changes that would be reasonably expected to occur in the foreseeable future if the project is not approved, based on current plans and consistent with available infrastructure and community services. Many of the reasonably foreseeable programs and projects typically included within the No Project Alternative affect water supply, water quality, or anadromous fisheries conditions as compared to Existing Conditions. The CEQA No Project Alternative assumes the same conditions as the NEPA No Action Alternative.

Similar to CEQA, NEPA requires an analysis of an alternative in which the Project is not implemented. The No Action Alternative is used as a basis of comparison to determine the environmental effects of the Project and alternatives. The No Action Alternative typically represents a projection of current conditions to reasonably foreseeable future conditions that could occur if the Project or alternatives are not implemented assuming continuation of existing policies and management direction.

Existing conditions and the future No Project/No Action alternatives were assumed to be similar in the Primary Study Area given the generally rural nature of the area and limited potential for growth and development in Glenn and Colusa counties within the 2030 study period used for this EIR/EIS as further described in Chapter 2 Alternatives Analysis. As a result, within the Primary Study Area, it is anticipated that the No Project/No Action Alternative would not entail material changes in conditions as compared to the existing conditions baseline.

With respect to the Extended and Secondary study areas, the effects of the proposed action alternatives would be primarily related to changes to available water supplies in the Extended and Secondary study areas (including the Bay-Delta and export areas), the Project's cooperative operations with other existing large reservoirs in the Sacramento watershed, and the resultant potential impacts and benefits to biological resources, land use, recreation, socioeconomic conditions, and other resource areas. DWR has projected future water demands through 2030 conditions that assume the vast majority of CVP and SWP water contractors would use their total contract amounts, and that most senior water rights users also would fully use most of their water rights. The Authority has accepted this assumption for this analysis. This increased demand in addition to the projects currently under construction and those that have received approvals and permits at the time of preparation of the EIR/EIS would constitute the No Project and No Action alternatives. As described in Chapter 2 Alternatives Analysis, the difference in current versus projected future water demands in the Sacramento Valley and other portions of the state is anticipated to be minimal because water demands have expanded to the levels projected to be achieved on or before 2030. Accordingly, existing conditions and the No Project/No Action alternatives are assumed to be the same for this EIR/EIS and as such are referred to as the Existing Conditions/No Project/No Action Condition, which is further discussed in Chapter 2 Alternatives Analysis. With respect to applicable reasonably foreseeable plans, projects, programs and policies that may be implemented in the future but that have not yet been approved, these are included as part of the analysis of cumulative impacts in Chapter 35 Cumulative Impacts. Potential impacts to and from the project associated with potential climate change are analyzed separately in Chapter 25 Climate Change and Greenhouse Gas Emissions.

For every resource discussion presented in Chapters 6 through 31, Alternatives A, B, C, and D were compared to the Existing Conditions/No Project/No Action Condition. Alternative C_1 was compared to the Existing Conditions/No Project/No Action Condition in Chapter 24 Air Quality, Chapter 25 Climate Change and Greenhouse Gas Emissions, and Chapter 31 Power Production and Energy, given the alternative would be the same as Alternative C other than electricity would not be generated as part of the implementation of Alternative C_1.

To reduce redundancy in the analyses of Alternatives A, B, C, C_1, and D, the analysis for Alternative A was presented first in the discussion, and then the analyses for Alternatives B, C, C_1, and D indicate if their impacts would be the same, or similar to, Alternative A. If the impacts were not similar, those analyses then described how they differed from Alternative A. Given the similarity between Alternatives C and D, many of the resource discussions reference the differences in conditions and impacts between the two alternatives, as appropriate. Additionally, as discussed above Alternative C_1 is discussed only in Chapter 24 Air Quality, Chapter 25 Climate Change and Greenhouse Gas Emissions, and Chapter 31 Power Production and Energy, as potentially significant impacts on all other resources that are anticipated to occur as part of implementing this alternative would be the same as those for Alternative C.

Each identified impact has been numbered in accordance with the naming convention presented in Table 5-1. Included in each impact discussion is the reasoning indicating *whether* and *why* there would be an impact and the level of significance of each impact, when compared to Existing Conditions/No Project/No Action Condition.

Table 5-1
Impact Naming Convention for each of the Resources Evaluated

Resource Area	Impact Numbering*
Surface Water Resources	Impact SW Res-#
Surface Water Quality	Impact SW Qual-#
Fluvial Geomorphology and Riparian Habitat	Impact Geom-#
Flood Control	Impact Flood-#
Groundwater Resources	Impact GW Res-#
Groundwater Quality	Impact GW Qual-#
Aquatic Resources	Impact Fish-#
Botanical Resources	Impact Bot-#
Terrestrial Biological Resources	Impact Wild-#
Wetlands and Other Waters	Impact Wet-#
Geology, Minerals, Soils, and Paleontology	Impact Geo/Soils-#
	Impact Min-#
	Impact Paleo-#
Faults and Seismicity	Impact Seis-#
Cultural/Tribal Cultural Resources	Impact Cul-#

Resource Area	Impact Numbering*
Indian Trust Assets	N/A
Land Use	Impact Land-#
Recreation Resources	Impact Rec-#
Socioeconomics	Impact Socio-#
Environmental Justice	Impact Env Jus-#
Air Quality	Impact Air Qual-#
Climate Change and Greenhouse Gas Emissions	Impact Climate-#
	Impact GHG-#
Navigation, Transportation, and Traffic	Impact Nav-#
	Impact Trans-#
Noise	Impact Noise-#
Public Health and Environmental Hazards	Impact Pub Health-#
Public Services and Utilities	Impact Services-#
Power Production and Energy	Impact Power-#
Visual Resources	Impact Vis-#

*Each resource impact is numbered, with the first impact numbered "1."

Note:

N/A = not applicable

5.5 Types of Impacts

Mechanisms that could cause impacts are discussed for each resource. General categories of impact mechanisms are construction and future operation and maintenance. Project-related impacts are categorized as follows and as appropriate, to describe the intensity or duration of the impact:

- **A temporary or short-term impact** would generally occur only during Project construction. Construction impacts would occur during the defined construction period (which would vary by facility and in some cases could extend several years) and include all activities that would occur to construct each Project facility. For the purposes of this analysis, the initial filling of the Sites Reservoir Project (Project) and Project access road construction was considered a construction-related impact. The construction disturbance area includes each Project facility footprint plus the land area around that footprint that would be used for materials laydown, soil stockpiling, equipment storage, construction vehicle parking, equipment/vehicle maintenance, spoil disposal, construction debris, batch plants, materials delivery, access roads, actual construction activity disturbance, and any other activity conducted during the construction period for a Project purpose that would cease after the Project facilities are built.
- **A long-term or permanent impact** would occur after the completion of Project construction. In some cases, a long-term impact could be a permanent impact. Project operational and maintenance impacts include any activities that must occur to operate and maintain each Project facility. These activities and their associated impacts are long-term and permanent. Operation activities include those related to the movement of water (such as Project level fluctuations, or the intake or release of water through the Delevan Pipeline Intake/Discharge Facilities), the generation/transmission of electricity, the use of roads during operation and maintenance activities, and the recreation activities that would be associated with operation of the reservoir.

- **A direct impact** is an impact that would be caused by an action and would occur at the same time and place as the action.
- **An indirect impact** is an impact that would be caused by an action but would occur later in time or at another location.

Impacts are discussed by resource in each chapter, and cumulative impacts are discussed in Chapter 35 Cumulative Impacts.

5.6 Determination of Significance of Impacts

For the purposes of the analyses conducted in this EIR/EIS of Alternatives A, B, C, C_1, and D, a combination of the CEQA Appendix G Environmental Checklist Form criteria were used, along with professional judgment that considered current regulations, standards, and/or consultation with agencies, knowledge of the area, and the context and intensity of the environmental effects. The specific criteria for determining impacts are listed in each resource chapter and were used to develop one consistent impact conclusion under both NEPA and CEQA by impact type.

The level of significance of the impacts for Alternatives A, B, C, C_1, and D as compared to the Existing Conditions/No Project/No Action Condition and was classified based on the following impact definitions:

- **Beneficial Effect:** The alternative would improve the environment. No mitigation is required.
- **No Impact:** No change in the environment would result from implementing the alternative. No mitigation is required.
- **Less-than-significant Impact:** No substantial adverse change in the environment would result from implementing the alternative. No mitigation is required.
- **Potentially Significant Impact:** A potentially substantial adverse change in the physical conditions of the environment would result from implementing the alternative based on the evaluation of project effects using specified significance criteria. Mitigation measures are proposed, when feasible, to reduce effects on the environment.

5.7 Mitigation Measure Development and Implementation

Mitigation measures were proposed, where feasible, to avoid, minimize, rectify, reduce, or compensate for significant and potentially significant impacts of the alternatives, in accordance with §15126.4 of the *CEQA Guidelines* and NEPA regulations (40 CFR 1508.20). To aid the reader, each mitigation measure was identified numerically to correspond with the number of the impact being mitigated by the measure.

When "potentially significant" impacts were identified, feasible mitigation measures were formulated to eliminate or reduce the intensity of the impacts and focus on the protection of sensitive resources. Under CEQA, the effectiveness of a mitigation measure was subsequently determined by evaluating the impact remaining after the application of the mitigation, and reaching one of two conclusions: (1) the mitigation reduced the impact to a less-than-significant level; or (2) no feasible mitigation exists to reduce the impact to a "less-than-significant level," and therefore, the impact was determined to be "significant and unavoidable." No mitigation measures were needed or proposed when an impact was determined to be "less than significant." Implementation of more than one mitigation measure may be needed to reduce an impact below a level of significance. The mitigation measures proposed in this EIR/EIS are identified within each resource chapter (Chapters 6 through 31) and are presented in the Mitigation Monitoring Plan (Appendix 1A).

5.8 Topics Eliminated from Further Analytical Consideration

CEQA Guidelines provide for the identification and elimination from detailed study the effects that are not potentially significant or that have been covered by prior environmental documentation (Public Resources Code, §21002.1; *CEQA Guidelines*, §15143). The NEPA regulations provide similar provisions (40 CFR 1501.7(a)(3)).

During initial and supplemental scoping with the public and governmental agencies, and based on information obtained through literature review, agency correspondence, consultations, and field data collection, it was determined that no resources should be eliminated from detailed study. Therefore, analyses of all resources identified as requiring potential review under CEQA and NEPA are included in this EIR/EIS.

However, during preparation of the impact analyses, it became evident that some of the potential impacts identified in the *CEQA Guidelines* Appendix G were not applicable to the Project, or that some discussions were not relevant to the analysis. The Authority and Reclamation described those situations in a “Topics Eliminated from Further Analytical Consideration” subsection in the resource chapters as appropriate.

5.9 Tools, Analytical Methods, and Applications

Each resource chapter includes a description of the methodology used to identify and assess the potential environmental impacts that would result from implementation of the alternatives. Analysis approaches ranged from field review, professional judgement, and/or models as appropriate to identify potential impacts. For those resources that used modeling output, a brief overview of the modeling tools and output is provided below.

Among the models and tools used to assist in identifying impacts, several tools and analytical methods were used to characterize and analyze the changes in water operations in the SWP and CVP systems for each alternative beyond the Primary Study Area where the Project would be constructed (i.e. within the Extended and Secondary study areas). These tools represent the best available technical tools for conducting the analyses and are standardly used in practice, generally eliminating the need for additional peer review.

The CALSIM II planning model was used to simulate the coordinated operation of the CVP and SWP over a range of hydrologic conditions. CALSIM II is a generalized reservoir-river basin simulation model that allows for specification and achievement of user-specified operating rules or goals (Draper et al., 2004). CALSIM II represents the best available planning model for the CVP and SWP operations (Reclamation, 2008a). CALSIM II outputs regarding system operation decisions including deliveries, flows and storages are then used by every other models in the analytical framework. CALSIM II operations were informed based on the reporting metrics from various models that simulate river temperatures, anadromous fish survival and population, Delta water quality, hydropower generation and socioeconomics. CALSIM II results were used to study the systemwide impacts in the various resource areas. Table 5-2 provides a description of the various modeling tools and an overview of how they were used for the impact analyses.

Table 5-2
Overview of Sites Reservoir Project EIR/EIS Modeling Tools, Analytical Methods, and Applications

Model Name	Description of Model
Surface Water Resources	
SWP and CVP Hydrology and System Operations Model (CALSIM II)	Simulates monthly operations of the SWP, CVP, and other water supply facilities in the Central Valley and approximates changes in storage reservoirs, river flows, and exports from the Delta. Inputs describe assumptions of hydrology at projected levels of land and water use, existing and Project facilities, and riverine and Delta regulatory conditions. SWP and CVP operations include assumptions presented in the Biological Assessment on the Continued Long-term Operations of the Central Valley Project and the State Water Project (Reclamation, 2008b) as modified by the December 2008 USFWS and the June 2009 NMFS biological opinions. The model and assumptions are described in Appendix 6A Modeling of Alternatives and Appendix 6B Water Resources System Modeling.
Artificial Neural Network (ANN)	Mimics the flow-salinity relationships as modeled in the DSM2, and provides a rapid transformation of this information into a form usable by the Statewide CALSIM II model. ANN is implemented in CALSIM II to inform the operations of the upstream reservoirs and the Delta export pumps to satisfy particular salinity requirements. The model and assumptions are described in Appendix 6A Modeling of Alternatives, and Appendix 6B Water Resources System Modeling.
Upper Sacramento River Daily Operations Model (USRDOM)	Simulates daily reservoir operations and daily river flows for the upper Sacramento River from Shasta Dam to Knights Landing, including the facilities and tributaries within this region; includes the Trinity River section of the Central Valley Project, the Sutter Bypass region (and other bypasses), and the conveyance and storage facilities of the Project. Uses CALSIM II outputs. The model is described in Appendix 6C Upper Sacramento River Daily River Flow and Operations Modeling.
Surface Water Quality	
Upper Sacramento River Water Quality Model (USRWQM)	Simulates the temperature regime of the Upper Sacramento River. The USRWQM, as modified for use in the Sites Reservoir Project Investigations, extends from Keswick Dam to Knights Landing and includes the Sacramento River, Sacramento River at Red Bluff Diversion Dam, Black Butte Dam, Stony Creek, Tehama-Colusa Canal, GCID Main Canal, Colusa Basin Drain, a proposed Delevan pipeline, the proposed Holthouse Reservoir, and the Project. Provides estimate of daily average riverine temperature conditions. Uses USRDOM outputs. The model is described in Appendix 7E River Temperature Modeling.
Preliminary Sites Reservoir Discharge Temperature Model	Simulates the temperature regime in the Project and the discharge of flows to the Sacramento River. Provides simulated daily average temperature conditions of discharge and blended flow in the Sacramento River. Uses USRDOM and USRWQM outputs. The model is described in Appendix 7E River Temperature Modeling.
Reclamation Monthly Temperature Models (Reclamation Temperature)	Simulates the temperature regime in the Trinity, Feather, Lower Sacramento, and Stanislaus river basins and upstream reservoirs. Provides simulated monthly reservoir and stream temperatures used for evaluating the effects of operations on mean monthly water temperatures in the basin. Uses CALSIM II outputs. The model is described in Appendix 7E River Temperature Modeling.
Folsom Reservoir CE-QUAL-W2 Temperature Model	Simulates the temperature regime in the American River. Provides simulated monthly reservoir and stream temperatures used for evaluating the effects of operations on mean monthly water temperatures in the basin. The model is described in Appendix 7E River Temperature Modeling.

Model Name	Description of Model
Delta Hydrodynamics Model (DSM2 HYDRO)	Simulates one-dimensional hydrodynamics of the Sacramento–San Joaquin Delta; models Delta channel flows, stages, and cross-section average velocities under tidal conditions. DSM2 is simulated on a 15-minute time step to address the changing tidal dynamics of the Delta system; however, one-dimensional and simplified boundary conditions limit use of results to monthly statistics. Uses outputs from CALSIM II. The model is described in Appendix 7D Sacramento-San Joaquin Delta Modeling.
Delta Salinity Model (DSM2 QUAL)	Simulates salinity based on Electrical Conductivity (EC) calibration; one-dimensional and simplified boundary conditions limit use of results to monthly statistics. Uses outputs from DSM2 HYDRO. The model is described in Appendix 7D Sacramento-San Joaquin Delta Modeling.
Fluvial Geomorphology and Riparian Habitat, Botanical Resources, and Terrestrial Biological Resources	
Sedimentation and River Hydraulics - Capacity (SRH-Capacity)	Simulates water and sediment budgets of the river system at the watershed scale. The model links sediment sources and transport with geomorphic change and accounts and predicts the sediment loads from tributaries and sediment balance in the main stem of the river. The study area is the Sacramento River from River Mile 295 (downstream of Keswick Dam) to River Mile 80 (near Knights Landing). The study area has been divided into 23 sub-reaches based on hydraulic conditions and river slope. Hydraulics conditions are averaged in each reach and then transport capacity in each reach is computed using the sediment size fraction. SRH-Capacity uses daily flow data from 19 tributaries and computes sediment load in these reaches to estimate sediment balance in the mainstem. Uses outputs from USRDOM. The model is described in Appendix 8A Sedimentation and River Hydraulics Modeling.
Sedimentation and River Hydraulics – Meander (SRH-Meander)	Simulates the bed topography, flow field, and bank erosion rate in curved channels with an erodible bed. In each time step, SRH-Meander first calculates the flow field. It then computes the channel bank erosion rate. Finally, the channel alignment is updated with the erosion rate, followed by a channel cutoff if needed. The model can be used to predict the channel migration in meandering rivers. Uses outputs from USRDOM. The model is described in Appendix 8A Sedimentation and River Hydraulics Modeling.
Sedimentation and River Hydraulics - Vegetation (SRH-1DV)	Simulates river hydraulics, sediment transport, erosion, deposition, and vegetation growth. Cottonwood growth and survival at different cross-sections along the Sacramento River is simulated between Keswick Dam and Colusa. The river is divided into five reaches. SRH-1DV uses groundwater data at several locations and river stage data at River Mile 183 and River Mile 193. Flow rates for the model are required at Hamilton City and Ord Ferry. Uses outputs from USRDOM. The model is described in Appendix 8A Sedimentation and River Hydraulics Modeling.
Riparian Habitat Establishment Model (RHEM)	Simulates the growth of riparian vegetation on point bars. Integrates the simultaneous effects of river stage, precipitation, evaporation, and plant transpiration on soil water content in the root zone. Uses these results to determine the plant survival by simulating the plant's ability to maintain sufficient transpiration to support continued root and shoot growth from germination through the initial establishment stage. Uses outputs from USRDOM and SRH. The model is described in Appendix 8A Sedimentation and River Hydraulics Modeling.
Sacramento River Ecological Flows Tool (SacEFT)	A tool that incorporates physical models of the Sacramento River with biophysical habitat models for three species that use riparian habitats along the Sacramento River to evaluate the ecological consequences of management-related changes in flow regime and channel restoration activities. Includes flow and habitat relationships for bank swallows and channel erosion/migration for large woody debris deposition and removal, western pond turtle, and Fremont cottonwood. The model is described in Appendix 8B Sacramento River Ecological Flows.

Model Name	Description of Model
Aquatic Biological Resources	
Reclamation Mortality Models (Reclamation Mortality and SacSalMort)	Estimates the fraction of population lost each year for winter-, spring-, fall-, and late-fall-run Chinook salmon due to thermal conditions only. Uses reach level empirical degree-day equations for the Trinity, Sacramento, Feather, American, and Stanislaus rivers. Uses monthly average outputs from Reclamation Temperature Model. Customized version for the Sacramento River (SacSalMort) uses daily outputs from USRWQM. The model is described in Appendix 12F Reservoir Water Surface Elevation Summary Tables.
Salmonid Population Model (SALMOD)	Simulates dynamics of freshwater life history of anadromous and resident salmonid populations using streamflow, water temperature, and habitat type. Provides potential fish production values reflecting the suitability of riverine habitat for winter-, spring-, fall-, and late-fall-run Chinook salmon. Simulates salmon habitat conditions in the Sacramento River between Keswick Dam and Bend Bridge. Uses outputs from USRDOM and USRWQM. The model is described in Appendix 12K Delta Passage Modeling.
Winter Run Chinook Life Cycle Model (IOS)	Simulates multiple life stages of winter-run Chinook salmon within the Sacramento River system. Life-cycle model provides a quantitative framework to evaluate the effects of flow, temperature, diversions, and habitat conditions on individual cohorts and overall population of winter-run Chinook salmon. The IOS model tracks daily salmon numbers from six different life stage categories (eggs, alevins, fry, smolts, subadults, and adults). The model is spatially explicit including detailed reaches of the Sacramento River, Delta migratory corridors, and the Pacific Ocean. Uses outputs from USRDOM, USRWQM and DSM2. The model is described in Appendix 12H Early Life-Stage Salmon Mortality Modeling.
Delta Passage Model (DPM)	Simulates detailed accounting of migratory pathways and reach-specific mortality for four runs (winter-, spring-, fall-, and late-fall) of Chinook salmon smolts traveling through a simplified network of reaches and junctions in the Delta. The DPM operates on a daily time step using simulated daily average flows and Delta exports as model inputs. The DPM does not attempt to represent sub-daily flows or diel salmon smolt behavior in response to the interaction of tides, flows, and specific channel features. The DPM for winter-run Chinook salmon is incorporated as a module of the IOS model. Uses outputs from DSM2. The model is described in Appendix 12I Salmonid Population Modeling.
Sacramento River Ecological Flows Tool (SacEFT)	A tool that incorporates physical models of the Sacramento River with biophysical habitat models for three Sacramento River fish species to evaluate the ecological consequences of management-related changes in flow regime and channel restoration activities. Includes flow and habitat relationships for Chinook salmon, steelhead, and green sturgeon. Constituent focal species “sub-models” provide performance measures specific to the species evaluated. Multi-year roll-ups of annual performance allow users to quickly zoom in on the much smaller set of performance measures, which differ significantly across management scenarios. Uses outputs from CALSIM II, USRDOM, and USRWQM. For fisheries analyses in the Project Investigations, the SacEFT was used to evaluate potential impacts on steelhead and green sturgeon. The model is described in Appendix 8B Sacramento River Ecological Flows.

Model Name	Description of Model
Recreation Resources	
Recreation-Day Benefit Values	Benefit values combine two equally weighted factors: (1) variety and quality of recreation, and (2) aesthetic qualities of the site. Factors considered in determining the variety and quality of recreation at a reservoir include the types of activities available, quality of the experience, quality of development, and operation and maintenance of the facilities and area. Aesthetic factors include reservoir operation, geologic, topographic, aquatic, vegetative, climate, and other environmental factors. Based on guidelines described in DWR's Economics and Recreation Planning Manuals and in Supplementary Procedures for Application of DWR's Guidelines for Evaluation of General Recreation, developed jointly by DWR and California Department of Parks and Recreation (California State Parks, 1967).
Socioeconomics	
Statewide Agricultural Production (SWAP) model	Simulates the decisions, production, and economics of agricultural producers in California's Central Valley. The model includes up to 27 crop production regions in the Central Valley and 20 categories of crops. Surface water supplies are estimated by hydrologic models and groundwater use and pumping lift are estimated based on assumptions about groundwater availability. SWAP model versions consider responses under average hydrologic conditions and responses during drought. The model maximizes the producer and consumer surplus to determine an optimal market solution. Uses outputs from CALSIM II. The model is described in Appendix 22F Agricultural Supply Economics Modeling.
Least Cost Planning Simulation Model (LCPSIM)	Simulation/optimization model that assesses the economic benefits and costs of increasing urban water service reliability (supply/demand balance) at the regional level. The total cost of the optimized regional water management plan is used in a comparative analysis to determine the potential economic benefit or cost of a proposed action. Models are available for the South Bay and South Coast regions. Uses outputs from CALSIM II. The model is described in Appendix 22D Urban Water Supply Economics Modeling.
Other Municipal Water Economics Model (OMWEM)	Urban water supply valuation for other urban areas using assumptions associated with availability of surface and groundwater supplies. Uses outputs from CALSIM II. The model is described in Appendix 22D Urban Water Supply Economics Modeling.
Lower Colorado River Basin Water Quality Model (LCRBWQM)	Assesses the regional economic effects of water salinity within the SWP system and Colorado River Aqueduct throughout the urban coastal region of southern California. Assesses the benefit of a change in average annual regional salinity costs based on demographic data; water deliveries; total dissolved solids (TDS) concentration; and costs for typical household, agricultural, industrial, and commercial water uses. Uses mathematical functions that define the relationship between TDS and items in each affected category, such as the useful life of appliances, specific crop yields, and costs to industrial and commercial customers. Uses long-term volume and salinity load information based on CALSIM II and DSM2 results. The model is described in Appendix 22E Urban Water Quality Economics Modeling.
Bay Area Water Quality Economics Model (BAWQM)	Assesses the benefit of a change in average annual regional salinity costs based on households in the South Bay region. Uses mathematical functions that define the relationship between TDS and items in each affected category, such as the useful life of appliances. Uses long-term volume and salinity load information based on CALSIM II and DSM2 results. The model is described in Appendix 22E Urban Water Quality Economics Modeling.
IMPLAN	IMPLAN develops input-output estimates of the economic impacts of various activities. For water resources planning, IMPLAN estimates the income and employment effects upon local communities from water project construction and the regional effects of water transfers. Uses outputs from SWAP. The model is described in Appendix 22C Regional Economics Modeling.

Model Name	Description of Model
Reporting Metrics Tool (RMT)	Developed for the NODOS Feasibility Report and EIR/EIS, RMT is a spreadsheet model that reports system operations and economics metrics. The reports are a summary of system specifications for scenarios evaluated, modeled operations, and modeled economics impacts at a range of detail. The reported system operations metrics include yield and water supply, water quality, and hydropower. The reported economics metrics include Project costs, agricultural and M&I water supply, and M&I water quality. The system operations metrics are characterized by user type, and because the modeled economics metrics do not include the entire modeled operations metrics, extensions are made in the RMT to provide estimates for these reporting gaps. Uses outputs from SWAP, LCPSIM, OMWEM, LCRBWQM, BAWQM and other Project-specific information. The model is described in Appendix 22B Reporting Metrics Tool.
Air Quality and Greenhouse Gas Emissions	
Off-Road Emissions Model (OFFROAD 2007)	The OFFROAD Model estimates the relative contribution of gasoline-, diesel-, compressed natural gas, and liquefied petroleum gas-powered vehicles to the overall emissions inventory of the state. The model is described in Appendix 24A Methodology for Air Quality and GHG Emissions Calculations.
Emissions & Generation Resource Integrated Database (eGRID)	The eGRID is a comprehensive source of data on the environmental characteristics of almost all electric power generated in the United States. These environmental characteristics include air emissions for nitrogen oxides, sulfur dioxide, carbon dioxide, methane, and nitrous oxide; emissions rates; net generation; resource mix; and many other attributes. Uses outputs from Reclamation Long Term Generation (LT-GEN), State Water Project Power Model (SWP Power) and Project Power. The model is described in Appendix 24A Methodology for Air Quality and GHG Emissions Calculations.
URBan EMISsions (URBEMIS 2007)	URBEMIS 2007 estimates air pollution emissions from a wide variety of land use projects. The model uses the California Air Resources Board's EMFAC2007 model for on-road vehicle emissions and the OFFROAD2007 model for off-road vehicle emissions. The model is described in Appendix 24A Methodology for Air Quality and GHG Emissions Calculations.
EMission FACtors (EMFAC 2007)	The EMFAC model is used to calculate emission rates from all motor vehicles, such as passenger cars to heavy-duty trucks, operating on highways, freeways and local roads in California. The model is described in Appendix 24A Methodology for Air Quality and GHG Emissions Calculations.
Power Production and Energy	
Reclamation Long Term Generation (LT-GEN)	Computes the power generation and capacity for CVP power plants and project use (pumping plant demand) for CVP pump stations at a monthly time step based on the operations defined by a CALSIM II simulation. Simplified factors are used to separate peak and non-peak generation and load. Includes calculations of transmission losses. Net-revenue is estimated based on price forecasts. Uses outputs from CALSIM II. The model is described in Appendix 31B CVP-SWP Power Modeling.
State Water Project Power Model (SWP Power)	Computes the power generation and capacity for SWP power plants and project use (pumping plant demand) for SWP pump stations at a monthly time step based on the operations defined by a CALSIM II simulation. Simplified factors are used to separate peak and non-peak generation and load. Net-revenue is estimated based on price forecasts. Uses outputs from CALSIM II. The model is described in Appendix 31B CVP-SWP Power Modeling.
NODOS Power	Computes the power generation and capacity for Project power plants and use (pumping plant demand) for Project pump stations at a monthly time step based on the operations defined by a CALSIM II simulation. Simplified factors are used to separate peak and non-peak generation and load. Net-revenue is estimated based on price forecasts. Uses outputs from CALSIM II. The model is described in Appendix 31B CVP-SWP Power Modeling.

Model Name	Description of Model
DWR-PARO Optimization Modeling	A DWR-PARO Power Planning Study was completed to analyze the current/designed components, and operational scenarios of the Project from a power planning perspective. The Study was aimed at optimizing Project operations to maximize its power portfolio's value (revenues-obligations). The Study is implemented using current power market information and regulations, and available power portfolio models/tools to better evaluate energy costs and revenues of the Project. The Study considered short time step pump-generation operations in addition to long-term water operations. Uses outputs from CALSIM II. The model is described in Appendix 31A Power Planning Study (PARO).

Typical long-term planning analyses of the Central Valley system and operations of the SWP and CVP have applied the CALSIM II model for analysis of system responses. CALSIM II simulates future SWP/CVP project operations based on an 82-year monthly hydrology derived from the observed 1922-2003 period. Future land use and demands are projected for the appropriate future period. The system configuration consisting of facilities, operations, and regulations are input to the model and define the limits or preferences on operation. The configuration of the Delta, while not simulated directly in CALSIM II, informs the flow-salinity relationships and several flow-related regressions for interior Delta conditions included in the model. For each set of hydrologic, facility, operations, regulations, and Delta configuration conditions, the CALSIM II model simulates changes in monthly river flows, exports, water deliveries, reservoir storage, water quality, and several derived variables to represent Delta flow and salinity conditions.

Use of the CALSIM II model also requires some refinements of the SWP and CVP operations related to delivery allocations and San Luis Reservoir target storage levels to reflect suitable north-south reservoir balancing under future conditions. These refinements are generally made by experienced modelers in conjunction with project operators. The model is based upon monthly time steps and assumptions that may not fully represent more real-time operations and assumptions. Therefore, the CALSIM II model is most appropriately used to compare one alternative to another and compare the results, such as the comparison of conditions under an alternative to the Existing Conditions/No Project/No Action Condition simulation. Using the CALSIM II model output in a comparative manner reduces the effects of using monthly assumptions and other assumptions that are indicative of real-time operations but do not specifically match real-time observations. Because CALSIM II model output is used directly or indirectly as input values for all of the remaining models, results from the other models also should be used in a comparative manner. Given that the CALSIM II model uses a monthly time step, incremental flow and storage changes of 5 percent or less are generally considered within the standard range of uncertainty associated with model processing; therefore, flow changes of 5 percent or less were considered to be similar to the Existing Conditions/No Project/No Action Condition flow levels in the CALSIM II comparative analyses conducted in this EIR/EIS.

The evaluation of potential impacts associated with the implementation of the Project alternatives and the Existing Conditions/No Project/No Action Condition were modeled based on the April 1st, 2010 benchmark version of CALSIM II (2010 CALSIM II). The 2010 CALSIM II model was developed by DWR and USBR in coordination with the USFWS, NMFS and the California Department of Fish and Wildlife (CDFW; formerly known as California Department of Fish and Game [CDFG]) to incorporate the 2008 USFWS Smelt and 2009 NMFS Salmon Biological Opinions (BOs). More recently, in support of the Water Storage Investment Program (WSIP), the California Water Commission (CWC) released a refined version of CALSIM II based on the DWR's 2015 Delivery Capability Report CALSIM II model

(DCR 2015). Both the 2010 and 2015 versions of CALSIM II represent the current regulatory requirements including the 2008 and 2009 BOs which are key regulatory drivers that influence CVP and SWP operations. The 2015 version of CALSIM included several updates related to any new information available for facilities, better implementation of the operational constraints, and other improvements from Reclamation, DWR and other experts, as described in Appendix 6D Comparison of Impact Assessment Results Using CALSIM II 2010 and 2015 Versions. Modeling performed in support of the Sites Reservoir WSIP application is based on the CWC's DCR 2015 CALSIM II model.

A sensitivity analysis was performed to compare the incremental changes in CVP/SWP operations simulated using the 2010 CALSIM II model to the simulated incremental changes using the DCR 2015 CALSIM II for Alternative D with respect to the Existing Conditions/No Project/No Action Condition. Overall, the changes in CVP-SWP operations associated with Alternative D using DCR 2015 CALSIM II remained consistent with the results using the 2010 CALSIM II, when compared to the Existing Conditions/No Project/No Action Condition. The findings of the sensitivity analysis, as summarized in Appendix 6D Comparison of Impact Assessment Results Using CALSIM II 2010 and 2015 Versions, indicated that the results under both CALSIM II model versions were similar except for minor changes related to reservoir storage in Folsom Lake, and SWP water deliveries that would not result in new or additional significant impacts.

The overall flow of information between the models and the general application and use of output for the resource evaluations are shown on Figure 5-1. The Delta Simulation Model (DSM2), described in Appendix 7D Sacramento-San Joaquin Delta Modeling, was used to simulate hydrodynamics (flow, velocity and water levels) and water quality (salinity) in the Sacramento-San Joaquin Delta. The Upper Sacramento River Daily Operations Model (USRDOM), described in Appendix 6C Upper Sacramento River Daily River Flow and Operations Modeling, utilizes results from CALSIM II to evaluate the impacts of changing diversion, in-basin use and Delta operations under projected conditions within current or future regulatory and operational regimes. It is particularly useful in verifying the CALSIM II simulated river conditions and the availability of excess flows to fill the Project under the capacity and operational constraints of the three intakes at the Red Bluff, Hamilton City, and Delevan locations.

The Upper Sacramento River Water Quality Model (USRWQM), described in Appendix 7E River Temperature Modeling, was used to simulate reservoir and river temperatures in the upper Sacramento River, from Shasta Lake to Knights Landing, including the CVP facilities in the Trinity River basin and the tributaries along the Sacramento River. Reclamation's Temperature Model, described in Appendix 7E River Temperature Modeling, was used to simulate reservoir and river temperatures in the Trinity River, Feather River, American River and Stanislaus River. The Folsom Reservoir CE-QUAL-W2 Temperature Model (PCWA, 2015) was also used as part of the analysis of potential water temperature impacts in the American River (see Appendix 7E River Temperature Modeling) given its recent and ongoing use in the evaluation of American River-specific actions and projects, in addition to the Reclamation Temperature Model. Using the flow results from USRDOM and temperature results from USRWQM, the SALMOD (Appendix 12K Delta Passage Modeling) and IOS (Appendix 12H Early Life-Stage Salmon Mortality Modeling) models were used to analyze the impacts of the action alternatives on anadromous fish populations in the Sacramento River. Similarly, using the temperature and flow results from Reclamation's Salmon Mortality Model (Appendix 12F Reservoir Water Surface Elevation Summary Tables) simulates the impacts of the alternatives on survival of early life stages of salmon anadromous fish in the Trinity, Sacramento, Feather and American rivers.

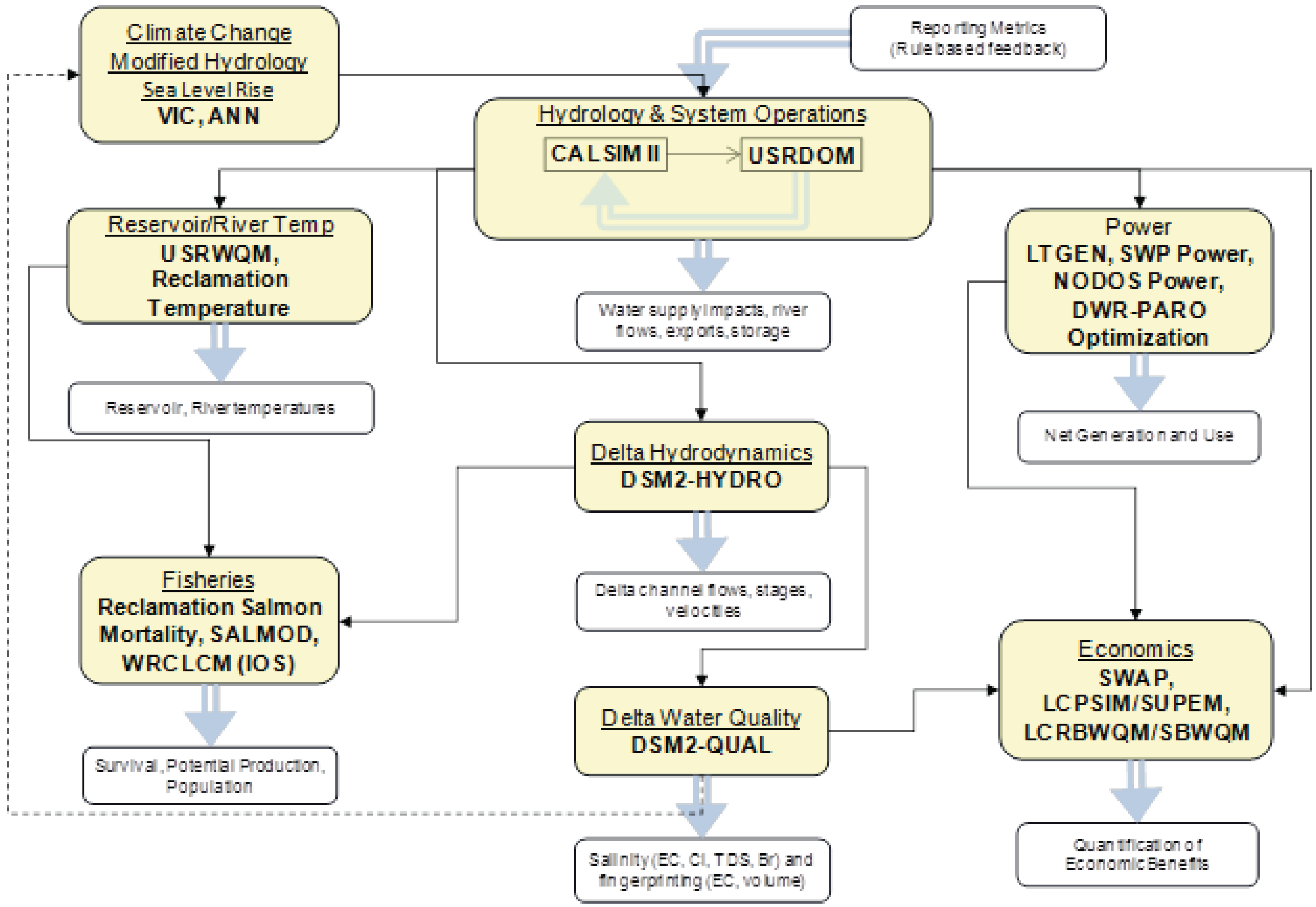

FIGURE 5-1
Information Flow among Models and General Application and Use of Output for Resource Evaluations
Sites Reservoir Project EIR/EIS

LTGEN, SWP Power, NODOS Power and other power modeling tools, described in Appendix 31A Power Planning Study (PARO) and Appendix 31B CVP-SWP Power Modeling, were used to study the impacts of the alternatives on the power production and use. Several economic modeling tools, described in the appendixes to Chapter 22 Socioeconomics, were used to study the impact of the alternatives on the agricultural water supply economics, urban water supply and water quality economics and other regional socioeconomics.

The models were used to assist in comparing and contrasting the potential effects among alternatives with various operating scenarios utilizing current and anticipated conditions and operational assumptions. The output of the models was used to show the comparative difference in the conditions among the different alternative scenarios. It should be recognized that model output does not predict absolute conditions in the future; rather, the output is intended to show what type of changes would occur for comparative purposes.

5.9.1 Pulse Flow Protection Diversion Assumptions

In anticipation of the use of the analyses in this EIR/EIS by cooperating and trustee agencies to support their decision making and the future permit acquisition process with NMFS, CDFW, and other resource agencies, the hydrology and operations modeling of the proposed Project included restrictions on diversions to limit impacts on out-migrating juvenile fish as a “surrogate” for likely permit conditions. Based on recent literature and the proposed permit conditions for other diversion projects, operations modeling for the proposed Project diversions were assumed to be restricted to minimize impacts to fish passage associated with pulse flow events that stimulate the observed spike in juvenile salmon outmigration. Actual operations are anticipated to be informed by real-time monitoring of fish movement.

The assumed limits on diversions during naturally occurring, storm-induced pulse flow events in the Sacramento River were based on a recent study by del Rosario et al. (2013), which found an abrupt and substantial spike in winter-run Chinook salmon arrivals at Knights Landing in association with the first storm event producing a flow of 400 cubic meters per second (14,126 cfs) at Wilkins Slough. This spike was followed shortly by passage of up to the 50th percentile of cumulative migration. This relationship was apparent for a wide range of water year types based on catch data collected between 1999 and 2007.

Accordingly, an assumed pulse protection period was developed that would extend from October through May to address out-migration of juvenile winter-, spring-, fall- and late-fall-run Chinook salmon, as well as steelhead. Pulse flows during this period would provide flow continuity between the upper and lower Sacramento River to support fish migration. It is recognized that research regarding the benefits of pulse flows is ongoing, and further research and adaptive management would be required to develop and refine a pulse flow protection strategy for fish migration and, as such, this assumption was used for modeling and informational purposes only.

For proposed Sites Reservoir operations, pulse flows are defined by extended peak river flows at Bend Bridge that originate primarily from storm event tributary inflows downstream from Keswick Dam. For the purposes of operations modeling, a naturally occurring pulse event was considered initiated when the 3-day running average flow below Bend Bridge exceeded 15,000 cfs. Such an event would need to continue for at least a 7-day duration to be considered a qualified storm event for the simulation process. Diversions to Sites Reservoir would not be allowed during the 7-day period that flow was greater than 15,000 cfs. The duration of a pulse flow event would be considered terminated under the following conditions: 1) the 3-day running average discharge flow remained greater than 15,000 cfs for 7 days after initiation, 2) the 3-day running average discharge flow dropped below 15,000 cfs before reaching the

7-day duration, or 3) the 3-day running average discharge flow exceeded 25,000 cfs before reaching the 7-day duration.

Given that del Rosario et al. (2013) indicate that the first storm event was associated with a spike in salmon arrivals at Knights Landing, diversions to Sites Reservoir would not be allowed during the first 7-day qualified pulse period, when flows reach 15,000 cfs during the out-migration season. For evaluation of Sites Project Reservoir operations, it was assumed that up to one qualified 7-day pulse event would occur each month during the pulse protection period from October through May, to encourage and support salmonid out-migration and minimize potential diversion impacts. Therefore, for operations modeling, diversions to Sites Reservoir storage would be restricted under the following conditions: 1) if pulse conditions exist at Bend Bridge, and a qualified pulse event has not already occurred within the given month, and 2) if Bend Bridge flows are less than 25,000 cfs during the pulse event. Diversions are allowed when flows exceed 25,000 cfs because flows of this magnitude are considered to provide lesser benefits to fish migration.

This potential diversion limitation is also discussed in Chapter 12 Aquatic Biological Resources, and Chapter 6 Surface Water Resources, and it is included as a proposed mitigation measure in Chapter 12 to address potential diversion-related fishery impacts. As described in Chapter 12, the actual diversion operation would be informed by a proposed monitoring program. It is anticipated that discussions with federal and state resource agencies would likely result in refinements to the proposed operational approach to best minimize potential impacts to aquatic resources.

Because of the comparative nature of these models, these results are best interpreted using various statistical measures, such as long-term and water year-type averages, and probability of exceedance. Additional detailed discussions of the modeling tools and assumptions are provided in the appendixes that are identified in Table 5-2.

5.10 Limitations of the Modeling Tools and Analytical Methods

Although computer-based modeling tools assist in projecting physical, chemical, economic, biological, and other factors related to potential impacts on environmental resources for comparative purposes, all modeling tools and analytical methods used in the impact analyses have limitations. The limitations related to the modeling tools are documented in each of the appendixes referenced in Table 5-2. It should also be recognized that potential effects related to anticipated climate change and sea-level rise and the operation of the Project and the potential effects of the Project on climate change are highly uncertain. A range of potential impacts of future climate and sea-level conditions on the operation of the Project and the Project's associated impacts is provided in Chapter 25 Climate Change and Greenhouse Gas Emissions and associated appendixes.

There are other uncertainties reflected in the EIR/EIS analyses presented in this document from conducting this large, complex, and evolving environmental study over many years, including site-specific biological and cultural resource surveys. As stated in each of the appropriate resource chapter discussions, all facility-related impacts will be verified and surveys conducted/updated and mitigation proposed in this EIR/EIS implemented as appropriate with all applicable federal, State, and local agencies.