Chapter 4
Introduction to Analysis

4.1 Introduction

The State Water Resources Control Board (State Water Board) is considering amendments to the 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (2006 Bay-Delta Plan) that would establish new Lower San Joaquin River (LSJR) flow objectives for the protection of fish and wildlife beneficial uses, revise the southern Delta water quality objectives (SDWQ) for salinity for the protection of agricultural beneficial uses, and establish a program of implementation to achieve those objectives.

This chapter provides an overview of the following topics: modifications made in this recirculated Substitute Environmental Document (SED) since the public draft 2012 SED (2012 Draft SED) was released on December 31, 2012; the framework for analysis; document and chapter organization; terminology used; baseline; and modeling and technical analyses.

4.2 Recirculated SED

The State Water Board has revised and recirculated the 2012 Draft SED released on December 31, 2012. This SED is a recirculated document that makes substantial changes from the 2012 Draft SED in consideration of the large number of oral and written public comments received concerning that document, and in light of additional information, including information stemming from the recent drought and in response to the state's adoption in 2014 of a state policy for sustainable groundwater management (Wat. Code, § 113) and passage of the Sustainable Groundwater Management Act (SGMA) (Wat. Code, §§ 10720 et seq.), which provide for sustainable local groundwater management. A summary of major changes made to address these concerns follows.

The State Water Board received approximately 4000 comments on the 2012 Draft SED during the public comment period (December 31, 2012 to March 29, 2013). The comments received on the 2012 Draft SED are in the administrative record and a summary of the comment letters is found in Appendix M, *Summary of Public Comments on the 2012 Draft SED*. Because the State Water Board is recirculating the entire document, it does not need to respond to the comments on the 2012 Draft SED. Instead, the State Water Board need only respond to comments submitted in response to this recirculated, revised SED. The State Water Board, however, has considered the major themes raised by the comments on the 2012 Draft SED in preparing this revised SED.

4.2.1 Hydrologic Modeling

Comments were received on the 2012 Draft SED regarding the assumptions used in developing the Water Supply Effects (WSE) model and the use of the WSE model to analyze impacts. In response, the WSE model was modified for use in this SED. Changes are summarized below. Appendix F.1, *Hydrologic and Water Quality Modeling,* provides additional details.

- The WSE model was modified to provide a representation of baseline conditions based on and calibrated to CALSIM[1] data but not using the CALSIM model results directly to represent the baseline scenario as was done in the 2012 Draft SED. The WSE model is used independently to simulate both the baseline and the LSJR alternatives for the purpose of analyzing impacts in this SED. The assumptions for the WSE modeled baseline and the LSJR Alternatives 2, 3, and 4 are listed below. All assumptions apply to both the modeled baseline and alternatives, except for the Vernalis Adaptive Management Plan (VAMP) minimum flow requirements (first bullet below, which were only included in the modeled baseline) and LSJR alternative minimum flow requirements, which are applied only in LSJR alternative scenarios.
  - VAMP minimum flow requirements on the Stanislaus, Tuolumne, and Merced Rivers per the San Joaquin River Agreement (SJRA) (USBR and SJRGA 1999). The State Water Board's Water Right Decision D-1641 (D-1641) (revised March 15, 2000) minimum flow requirements are in effect for February 1–June 30 for both baseline and the LSJR alternatives, although in baseline, D-1641 flows are replaced with the VAMP flow requirement volumes in the pulse flow portions of April and May ~~only~~.
  - Reasonable and Prudent Alternative (RPA) Action 3.1.3 of the June 2009 National Marine Fisheries Service (NMFS) Biological Opinion (BO) to the U.S. Bureau of Reclamation (USBR) for the long-term operation of the Central Valley Project (CVP) and the State Water Project (SWP) (Operational Criteria and Plan [OCAP]) minimum streamflows at Goodwin Dam required by BO Appendix 2E as a function of the New Melones Index (NMFS 2009).
  - Stanislaus River maximum CVP diversions based on a 155 thousand acre-feet (TAF) total maximum for Stockton East Water District (SEWD) and Central San Joaquin Water Conservation District (CSJWCD) (USBR 2013a, 2013b), and 600 TAF for South San Joaquin Irrigation District (SSJID) and Oakdale Irrigation District (OID) per the 1988 Stipulation Agreement with USBR (SJRGA 1999).
  - Implementation of LSJR alternative minimum flow requirements as a percent of unimpaired flow[2] February–June during high flow events.
  - Future San Joaquin River Restoration Program (SJRRP)[3] flows are not included.
- The WSE model calculates flow in each tributary as a continuous simulation for all months year-round, including July–January, as opposed to relying on CALSIM output for those months, as was done in the 2012 Draft SED. Streamflows are based on the minimum flow requirements applicable to each tributary and Vernalis, plus any reservoir releases needed to maintain compliance with flood storage curves. The model continues to use estimates of reservoir

[1] CALSIM is a generalized water resource simulation model for evaluating operational alternatives of the State Water Project (SWP)/Central Valley Project (CVP) system (USBR 2005). CALSIM II is the latest application of the generic CALSIM model to simulate SWP/CVP operations. CALSIM and CALSIM II are products of joint development between the California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (USBR). This document uses CALSIM and CALSIM II interchangeably.

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

[3] Implementation of the settlement and the Friant Dam release flows required by the San Joaquin River Restoration Program are expected to increase the existing SJR flows at Stevinson in the near future.

inflows, downstream accretions and depletions, and other inputs as developed by USBR for CALSIM.

- The previous WSE modeling in the 2012 Draft SED was configured to closely match the baseline distribution of end-of-September storage levels in the main reservoirs on each tributary. The modified WSE model calculates the amount of water available for diversion each year based on the sum of available end-of-February storage plus March–September inflows, less the sum of March–September river flow requirements and end-of-September minimum storage guidelines (the latter subject to annual drawdown limitations). Available water is then compared against estimates of surface water demand (primarily agricultural irrigation) for the year, with the lesser determining the amount diverted.
- The WSE model has multiple reservoir storage controls to both maintain empty storage capacity for flood control and to maintain carryover storage for coldwater reserves to ensure there are no temperature-related impacts on fisheries during the summer and fall. Reservoir releases for diversion are restricted based on minimum end-of-September storage guidelines in the model. Each year, only a certain percentage of the available water (i.e., the amount above what is required to meet end-of-September storage and in-stream flow requirements) can be released from storage for diversion. This protects storage prior to dry years. In addition, when reservoir levels are low (typically after a dry years) the model limits the amount of inflow that can be used in a subsequent wet year(s) for diversion. By reducing the amount of inflow that can be diverted in such years, reservoirs and associated coldwater pools recover more quickly after dry year(s).
- Diversion demands for major irrigation districts are derived from annually- and monthly-varying Consumptive Use of Applied Water (CUAW) demand estimates from CALSIM, with operational efficiency estimates derived from Agricultural Water Management Plans (AWMPs), and total diversion and use adjusted for best match to AWMP surface water use data. For smaller diversions, CALSIM values are used.
- The WSE model is calibrated to best match to CALSIM baseline diversions, streamflows, and reservoir levels. This exercise demonstrates the WSE model's effectiveness in representing system dynamics similarly to the CALSIM model.
- The water budget quantities in the WSE model are improved and based on published estimates of reservoir losses, municipal and industrial water use, and other factors described in Appendix F.1. The final WSE baseline used in LSJR alternatives analysis includes all of the above changes, but with additional revisions to improved parameters. This differs slightly from the original CALSIM baseline.
- In some water year types, a portion of LSJR alternative instream flow requirement has been "shifted" outside of the February–June period to summer or fall months to avoid temperature impacts caused by lower reservoir levels and to represent one of the methods of adaptive implementation as described in Chapter 3, *Alternatives Description*.
- Maximum streamflows ("flow caps") in downstream reaches have been removed.

4.2.2 Dry Year Evaluation

The 2012 Draft SED analyzed the effects of the flow proposal over an 82-year period of varied hydrology, which included dry years. It did not, however, specifically identify the water supply effects in dry years and consecutive dry years. This SED includes a new chapter Chapter 21, *Drought*

Evaluation, which provides analyses of dry years and multiple dry years. The drought years during the 1922–2003 time period that were modeled using the WSE model are compared with the more recent period of 2004–2015. This new analysis provides an examination and evaluation of the effects of LSJR Alternatives 2, 3, and 4 on reservoir operations and water supply for the more recent drought years from 2012–2015 to verify that water supply effects of drought conditions were accurately calculated and evaluated by the WSE model. It also includes a comparison of available water supply and other parameters during drought periods under baseline conditions and under LSJR Alternatives 2, 3, and 4.

4.2.3 Antidegradation Analysis

The 2012 Draft SED did not contain an antidegradation analysis. This SED contains an antidegradation analysis in Chapter 23, *Antidegradation Analysis*. The antidegradation analysis evaluates LSJR Alternative 3 and unimpaired flows ranging from 20 percent to 60 percent, and SDWQ Alternative 2 to assess the effect of the alternatives on water quality.

4.2.4 Fish Benefits Analyses

This recirculated SED includes Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30*, which is intended to assist the public with understanding the expected benefits of the LSJR alternatives to native fish. The chapter describes biologically important and measurable benefits of providing higher and more variable flow during the February 1–June 30 time period, with a focus on improved water temperature conditions and enhanced floodplain inundation. The chapter also presents results from a life-history population simulation model (SalSim) for fall-run Chinook salmon originating from the LSJR and the three eastside tributaries[4] to provide insight into population level changes that could be expected under a variety of flow conditions. These new analyses document the ecological linkages between flow, temperature, habitat, and other important criteria for evaluating the expected biological benefits over a range of percent of unimpaired flows encompassed by LSJR Alternatives 2, 3, and 4. The results of the temperature, floodplain, and SalSim evaluations indicate that as the percentage of unimpaired flow increases during the February–June time period, habitat conditions important to native fish can improve dramatically, and the number of adult salmon produced by the the three eastside tributaries would be expected to increase substantially compared to baseline conditions during the time period of 1994–2010.

The fish benefits analyses in Chapter 19 includes the following.

- Discussion of the importance of temperature for key fish species and their lifestages.
- A temperature analysis using San Joaquin River Basin-Wide Water Temperature Model for LSJR Alternatives 2, 3, and 4.
- Discussion of natural flow variation and floodplain inundation for key fish species and their lifestages and a floodplain analysis using the WSE model and floodplain area-versus-flow relationships to evaluate changes in frequency and magnitude of floodplain inundation events for LSJR Alternatives 2, 3, and 4.

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

- SalSim analysis using WSE model results and temperature model results as input to explore and compare a variety of flow scenarios, including LSJR Alternatives 2, 3, and 4, in terms of modeled population-level responses of fall-run Chinook salmon from the Stanislaus, Tuolumne, and Merced Rivers.
- Discussion of the other expected benefits to native fish and wildlife.

4.2.5 Fish Impact Analyses

In response to comments on the 2012 Draft SED, Chapter 7, *Aquatic Biological Resources*, now analyzes flow impacts (e.g., cumulative distributions of weighted usable area values) based on changes in the magnitude and frequency of modeled flows over the 82-year modeling period instead of using median flows. It also includes a qualitative discussion regarding other fish species and incorporates Instream Flow Incremental Metholology and predation information where appropriate.

4.2.6 Groundwater Effects and Agricultural Resource Modeling

The analysis in the 2012 Draft SED did not attempt to quantify how much of the surface water supply deficit under the LSJR alternatives would be replaced by groundwater supplies. Instead, the 2012 Draft SED analyzed both full replacement by groundwater and no replacement, thereby accounting for the range of possible effects. As described in Appendix G, *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, this recirculated SED now evaluates the likely levels of groundwater replacement, surface water storage and reservoir reoperation, and quantity of surface water deficit not replaced by additional groundwater pumping. This updated analysis relies on new information provided by the water districts and is reflective of additional groundwater pumping capacity developed during recent drought years. Although this approach is intended to reasonably identify the most likely balance between water supply deficit and additional groundwater pumping, the precise balance is unknowable. The updated results from the groundwater pumping analysis are used in Chapter 9, *Groundwater Resources,* Chapter 13*, Service Providers,* and Chapter 22*, Integrated Discussion of Potential Municipal and Domestic Water Supply Management Options.*

This recirculated SED also uses the Statewide Agricultural Production (SWAP) model to perform an agricultural economic analysis. SWAP, an agricultural production model, is used to estimate the direct revenue and crop production effects associated with changes in applied water for agriculture, which is similar to how it was used in the 2012 Draft SED. However, as described in Appendix G, the results of the WSE model are post-processed differently, and the geographic boundaries for the SWAP analysis differ from the 2012 Draft SED. The geographic boundaries used in the SWAP modeling were refined from the 2012 Draft SED to include six geographic areas representing the different irrigation districts that could be most affected by the LSJR alternatives, rather than one aggregated region. Estimates of applied water are determined based on surface water diversions calculated in the WSE model and on groundwater pumping to replace surface water deficit calculated in the groundwater analysis. The applied water estimates are used, along with crop distributions from the California Department of Water Resources (DWR), as inputs for SWAP to estimate agricultural production and associated revenues under baseline conditions and LSJR Alternatives 2, 3, and 4. The changes to the agricultural economics analysis and the additional inputs to the SWAP model provide a more refined analysis, while taking into account potential groundwater pumping.

4.2.7 City and County of San Francisco Water Operations and Supply Analyses

The 2012 Draft SED contained a limited evaluation of the City and County of San Francisco (CCSF) water operations and supply. This SED includes additional analyses to address potential impacts on CCSF in Appendix L, *City and County of San Francisco Analyses,* Chapter 13, *Service Providers*, and Chapter 16, *Evaluation of Other Indirect and Additional Actions*. This appendix and these chapters generally describe how CCSF's water supply could be affected by the flow objectives; quantifies potential water supply effects on CCSF ; describes water transfers and other actions CCSF could take to meet water supply demand if water supplies are reduced; and summarizes the potential economic effects of water supply changes associated with a water transfer.

4.2.8 Effects of the Flow Proposal on Municipal Water Supplies

This SED includes a new chapter, Chapter 22, *Integrated Discussion of Potential Municipal and Domestic Water Supply Management Options*, summarizing the overall effect the project is expected to have on drinking water. This new chapter synthesizes information from other resource chapters, including Chapter 2, *Water Resources*, Chapter 9, *Groundwater Resources*, Chapter 13, *Service Providers*, and Chapter 21, *Drought Evaluation*, in order to provide an integrated discussion of how drinking water supplies would be affected by the plan amendments[5]. The chapter discusses both the initial effects and the potential long-term changes that could occur when SGMA is fully implemented.

4.2.9 Economic Analyses

Chapter 20, *Economic Analyses*, of this recirculated SED summarizes the economic effects associated with the LSJR Alternatives 2, 3, and 4 and SDWQ Alternatives 2 and 3. The information in Chapter 20 is derived from various locations in this SED, including: Chapter 10, *Recreational Resources and Aesthetics*; Chapter 13, *Service Providers*; Chapter 16, *Evaluation of Other Indirect and Additional Actions;* Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30*; Appendix G, *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results;* and, Appendix L, *City and County of San Francisco Analyses*. Chapter 20 (as well as the other chapters and appendices that it relies on) contains the following new analyses that were not included in the 2012 Draft SED.

- Fiscal analysis associated with regional agricultural effects under the LSJR alternatives.
- Cost evaluation of municipal and industrial water supplies and affected regional economies under the LSJR alternatives.
- Cost evaluation of additional actions (e.g., non-flow measures[6]) under the LSJR alternatives.

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

[6] Depending on the context, the terms *non-flow measures* and *non-flow actions* may be used interchangeably in this document.

- Evaluation of potential use and non-use benefits associated with supporting and maintaining sustainable Chinook salmon populations in the three eastside tributaries under the LSJR alternatives.
- Regional economic analyses for CCSF under the LSJR alternatives using Impact Analysis for Planning (IMPLAN).

In addition, the agricultural economic analysis was refined using IMPLAN model multipliers to estimate total (direct, indirect, and induced) economic impacts on employment and regional economic output associated with changes in agricultural production. The discussion describes the effects on all inter-connected sectors of the regional economy.

4.2.10 Plan Area

The plan area and extended plan area are described in Chapter 1, *Introduction*. The plan area encompasses the areas where the proposed plan amendments apply to protect the beneficial uses. In addition to the implementation of the plan amendments in the plan area, implementation of the plan amendments also has the potential to affect the Stanislaus, Tuolumne, and Merced River Watersheds above the rim dams.[7] These areas are referred to as the extended plan area.

Impacts in the extended plan area are addressed in the SED as appropriate. As explained in Chapter 5, *Surface Hydrology and Water Quality*, given the small volume of water held in non-hydropower post-1914 rights for consumptive use in the extended plan area compared to the volume held in non-hydropower post-1914 water rights used below the rim dams, most of the effect of implementing LSJR alternatives would occur at, or downstream of, the major rim dams in the three tributaries. As such, the overall analysis of impacts in the SED focuses on the plan area, downstream of the rim dams, where the flow objectives would be implemented at the confluence of the Stanislaus, Tuolumne, and Merced Rivers. The primary means by which the extended plan area reservoirs and rivers might be affected is if water is bypassed by junior water rights holders, in accordance with the rules of priority and applicable law, to achieve the required flows in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR.

The impacts of reduced water diversions, reduced reservoir levels, and additional flow to rivers that could occur in the extended plan area under LSJR Alternatives 2, 3, and 4 are qualitatively evaluated. The analysis of the extended plan area generally identifies how the impacts may be similar or different to the impacts in the plan area (i.e., downstream of the rim dams) depending on the similarity of the impact mechanism (e.g., changes in reservoir levels, reduced water diversions, and additional flow in the rivers) or location of potential impacts in the extended plan area. The extended plan area impacts are primarily discussed in Chapters 5–14 and Appendix B, *State Water Board's Environmental Checklist*. Table 18-2 summarizes any differences between the impact determinations in the plan area and extended plan area.

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

4.2.11 Alternatives, Adaptive Implementation, and Analysis

The State Water Board has revised the proposed plan amendments in Appendix K, in *Revised Water Quality Control Plan.* Chapter 3, *Alternatives Description*, describes LSJR Alternatives 2, 3, and 4, and SDWQ Alternatives 2 and 3. This SED has been revised to evaluate the impacts of the revised alternatives. Major changes with respect to the SED regarding the revised alternatives are discussed below.

Preferred Alternative

The evaluation of the preferred alternatives was included in Chapter 20, *Preferred LSJR Alternative and SDWQ Alternative* of the 2012 Draft SED. This chapter has been eliminated. The different alternatives are evaluated in a manner to inform the decision makers and the public about the effects associated with each alternative.

No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)

The metrics and criteria used to evaluate the No Project Alternative are changed to be consistent or similar to those used in Chapters 5–14. In addition, where necessary, the analysis references the different LSJR alternatives to provide comparisons to what would occur if an LSJR alternative was not selected.

LSJR Flow Objectives

This SED evaluates four alternatives for LSJR flows during the February–June time frame, including the No Project Alternative (LSJR Alternative 1), and three other LSJR alternatives (LSJR Alternatives 2, 3, and 4). Each of the LSJR alternatives includes an unimpaired flow range (e.g., 30 percent to 50 percent under LSJR Alternative 3), and the ability to adaptively manage flows within this range. LSJR Alternative 2, 3, and 4 also include common elements, such as a the minimum base flow requirement at Vernalis and the monitoring and reporting program, which are discussed in more detail in Chapter 3, *Alternatives Description.*

The program of implementation for LSJR Alternatives 2, 3, and 4 includes adaptive implementation that allows adaptive adjustments to the flow requirements, such as the magnitude and timing of flows, if information produced through monitoring and review processes, or other best scientific information supports that such changes would be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta and meet any existing biological goals approved by the State Water Board. Adaptive implementation could optimize flows to achieve the flow objectives while allowing for consideration of other beneficial uses, such as agricultural, municipal, and recreational uses, provided that these other considerations do not reduce intended benefits to fish and wildlife.

Four different methods of adaptive implementation are analyzed under each LSJR alternative. In general, the methods are as follows: method 1, adjusting the required percent of unimpaired flow within the approved range (e.g., increasing or decreasing the percent of unimpaired flow required by 10 percent depending on the LSJR alternative selected); method 2, managing the required percent of unimpaired flow for February–June as a total volume of water; method 3, allowing a portion of the required unimpaired flow to be shifted outside of February–June, depending on the

LSJR alternative selected; and method 4, allowing adjustments in base flow for February–June in the SJR at Vernalis.

While adaptive implementation is a part of LSJR Alternatives 2, 3, and 4, this SED provides an analysis of these alternatives with and without adaptive implementation. This is because adaptive implementation may take place on either a short-term (e.g., monthly or annually) or a longer-term basis, depending on the method, and would require the coordination, and cooperation stakeholders or the State Water Board. It is also possible that, at times, adaptive implementation would not occur. As such, the frequency, duration, and extent to which adaptive implementation would be used, if at all, within a year or between years under each LSJR alternative is unknown. The analysis, therefore, discloses the full range of impacts that could occur under an LSJR alternative, from no adaptive implementation to full adaptive implementation.

The methodology sections in the chapters summarize the four methods of adaptive implementation and describe how they are analyzed. Impacts are generally assessed by comparing the baseline flow results with the results for LSJR Alternatives 2, 3, and 4. Typically, the quantitative results included in the figures, tables, and text of the chapters present WSE modeling of the specified unimpaired flow requirement for each LSJR alternative (i.e., 20, 40, or 60 percent). Most chapters incorporate a qualitative discussion of adaptive implementation under each of the LSJR alternatives that includes the potential environmental effects associated with adaptive implementation. To inform the qualitative discussion and account for the variability allowed by adaptive implementation, modeling was performed to predict conditions at 30 percent and 50 percent of unimpaired flow (as reported in Appendix F.1). The modeling also allows some inflows to be retained in the reservoirs until after June, as could occur under adaptive implementation method 3, to prevent adverse temperature effects to fish. This variety of modeling scenarios provides information to support the analysis and evaluation of the effects of the alternatives and adaptive implementation. However, some chapters (i.e., Chapter 5, *Surface Hydrology and Water Quality*; Chapter 9, *Groundwater Resources*; Chapter 10, *Recreational Resources and Aesthetics*; Chapter 13*, Service Providers*, and Chapter 14, *Energy and Greenhouse Gases*) provide a more quantitative discussion of adaptive implementation by evaluating modeling results at either 30 percent or 50 percent unimpaired flow, or both. Most of the significant impacts at the 40 percent or 60 percent unimpaired flow are also significant at 30 percent or 50 percent unimpaired flow, respectively. While the impact determination may not change, there may be a slight change to the magnitude of the impact (less severe as the required percent of unimpaired flow decreases), which is described where necessary. Because the analysis includes a wide range of unimpaired flows for each of the LSJR alternatives with adaptive implementation, the analysis inherently covers the different mixes of adaptive implementation methods 1, 2, 3, and 4 that could occur.

Baseline

As described in Section 4.2.1, *Hydrologic Modeling,* the WSE model now represents both baseline and LSJR alternative conditions, whereas previously, in the 2012 Draft SED, CALSIM provided the baseline condition. Section 4.7, *Baseline*, describes the characterization of baseline.

Methods of Compliance and Other Indirect and Additional Actions

The 2012 Draft SED evaluated different methods of compliance in Appendix H, *Supporting Materials for Chapter 16*. This SED modifies the discussion of the methods of compliance for LSJR Alternatives 2, 3, and 4. It also expands the discussion to include other indirect and additional actions that could be undertaken by the regulated community. The methods of compliance evaluated for the LSJR alternatives include the methods listed below.

- Releasing or bypassing flow at existing reservoir or at existing diversion points—flows being released into the rivers to meet the unimpaired flows as defined by the LSJR alternatives with or without adaptive implementation.
- Reoperating reservoirs—modifying reservoir operations to meet the unimpaired flows as defined by the LSJR alternatives with or without adaptive implementation.
- Reducing surface water diversions—reducing surface water diversions to allow for the release or bypass of flows or reoperation of reservoirs meet the unimpaired flows as defined by the LSJR alternatives with or without adaptive implementation.

The State Water Board also provides an evaluation of other actions associated with LSJR Alternatives 2, 3, and 4. These include different actions that the regulated community could take to reduce potential reservoir or water supply effects associated with implementing LSJR Alternatives 2, 3, and 4. These actions are evaluated in Chapter 9, *Groundwater Resources*, Chapter 11, *Agricultural Resources*, Chapter 13, *Service Providers*, Chapter 14, *Energy and Greenhouse Gases*, and Chapter 16, *Evaluation of Other Indirect and Additional Actions*, as well as Appendix H, *Supporting Materials for Chapter 16*, and Appendix L, *City and County of San Francisco Analyses*. There are also additional actions (i.e., non-flow measures) that would inform the body of scientific information used to make adaptive implementation decisions under LSJR Alternatives 2, 3, and 4; these are evaluated in Chapter 16, *Evaluation of Other Indirect and Additional Actions.* The other actions are listed below.

- Transfer or sale of surface water.
- Substitution of surface water with groundwater.
- Aquifer storage and recovery.
- Recycled water sources for water supply.
- In-Delta diversions.
- Water supply desalination.
- New surface water supplies.
- Floodplain and riparian habitat restoration.
- Reduce vegetation-disturbing activities in floodplains and floodways.
- Gravel augmentation.
- Enhanced in-channel complexity.
- Improve temperature conditions.
- Fish passage—fish screens (screen unscreened diversions in tributaries and LSJR).
- Fish passage—physical barrier in the southern Delta.
- Fish passage—human-made barriers to fish migration.
- Predatory fish control.
- Invasive aquatic vegetation control.

Cumulative Analysis

Cumulative impacts are analyzed in this SED in Chapter 15, *No Project Alternative* (*LSJR Alternative 1 and SDWQ Alternative 1)*, for the No Project Alternative, Chapter 16, *Evaluation of Other Indirect and Additional Actions*, and in Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*.

4.3 Analytical Framework

This section describes the analytical framework in this SED used to evaluate the environmental impacts of the LSJR and SDWQ alternatives, as well as economic effects, benefits to fish, and other considerations.

This SED evaluates the potentially significant environmental impacts associated with the LSJR and SDWQ alternatives. The assessment of environmental effects in this SED was conducted at a programmatic level, which is a broader level than a project-specific analysis. The State Water Board's adoption of amendments to the 2006 Bay-Delta Plan will not result in direct physical changes in the environment. Rather, it is through the implementation of the Bay-Delta Plan that physical changes in the environment potentially may occur. Accordingly, all potential environmental effects evaluated in this SED are indirect effects associated with implementation, which would occur later in time and would be subject to project-specific environmental review, in compliance with CEQA.

The evaluation of the impacts of the LSJR and SDWQ alternatives on particular resources is contained in Chapters 5–18 and Appendix B, *State Water Board's Environmental Checklist*. Appendix B is based on the template contained in Appendix A of the State Water Board's CEQA regulations. (Cal. Code Regs., tit. 23, §§ 3720–3781.)

As required by Public Resources Code Section 21159 and the State Water Board's regulations (Cal. Code Regs., tit. 23, § 3777), this SED evaluates the environmental impacts related to reasonably foreseeable methods of compliance with plan amendments. It programmatically evaluates indirect actions and additional actions, including reasonably foreseeable methods of compliance, in Chapters 5–16. Chapter 16, *Evaluation of Other Indirect and Additional Actions,* augments the analyses in the preceding chapters to include an evaluation of the methods of compliance for the SDWQ alternatives. Chapter 16 also evaluates indirect actions that the regulated community may take in response to complying with the LSJR alternatives, such as transferring or selling surface water, substituting surface water with groundwater, practicing aquifer storage and recovery, recycling water sources for water supply, diverting in-Delta water, desalinating for water supply, and utilizing new surface water supplies.

In addition, this SED contains additional information, including economic information, to support evaluations such as those under Public Resources Code, Section 21159 and the Porter-Cologne Water Quality Control Act. (Wat. Code, § 13000 et seq.) For example, Water Code Section 13141 requires an estimate of total cost of an agricultural water quality control program before implementing such a program. This information can be found in Chapter 16, *Evaluation of Other Indirect and Additional Actions*, and Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, which provides an evaluation of the agriculture economic-related effects of reduced surface water diversions. Because the State

Water Board wishes to understand the water supply effects associated with LSJR Alternatives 2, 3, and 4, this SED also evaluates the related indirect and induced effects on the regional economy. Chapter 20, *Economic Analyses*, provides a summary of the economic effects of the LSJR and SDWQ alternatives, methods of compliance, and other indirect and additional actions.

4.3.1 Impacts Associated with LSJR Alternatives

The existing water quality objectives identified in the 2006 Bay-Delta Plan would be amended to protect the beneficial uses of fish and wildlife on the three eastside tributaries and the LSJR. Three of the four LSJR alternatives evaluated in this SED include a narrative and numeric objective to establish flow sufficient to support and maintain the natural production of fish populations in the plan area that mimic the natural hydrograph with respect to relative magnitude, duration, timing, and spatial extent of flows. The LSJR alternatives are as follows.

- LSJR Alternative 1, the No Project Alternative, would continue the flow requirements as established in the 2006 Bay-Delta Plan and implemented through D-1641; this also includes continuation of, and full compliance with, the southern Delta salinity objective as described in SDWQ Alternative 1.
- LSJR Alternative 2 would establish a range between 20 and 30 percent, with 20 percent as the starting percentage of unimpaired flow in the program of implementation.
- LSJR Alternative 3 would establish a range between 30 and 50 percent, with 40 percent as the starting percentage of unimpaired flow in the program of implementation.
- LSJR Alternative 4 would establish a range between 50 and 60 percent, with 60 percent as the starting percentage of unimpaired flow in the program of implementation.

Details of these four LSJR alternatives are provided in Chapter 3, *Alternatives Description*, and the language of the updated 2006 Bay-Delta Plan is included in Appendix K, *Revised Water Quality Control Plan.*

Mechanisms Causing Potential Impacts

The following list summarizes the physical changes that could result from the plan amendments and have the potential for quantifiable impacts on environmental resources.

- River flows—changes in river flows could result in impacts (e.g., reduction in aquatic resource habitat).
- Reservoir operations—changes to reservoir operations could result in impacts.
- Surface water diversions—changes to surface water diversions could result in impacts (e.g., reduction of irrigated agricultural land).
- Groundwater pumping rates—changes to surface water diversions could result in increased groundwater pumping.

The potential environmental impacts of these physical changes are evaluated in Chapters 5–17 of this SED. The agricultural economic effects of surface water diversion reductions are summarized, along with all other economic impacts, in Chapter 20, *Economic Analyses*, and are evaluated in detail in Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*.

Methods of Compliance

The following list summarizes the methods of compliance that could be implemented by irrigation districts or reservoir operators to comply with the LSJR alternatives. The potential environmental impacts of these methods of compliance are evaluated further in Chapters 5–17 of this SED. The agricultural economic effects of surface water diversion reductions are summarized, along with all other economic impacts, in Chapter 20, *Economic Analyses*, and are evaluated in detail in Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*.

- Releasing or bypassing flow at existing reservoir or at existing diversion points—flows being released into the rivers to meet the unimpaired flows as defined by the LSJR alternatives with or without adaptive implementation.
- Reoperating reservoirs—modifying reservoir operations to meet the unimpaired flows as defined by the LSJR alternatives with or without adaptive implementation.
- Reducing surface water diversions—reducing surface water diversions to allow for the release or bypass of flows or reoperation of reservoirs meet the unimpaired flows as defined by the LSJR alternatives with or without adaptive implementation.

Other Indirect and Additional Actions

The following list summarizes the other indirect and additional actions that could be implemented by irrigation districts, water districts, or municipalities to respond to the LSJR alternatives and methods of compliance.

- Transfer/sale of surface water—water transfers or sales between water users.
- Substitution of surface water with groundwater—construction and operation of new groundwater wells.
- Aquifer storage and recovery—increased conjunctive groundwater use by agricultural and municipal and industrial water suppliers.
- Recycled wastewater sources for water supply—construction and operation of new recycled wastewater facilities or increased utilization of existing facilities.
- In-Delta diversions—construction and operation of new in-delta diversion for SFPUC service area.
- Water supply desalination—construction and operation of desalination plant for SFPUC service area.
- New surface water supplies—construction and operation of new surface water reservoirs.
- Floodplain and riparian habitat restoration—actively restoring floodplain or riparian habitat adjacent to rivers by creating or expanding existing natural or engineered floodways or flood bypasses; modifying river or floodplain geometry; planting riparian vegetation; hydrologically reconnecting historic floodplain; or removal or riprap.
- Reduce vegetation-disturbing activities in floodplains and floodways—actions may be included among discretionary or non-discretionary permit conditions, guidelines, or policies governing existing levee and floodway maintenance activities, as well as implementation of floodplain,

floodway, or riparian management and restoration plans in areas adjacent or within the Stanislaus, Tuolumne, and Merced River channels.

- Gravel augmentation—artificially adding spawning-size gravel to streams by adding gravel to streams; modifying river and then adding gravel to streams; or adding larger structures to river to create hydraulic conditions conducive to gravel deposition and retention.
- Enhanced in-channel complexity—placement of large wood or boulder structures in rivers.
- Improve temperature conditions—installation or modification of temperature curtains or shutters in reservoirs.
- Fish passage—fish screens (screen unscreened diversions in tributaries and LSJR)—Screen existing unscreened diversions with different types of screens in accordance with established design, operational, and maintenance criteria and guidelines from wildlife and resource agencies.
- Fish passage—physical barrier in the southern Delta—construction and operation of a permanent operable barrier at the e Head of Old River (HORB) barrier in the Southern Delta.
- Fish passage—human-made barriers to fish migration—feasibility and design studies to explore the feasibility of modifying existing barriers on the three eastside tributaries that restrict fish migration, including trucking and hauling and elevators.
- Predatory fish control—directly remove known predators within the Delta or three eastside tributaries or modify habitat to remove predator habitat.
- Invasive Aquatic Vegetation Control—small scale and large scale applications of herbicides in the Delta and small scale mechanical removal of invasive species in the Delta.

A site-specific, project-level analysis of these actions is not possible due to uncertainty about timing, duration, and magnitude of the actions. Therefore, a conceptual environmental evaluation and cost evaluation are provided primarily in Chapter 16, *Evaluation of Other Indirect and Additional Actions*. Chapter 9, *Groundwater Resources*; Chapter 11, *Agricultural Resources*; Chapter 13, *Service Providers*; Chapter 14, *Energy and Greenhouse Gases*, as well as Appendix H, *Supporting Materials for Chapter 16*, and Appendix L, *City and County of San Francisco Analyses* also provide some evaluation. Cost evaluations associated with these actions are summarized with all other economic impacts in Chapter 20, *Economic Analyses*, and Appendix L, *City and County of San Francisco Analyses*. Many of the actions described above may require permits or other approvals from other agencies prior to implementation. Their inclusion in this SED does not equate to an expression of jurisdiction over, or approval by, the State Water Board.

4.3.2 Impacts Associated with SDWQ Alternatives

The SDWQ alternatives would amend the existing water quality objectives for salinity identified in the 2006 Bay-Delta Plan to protect agricultural beneficial uses in the southern Delta. The alternatives evaluated in this SED are listed below.

- SDWQ Alternative 1, the No Project Alternative, would continue the existing salinity (electrical conductivity [EC][8]) objective as 1.0 deciSiemens per meter (dS/m) September–March and 0.7 dS/m April–August in the southern Delta; include continued conditioning of the DWR's and USBR water rights to meet the objectives at certain locations.
- SDWQ Alternative 2 would establish a numeric salinity objective of 1.0 dS/m as a maximum 30-day running average of mean daily EC for all months in the SJR in the southern Delta. Compliance will be assessed within the following river segments: between Vernalis and Brandt Bridge, Middle River from Old River to Victoria Canal, and Old River/Grant Line Canal from the Head of Old River to West Canal. The SJR at Airport Way Bridge near Vernalis compliance location would not change. Revised D-1641 imposes conditions on USBR's water rights requiring implementation of EC levels of 0.7 mmhos/cm from April–August and 1.0 mmhos/cm from September–March at Vernalis (units of mmhos/cm are equal to units of dS/m). USBR would continue to be required to comply with these salinity levels, as a condition of their water rights, in order to implement and meet the proposed salinity water quality objectives in the interior southern Delta.
- SDWQ Alternative 3 is similar to SDWQ Alternative 2 but would establish a salinity objective of 1.4 dS/m maximum 30-day running average of mean daily EC for all months for the southern Delta and include continued conditioning of USBR water rights to meet its current salinity D-1641 compliance requirement at Vernalis. The compliance locations and all other provisions of SDWQ Alternative 3 are the same as for SDWQ Alternative 2.

Details of these three SDWQ alternatives are provided in Chapter 3, *Alternatives Description*, and the language of the amended Bay-Delta Plan is included in Appendix K, *Revised Water Quality Control Plan.*

Mechanisms Causing Potential Impacts

The following summarizes the physical changes that could result from the SDWQ alternatives and have the potential for impacts on environmental resources and the economy.

- EC/salinity concentrations—changes in surface water EC resulting from the LSJR or SDWQ alternatives could result in impacts.

The potential environmental impacts of these physical changes are evaluated in Chapters 5–17 of this SED. The associated economic impacts were evaluated and summarized together with all other economic impacts in Chapter 20, *Economic Analyses.*

Methods of Compliance

The following summarizes the potential methods of compliance that could be implemented by municipalities, agricultural producers, and the CVP and SWP to comply with the SDWQ alternatives. A site-specific, project-level analysis of these potential methods of compliance is not possible due to uncertainty about which actions would be taken, and the timing, duration, and magnitude of the

[8] In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

actions. Therefore, a conceptual environmental evaluation of these methods of compliance and a cost evaluation of each are provided in Chapter 16, *Evaluation of Other Indirect and Additional Actions*. Economic impacts associated with these methods of compliance are summarized with all other economic impacts in Chapter 20, *Economic Analyses*. Many of the actions described below may require permits or other approvals from other agencies prior to implementation, and their inclusion in this SED does not equate to an expression of jurisdiction over, or approval by, the State Water Board.

Municipal Wastewater Treatment Plants

Although other actions could be undertaken, it is reasonably foreseeable that municipalities would take one or more of the following actions to comply with ~~National Pollutant Discharge Elimination System (NPDES) effluent limits established by the Central Valley Regional Water Quality Control Board (Central Valley Water Board), which would use the numeric salinity objectives in~~ the SDWQ alternatives.

- New source water supplies—develop and utilize alternate low-salinity municipal water supplies.
- Salinity pretreatment programs—implement industrial and residential salinity source controls.

~~Desalination—construct and operate salinity removal facilities at municipal wastewater treatment plants.~~Appendix K provides that reverse osmosis treatment for municipal wastewater treatment plants' (WWTPs') wastewater discharges into the southern Delta is not currently a feasible technology to control salinity in the Delta for the reasons given therein. WWTPs are, however, required to evaluate whether technological or economic changes have made previously deemed infeasible upgrades to control salinity in the WWTP effluent feasible. Appendix K states that where it is feasible for a WWTP to comply with traditional numeric water quality based effluent limitations for salts in the southern Delta, the Regional Water Board shall require them in the applicable NPDES permit. In that event, the WWTP may take the following action:

- Desalination—construct and operate salinity removal facilities at municipal wastewater treatment plants.

Agricultural Producers

Although other actions could be undertaken, it is reasonably foreseeable that drainage districts and/or farmers would take the following action to control salinity loads in agricultural return flows to comply with salinity load allocations.

- Real-time management—Shift the agricultural discharge timing such that the agricultural return flow released from agricultural lands would occur during times of high assimilative capacity for the receiving waters. This would require the construction and operation of detention ponds.

CVP and SWP

Although they could undertake other actions, it is reasonably foreseeable that DWR for SWP operations and USBR for CVP operations would take the following actions to comply with the water level and flow conditions of the SDWQ alternatives in the event that such modifications are warranted.

- Continuation of the Temporary Barriers Program—continuation of the existing program of four temporary barriers (three for agriculture, one for fish) for an unknown duration.
- Low-lift pumping stations—construct and operate either temporary or permanent pumping system(s) near the Middle River, Grant Line Canal, and/or Old River at Tracy Temporary Barriers Project in the southern Delta.

4.4 Chapter Organization

This section describes how the chapters in this SED are organized, the type of information they contain, and where information can be found.

4.4.1 Resource Chapters

The discussion in Chapters 5–14 is divided into several parts, including an introduction, a description of the environmental and regulatory setting, and analysis of environmental impacts.

Introduction

The introduction provides an overview of the existing environmental setting and impacts evaluated for the resource. A summary of the impacts on the resource is presented in a table at the end of the introduction. These tables provide each impact statement for the resource, summarize the impacts and their levels of significance in relation to each of the LSJR or SDWQ alternatives, and identify the significance determination after implementation of all feasible mitigation. This information is also summarized in Chapter 18, *Summary of Impacts and Comparison of Alternatives*, Tables 18-1, 18-2, and 18-3.

Environmental Setting

The environmental setting section provides a historical perspective and a detailed description of the current conditions for the resource. This section also presents specific baseline information, including information obtained from published environmental documentation, books, websites, research and journal articles, and personal communications with field experts.

Regulatory Background

The regulatory background section lists and describes laws, regulations, and policies that are relevant to the State Water Board's plan amendments, the assessment of impacts, or development of mitigation. Often, as in aquatic or terrestrial biological resources, the regulatory framework is the basis for the conclusion of the level of significance and, therefore, plays a role in impact assessment.

Environmental Impacts

A reasonable range of alternatives are evaluated in this SED to show differences in environmental consequences of the alternatives. The alternatives are feasible and satisfy the objectives and goals of amending the 2006 Bay-Delta Plan. This SED analyzes all alternatives identified in Chapter 3, *Alternatives Description*.

Thresholds

The thresholds section describes thresholds of significance used for the resource to determine the significance of impacts as required in an SED.

Methods and Approach

The methods and approach section in the resource chapters describes the resource-specific assessment methods, approach, and analytical models used to identify and evaluate the environmental impacts for the resource. It also describes any specific significance criteria used in the assessments to determine the level of significance of an impact. It also describes how the four methods of adaptive implementation are integrated into the analysis of the resource and what information is used to evaluate adaptive implementation.

Mitigation Measures

An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777 (b)(d).) Feasible mitigation measures are intended to avoid, reduce, or compensate for adverse impacts on a resource. For each impact identified as significant, a mitigation measure to reduce that impact to a less-than-significant level is described, if appropriate, or the infeasibility of mitigation is discussed.

4.4.2 No Project Alternative Impacts

Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)* and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, discuss the No Project Alternative. As State CEQA Guidelines Section 15126.6(e)(3)(A) states, "when the project is revision of an existing regulatory plan ... the 'no project' alternative will be the continuation of the existing plan ... into the future." The No Project Alternative represents the likely future conditions without adoption and implementation of the flow or salinity amendments to the 2006 Bay-Delta Plan. The No Project Alternative assumes continued implementation of the 2006 Bay-Delta Plan, which includes flow objectives implemented through D-1641 and flow objectives to comply with the salinity objective for the SJR at Vernalis and the three interior compliance stations (Brandt Bridge on the SJR, Old River near Middle River, and Old River at Tracy Road Bridge). Chapter 15 describes LSJR Alternative 1 and SDWQ Alternative 1, summarizes technical results, and describes the environmental impacts of LSJR Alternative 1 and SDWQ Alternative 1. Appendix D presents the technical assumptions for the No Project Alternative. Because the No Project Alternative is discussed in Chapter 15 and Appendix D, any reference to LSJR alternatives or SDWQ alternatives in Chapters 5–14 refers to LSJR Alternatives 2, 3, or 4, or SDWQ Alternatives 2 and 3, respectively.

4.4.3 Evaluation of Other Indirect and Additional Actions

Chapter 16, *Evaluation of Other Indirect and Additional Actions*, discusses those other indirect and additional actions that could occur under the LSJR alternatives and the methods of compliance that could occur under the SDWQ alternatives, as described below.

LSJR Alternatives

Chapter 16 describes actions that the regulated community could take to reduce potential reservoir or water supply effects associated with implementing LSJR Alternatives 2, 3, and 4. The cost and potential environmental effects of these actions are programmatically evaluated in this chapter using reference projects, standard assumptions regarding the type and potential location of these measures, and impact mechanisms likely to occur under these activities. Potential mitigation measures are proposed for those actions that may have potentially significant environmental impacts.

- Transfer/sale of surface water.
- Substitution of surface water with groundwater.
- Aquifer storage and recovery.
- Recycled water sources for water supply.
- In-Delta diversions.
- Water supply desalination.
- New surface water supplies.

Chapter 16 also describes actions that would inform the body of scientific information potentially used to make adaptive implementation decisions under LSJR Alternatives 2, 3, and 4 (i.e., non-flow actions).The cost and potential environmental effects of non-flow actions are programmatically evaluated using reference projects, standard assumptions regarding the type and potential location of these actions, and impact mechanisms likely to occur under these actions. The non-flow actions are listed below. Potential mitigation measures are proposed for those actions that may have potentially significant environmental impacts.

- Floodplain and riparian habitat restoration.
- Reduce vegetation-disturbing activities in floodplains and floodways.
- Gravel augmentation.
- Enhanced in-channel complexity.
- Improve temperature conditions.
- Fish passage—fish screens (screen unscreened diversions in tributaries and LSJR).
- Fish passage—physical and non-physical barriers in the southern Delta.
- Fish passage—human-made barriers to fish migration.
- Predatory fish control.
- Invasive species control (i.e., plant control).

SDWQ Alternatives

Chapter 16 also describes the methods of compliance that could be undertaken by the regulated community to comply with the SDWQ alternatives. The cost and potential environmental effects of these methods of compliance are programmatically evaluated using reference projects, standard assumptions regarding the type and potential location of these measures, and impact mechanisms likely to occur under these measures. The methods of compliance are listed below. Potential mitigation measures are proposed for those that may have potentially significant environmental impacts.

- New source water supplies.
- Salinity pretreatment programs.
- Desalination.
- Agricultural return flow salinity control.
- Southern Delta temporary barriers.
- Low-lift pumping stations.

Finally, Chapter 16 provides a brief summary of the federal and state sources of funding that could be used for those actions that could occur under the LSJR or SDWQ alternatives.

4.4.4 Cumulative and Growth-Inducing Impacts

Cumulative impacts are analyzed in this SED in Chapter 15, *No Project Alternative* (*LSJR Alternative 1 and SDWQ Alternative 1)*, Chapter 16, *Evaluation of Other Indirect and Additional Actions*, and in Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*.

4.5 Terminology

The following terms are used in this SED.

- No impact: No adverse changes in the environment are expected.
- Less-than-significant impact: The alternative would not result in a substantial adverse change in the environment (i.e., the impact would not reach the threshold of significance). Mitigation is not required.
- Significant: The alternative would result in a substantial, or potentially substantial, adverse change in the environment (i.e., the impact exceeds the applicable significance threshold established by the State Water Board). Mitigation measures or alternatives to the project must be provided, if feasible, in an attempt to reduce or avoid significant impacts.
- Significant and unavoidable: The alternative would result in a substantial adverse change in the environment, and there are no feasible alternatives or mitigation measures that would substantially lessen the impact to a less-than-significant level.
- Mitigation: Mitigation refers to measures that would be implemented to avoid or lessen potentially significant impacts. Mitigation measures would be proposed as a condition of plan approval and would be monitored to ensure compliance and implementation. Mitigation includes the following effects. (Cal. Code Regs., tit. 14, § 15370.)
    - Avoiding the impact altogether by not taking a certain action or parts of an action.
    - Minimizing the impact by limiting the degree or magnitude of the action and its implementation.
    - Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
    - Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.

- Compensating for the impact by replacing or providing substitute resources or environments.

4.6 Scope of Analysis

In developing the scope of the environmental analysis, , the State Water Board considered the potential effects of the proposed plan amendments, comments received in response to the notice of preparation (NOP) and during public consultation, other public comments and information, and the environmental issues identified in Appendix A of the State Water Board's CEQA regulations. (Cal. Code Regs., tit. 23, §§ 3720–3781.) The State Water Board's determinations regarding impacts that are not potentially significant and that are not addressed detail in this SED are explained in Appendix B, *State Water Board's Environmental Checklist*. The following chapters evaluate environmental impacts.

- Chapter 5: *Surface Hydrology and Water Quality*
- Chapter 6: *Flooding, Sediment, and Erosion*
- Chapter 7: *Aquatic Biological Resources*
- Chapter 8: *Terrestrial Biological Resources*
- Chapter 9: *Groundwater Resources*
- Chapter 10: *Recreational Resources and Aesthetics*
- Chapter 11: *Agricultural Resources*
- Chapter 12: *Cultural Resources*
- Chapter 13: *Service Providers*
- Chapter 14: *Energy and Greenhouse Gases*
- Chapter 15: *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*
- Chapter 16: *Evaluation of Other Indirect and Additional Actions*
- Chapter 17: *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*
- Chapter 18: *Summary of Impacts and Comparison of Alternatives*

Each resource chapter describes the criteria or thresholds of significance used to evaluate the environmental impact and the significance determinations.

Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30*, describes biologically important and measurable benefits of providing higher and more variable flow during the February 1–June 30 time period, with a focus on improved water temperature conditions and enhanced floodplain inundation. This chapter is provided to assist the public with understanding the expected benefits of the LSJR alternatives to native fish. It does not evaluate impacts.

Several technical appendices support the analysis in the SED chapters.

- Appendix A: *NOP Scoping and Other Public Meetings*

- Appendix B: *State Water Board's Environmental Checklist*
- Appendix C: *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*
- Appendix D: *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*
- Appendix E: *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*
- Appendix F.1: *Hydrologic and Water Quality Modeling*
- Appendix F.2: *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*
- Appendix G: *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives*
- Appendix H: *Supporting Materials for Chapter 16*
- Appendix I: *Cultural Resources Overview*
- Appendix J: *Hydropower and Electric Grid Analysis of Lower San Joaquin River Flow Alternatives*
- Appendix K: *Revised Water Quality Control Plan*
- Appendix L: *City and County of San Francisco Analyses*
- Appendix M: *Summary of Public Comments on the 2012 Draft SED*

Appendix B, *State Water Board's Environmental Checklist*, also identifies and explains why the alternatives would result in either no impacts or less-than-significant impacts on particular resources.

4.7 Baseline

CEQA requires a description of the physical environmental conditions in the vicinity of the project as they exist at the time the NOP is published (February 13, 2009), or if no NOP is published, at the time environmental analysis is commenced. (Pub. Resources Code, § 15125.) This environmental setting will normally constitute the baseline physical conditions by which a lead agency determines whether an impact is significant. In general, the baseline used in this SED reflects the physical environmental conditions in 2009 as they existed under the 2006 Bay-Delta Plan, as implemented through D-1641. The WSE modeled baseline (as described in Appendix F.1, *Hydrologic and Water Quality Modeling*) allocates flow to comply with the 2006 Bay-Delta Plan flow objectives and other requirements that existed in 2009, including implementation of VAMP (which ended in 2011), the NMFS BO flow requirements on the Stanislaus River, FERC flow requirements on the Tuolumne River and on the Merced River, the Davis-Grunsky Contract between the State of California and Merced Irrigation District, and the Cowell Agreement. The baseline does not include the long-term SJRRP flow requirements, although these conditions are considered in the cumulative impacts analysis. Periodic exceedances of the interior southern Delta salinity objectives occur in the historical record, and likewise remain in the modeled baseline condition.

Each chapter describes the existing environmental conditions relevant to a particular resource. The baseline pertinent to each of the resource areas is included in the environmental setting section of each resource chapter. Below is a description of how different resource parameters may vary over time and how they may be incorporated into baseline conditions.

The environmental conditions in the Bay-Delta and SJR Basin are determined by numerous complex interactions and changing conditions. Defining baseline is challenging in such a variable environment. To take into account natural variability, while still representing shifts that have occurred over time, baseline conditions for surface hydrology, water diversions, water quality, aquatic resources, and other relevant resources are characterized based on recent historical conditions. The recent historical period used in the analysis differs for each resource considered, depending on the availability and suitability of data to represent existing conditions. Since hydrologic conditions vary naturally from year to year, sometimes dramatically, parameters strongly dependent on hydrology, such as water supply, are simulated using the WSE model for the long-term period of record 1922–2003 at the present level of development, an approach derived from CALSIM II, including the assumption that the major reservoirs were in existence for this entire period. Recent data and published reports in combination with WSE model output are also used to estimate baseline conditions for water supply.

Other parameters, such as cultural resources, also change over time but do not exhibit significant annual variability. These types of parameters are defined by the conditions present at the time the NOP was issued. This may be constrained in some instances by data availability; in those instances, the most current readily available information is used. It should be noted that a second NOP was released on April 1, 2011. This SED considers the relevance of changes of information that may have occurred since the issuance of the 2009 NOP, where appropriate.

Regulatory requirements, which may also affect existing conditions (e.g., surface water hydrology), are subject to change. Baseline conditions generally represent long-term flood control, water management, environmental, and other requirements applicable to the major water projects. These requirements are discussed in more detail in each appropriate chapter. Modeling and Technical Analyses

This SED relies on numerous modeling and technical analyses to describe and evaluate baseline conditions and impacts. This section provides a brief overview of the types of modeling and technical analyses performed. It identifies the chapters and appendices that describe this information in more detail and the chapters that primarily use the results of the modeling and technical analysis to determine impacts.

4.8 Modeling and Technical Analysis

4.8.1 Peer-Reviewed Scientific Basis Report

The scientific basis of any statewide plan, basin plan, plan amendment, guideline, policy, or regulation must undergo external peer review before adoption by the state or regional board (Health and Safety Code, § 57004.) State Water Board staff, in accordance with Health and Safety Code Section 57004, submitted a peer review request for the report titled, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow Objectives for the Protection of Fish and Wildlife Beneficial Uses and Water Quality Objectives for the Protection of Southern Delta Agricultural Beneficial Uses and the Program of Implementation for Those Objectives* (included in this document as Appendix C, *Technical Report On The Scientific Basis For Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*). This technical report provides the scientific basis for the LSJR and

SDWQ alternatives. Also included as attachments to Appendix C are the peer reviews and a summary of the State Water Board staff's response.

4.8.2 Hydrologic and Water Quality Modeling

The analysis in this SED relies on the modeling output and results of the State Water Board's WSE model, which is described below. In addition, a temperature model was used to determine temperature changes as a result of the LSJR alternatives.

Water Supply Effects Model

The WSE model is a monthly water balance spreadsheet model based on the CALSIM II analysis framework that calculates for each tributary reductions in water supply diversions and changes in reservoir operations that could occur based upon user-defined diversion and reservoir operating rules, flood storage curves, and minimum river flow requirements, across 82 years of monthly historical watershed hydrology. The model estimates the amount of water available for diversion each year, based on the difference between estimates of available water for the year and the amount needed to satisfy downstream flow and other requirements. Available water is then compared to estimates of demands (primarily agricultural irrigation) for the year, with the lesser determining the amount diverted. The model uses estimates of reservoir inflows, downstream accretions and depletions, and other inputs as developed by DWR and USBR for the CALSIM model.

Appendix F.1, *Hydrologic and Water Quality Modeling*, provides a detailed description of the WSE model and the results from the modeling. Chapter 5, *Surface Hydrology and Water Quality*, also provides a summary of the WSE model and uses the modeling results to establish baseline conditions and analyze LSJR and SDWQ alternative surface hydrology and water quality impacts. Additional chapters, such as Chapter 7, *Aquatic Biological Resources*; Chapter 8, *Terrestrial Biological Resources*; Chapter 10, *Recreational Resources and Aesthetics*; Chapter 11, *Agricultural Resources*; and Chapter 13, *Service Providers*, use the WSE model-predicted river flows and diversion modifications to evaluate impacts on various environmental resources.

Temperature Model

To model effects on temperature in the LSJR and three eastside tributaries, the State Water Board modified the SJR Basin-Wide Water Temperature Model (temperature model), a model using the Hydrologic Water Quality Modeling System (HWMS-HEC5Q), a graphical user interface that employs the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC) flow and water quality simulation model, HEC-5Q. The SJR temperature model was developed by the California Department of Fish and Wildlife (CDFW) and a group of consultants between 2003 and 2013 funded through a series of CALFED Bay-Delta Program contracts that included peer review and refinement (CALFED 2009; CDFW 2013). The temperature model was used to accurately simulate temperature for a range of reservoir operations, river flows, and meteorology. To determine effects of the LSJR alternatives on river temperatures, this model was adapted to run with streamflows from WSE model representations of the alternatives and baseline, with the resulting temperatures compared at key locations along each tributary.

Appendix F.1, *Hydrologic and Water Quality Modeling*, provides a detailed description of the temperature model and the modeling results. Chapter 5, *Surface Hydrology and Water Quality*, also provides a summary and uses modeling results to establish baseline conditions. Chapter 7, *Aquatic*

Biological Resources, uses the temperature results to evaluate impacts on aquatic resources and Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30* to inform the benefits to temperature under the LSJR alternatives.

4.8.3 Agricultural and Economic Modeling

The WSE model estimates the amount of surface water diversion for the LSJR alternatives and baseline for agricultural irrigation across 82 years of historical watershed hydrology. These diversion estimates are used in the SWAP model to estimate the agricultural production and revenues associated with each of the LSJR alternatives and baseline. The SWAP model was selected to estimate the agricultural production (crop acreages) and revenues (total production value) associated with the surface water diversions under the LSJR alternatives and baseline conditions. SWAP is an agricultural production model that simulates the decisions of farmers at a regional level based on principles of economic optimization. The model assumes that farmers maximize profit (revenue minus costs) subject to resource, technical, and market constraints. The model selects those crops, water supplies, and irrigation technology that maximize profit subject to these equations and constraints. The model accounts for land and water availability constraints given a set of factors for production prices and calibrates exactly to observed yearly values of land, labor, water, and supplies use for each region.

The results of SWAP were then used as inputs for IMPLAN. IMPLAN is an input-output multiplier model that considers interrelationships among sectors and institutions in the regional economy. Production in the different economic sectors is simulated in IMPLAN by using fixed factors. The model then applies these factors in a matrix that accounts for changes in transactions between producers and intermediate and final consumers in other sectors of the economy. The IMPLAN approach also considers nonmarket transactions, such as unemployment insurance payments and associated changes in tax revenues for government.

Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, provides a detailed description of SWAP and IMPLAN and their results. Chapter 11, *Agricultural Resources*, and Chapter 20, *Economic Analyses*, use the results of SWAP to analyze potential impacts of the LSJR alternatives on agricultural resources and economics, respectively.

4.8.4 SalSim

SalSim is a life-history population simulation model for fall-run Chinook salmon originating from the Stanislaus, Tuolumne, and Merced Rivers, and is used to evaluate the effects of potential water management scenarios on salmon from these rivers. SalSim was developed by CDFW (2014), and is intended as a user-friendly web-based application. Users can interactively perform simulation runs for different water management scenarios, view results on the screen (GUI output) and download results for further analysis using third party software, such as HEC-DSS (USACE Data System Storage) and Microsoft Excel (via CSV output files). SalSim can also use external data generated by other basin-wide operational and/or water temperature models, such as CALSIM II, the WSE model, and the San Joaquin River Basin-Wide Water Temperature Model (HEC-5Q).

To provide insight into population level changes that could be expected under a variety of unimpaired flows which are being evaluated for this Bay-Delta Plan update, the State Water Board used SalSim to compare effects of unimpaired and baseline flows on fall-run Chinook salmon by evaluating potential changes in annual salmon production. Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30,* describes the SalSim results.

4.8.5 Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta

Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta,* prepared by Dr. Glen Hoffman, describes the scientific literature and information on subjects that impact crop productivity with saline irrigation water and analyzes the existing information from the southern Delta and quantifies how the various factors influencing the use of saline water apply to conditions in the southern Delta.

Information from Appendix E is used to determine potential impacts on agriculture as a result of implementing the SDWQ alternatives in Chapter 11, *Agricultural Resources*.

4.8.6 Hydropower Modeling

To assess the potential impacts of the LSJR alternatives on California's electric grid, the Capacity Reduction Calculation and Power Flow Assessment was used to simulate the operation of the electric grid under peak summer demand conditions. These two technical analyses use the input of the WSE model to determine if hydropower capacity reductions and violations of California's transmission grid would occur. Appendix J, *Hydropower and Electric Grid Analysis of Lower San Joaquin River Flow Alternatives*, describes the methods and results associated with these two analyses. Information from Appendix J is used to determine potential impacts on energy and climate change from implementing the LSJR alternatives in Chapter 14, *Energy and Greenhouse Gases*.

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